

# Natural Jojoba Oil versus Dryness and Free Radicals

Hal C. Purcell, M.D., President, Purcell Natural Jojoba

**N**atural jojoba "oil" is actually an array of esters that can help avoid dryness and lipid peroxidation, two of the most important causes of premature aging of the skin. Attempts to delay the progression of wrinkling, roughness, laxity, dryness and brown spots must include protection against environmental insults that accelerate genetically controlled, chronological aging. For example,

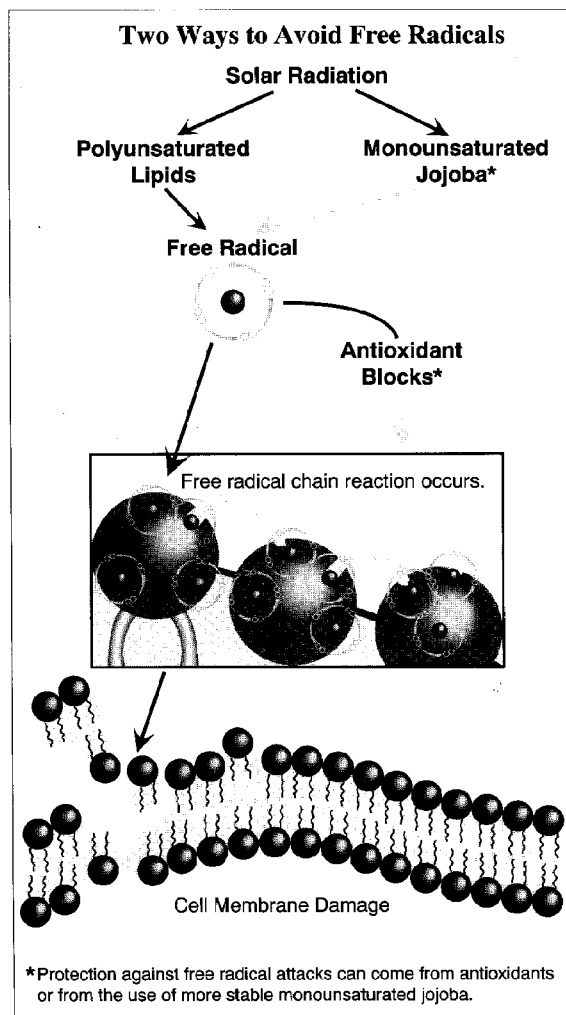
excellent progress has been made using sunblockers to reduce "photoaging". Another example is the avoidance of excessive lipid peroxidation and activated "free radicals", the powerful atomic forces that are closely associated with ripening of fruit, aging of our skin and product rancidity. Also, jojoba's non-occlusive moisture retention keeps cells moist to reduce the dryness and itching that comes with age.

Protection against free radical excesses can come from antioxidants that interrupt the peroxidation... or from the use of more stable materials that are resistant to oxidation. The most stable natural oil-like material available is the unique array of monounsaturated, liquid wax esters called jojoba "oil." Its extraordinary oxidative stability has been well demonstrated by the Active Oxygen Method (AOM) and Rancimat Testing<sup>1,2,3,4</sup>.

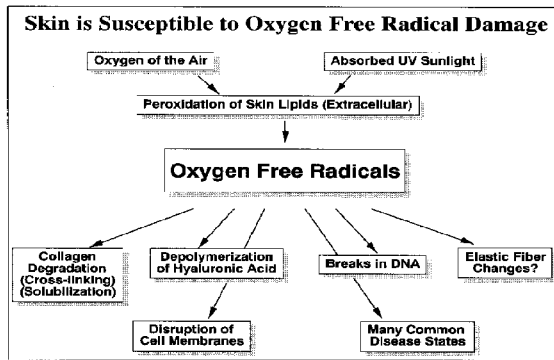
Controlled oxidation to burn fuel (food) for energy is a normal and vital metabolic process that occurs with every breath of air. Uncontrolled chain reactions called peroxidation occur when the body's elaborate antioxidant defenses are depleted. Self-propagating free radical molecules with an odd number of electrons are the byproduct of peroxidation. This autocatalytic chain reaction can be very damaging to living cells and tissues.

A growing body of biological research<sup>5</sup> over the past 20 years strongly implicates free radical build-up in premature aging and at least 60 disease states, including atherosclerosis, cancer and heart disease. Lipids are primary targets of free radicals. The skin surface with its abundant lipids, exposure to solar radiation and constant exposure to oxygen in the air, is particularly vulnerable to attack by free radicals. Studies have shown that lipid peroxide byproducts of oxidation significantly increase on and in the skin with aging or exposure to ultraviolet light.<sup>6,7</sup> It has also been shown that unstable cosmetic ingredients undergo lipid peroxidation on the skin surface.<sup>8</sup>

Free radicals have many damaging effects that contribute to premature aging and cancerous changes of skin. One effect is strong cross-linkage of collagen and an increase in soluble collagen to cause thin inflexible wrinkled skin<sup>9</sup>. Also, free radicals break down of hyaluronic acid diminishes the skin's water holding capacity. Free radicals can attack the vulnerable phospholipids of the cell membranes, thereby gaining access to DNA, increasing the risk of cancer and



**Caption No. 1** Jojoba oil's extreme oxidative stability can help antioxidants avoid tissue damaging lipid peroxidation with its free radicals.



**Caption No. 2** Solar radiation, surface lipids and constant exposure to oxygen make the skin vulnerable to damage from free radical chain reactions.

mutations. The free radical chain reactions initiated by UV-radiation can also damage hair by weakening the tensile strength and breaking cross-linkages of keratin as well as causing alteration in melanin pigments<sup>10,11</sup>.

Traditionally, auto-oxidation of foods and many other products has been controlled with synthetic antioxidants. Some of these synthetics themselves are now coming under attack from various governmental regulatory agencies for other health reasons. Today, chemists are searching for alternative antioxidative methods to



**Caption No. 3** The high-yielding 'Keiko' cultivar tree is shown alongside its namesake, Keiko Purcell, illustrator for this article.

prevent deleterious, autooxidative effects on products.

One alternative way to avoid excessive free radicals is to use more stable ingredients. Jojoba's safety and excellent stability have not gone unnoticed by formulators trying to improve shelf life of products. A Lancôme patent<sup>12</sup> states that jojoba helps to stabilize the highly unstable polyunsaturated GAL (gamma linoleic and linolenic acids) and that by virtue of this remarkable stability to oxidation, it is "not necessary to use antioxidants." In addition to excellent oxidative stability, jojoba has extreme thermal stability, being resistant to flammability up to 338°C.

### Moisturization and Emolliency

Jojoba's excellent, light, non-occlusive, long-lasting emolliency is well recognized. Jojoba oil is used to help prevent moisture loss in hundreds of formulations, including some "oil-free" products. After 10-12 years, L'Oréal and Shiseido continue to use 10% jojoba in their high quality moisturizing lotions. Shiseido Laboratories found that "Jojoba oil gives a unique favorable texture to the skin" and that "unacceptable glare and greasy feel is suppressed."<sup>13</sup> Pola laboratories of Japan concluded from a 1988 study that jojoba spreads well, does not shine, is moist to touch and softens and smoothes skin<sup>14</sup>. Goldemberg compared 85 cosmetic emollients and found jojoba oil to produce "extraordinarily high scores" in a series of tests to determine initial slip and residual skin feel, oiliness, friction, smoothness and moisturizing effect<sup>15</sup>.

The skin is the largest and most visible organ of the human body. It keeps moisture and other vital elements inside and protects us against environmental insults from the outside. As skin care products are applied, they first encounter the thin layer of sebaceous gland excretion, sebum, that coats the stratum corneum. Jojoba is completely miscible (mixes well) with the sebum, which itself consists of 25-30% liquid wax esters<sup>16</sup> very similar to those of jojoba. It is known that sebum is greatly diminished with age, but its function in the skin has not been elucidated. Recent studies of the moisturization mechanism of the eyeball may provide some insight.

Moisture control is essential for the cellular function that keeps our skin supple, smooth and flexible, but in the eye it takes on the added function of corneal clarity for good vision. A material similar to sebum, called meibum excreted from the modified sebaceous glands called Meibomian glands in the eyelids, contains over 50% wax esters. Meibum forms a thin lipid layer in the tear film that helps prevent evaporative moisture loss. Recent studies show that when meibum is deficient the tears evaporate four times faster<sup>17</sup>. The similarity between the wax esters of meibum and jojoba, as well as the comfort and safety of jojoba applied to the eye, has stimulated research with jojoba formulations as meibum substitutes for the perplexing problem of sight-threatening dry eyes.

The skin is more difficult to evaluate than the

transparent cornea of the eye, but the efficacy of ingredients to help maintain functional moisture levels in the skin can be inferred from measurements of softness and suppleness of the skin's surface. One bioengineering technique is to attach a gas-bearing electro-dynamometer to the skin and gently move it 1-2 mm. back and forth to measure skin suppleness, stiffness and compliance. This technique takes into account the status of both the stratum corneum and the dermis. Researchers<sup>13</sup> found that a 10% jojoba in water emulsion increased skin suppleness by 50% within one hour and that after eight hours over half of the effect was still present.

Measurement of Superficial Fine Lines, another test to evaluate moisturizing efficacy, was done by applying pure jojoba to one side of the face of 20 females between 35 and 55 years of age, then having a panel of trained judges count fine lines. The results<sup>19</sup> were a 25% reduction in fine lines after one hour, an 18% reduction after 4 hours and a 12% reduction after 8 hours.

Extensive safety testing of jojoba on skin and eyes has revealed neither acute or chronic toxicity nor irritation<sup>20,21,22</sup>. Jojoba oil-free esters are also non-comedogenic<sup>23,24</sup> and do not support the growth of five common bacteria including *S. aureus*, *Psuedomonas* as well as the fungus, *C. albicans*<sup>25</sup>.

### Jojoba, Unique Natural Botanical Environmentally Friendly

The desert bush-tree *Simmondsia chinensis* (jojoba) evolved over millions of years through many trillions of recombinations of DNA. Man's heritage from jojoba's adaptation to the harsh desert's dry winds and intense solar radiation (52°C.) is an unique array of extremely stable, liquid wax esters called jojoba "oil." Of 300,000 plant species, jojoba is the only known source of significant amounts of liquid wax esters. The seed oil of

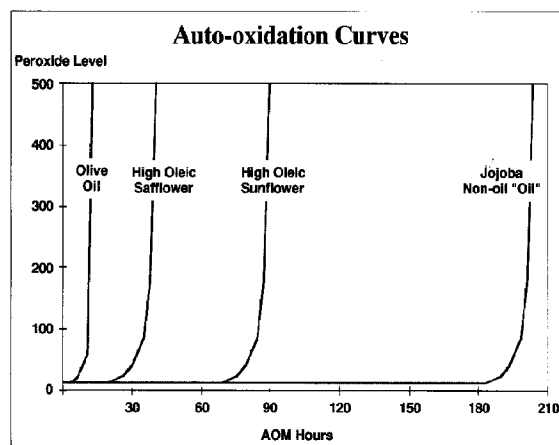
the others is composed of triglycerides that are much more susceptible to oxidation.

The metabolic pathways that have evolved in jojoba plants produce a pure array of liquid wax ester molecules that are 98% cis-monounsaturated at the omega 9 position, i.e. between the 9th and 10th carbon atoms counting from the ends of the molecules.<sup>26</sup> Jojoba's unique configuration and resonance provide an extremely stable natural cosmetic ingredient.

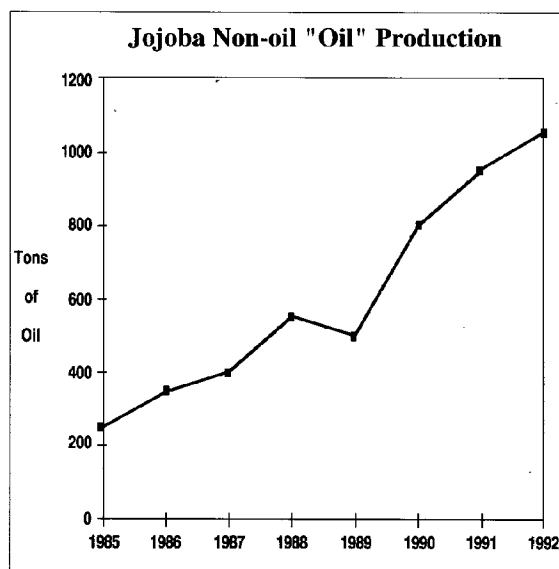
Jojoba is the first native, wild plant successfully domesticated in the United States in over a century. As can be seen in the chart<sup>27</sup>, millions of pounds of jojoba nuts (technically seeds) are now harvested every year from millions of jojoba trees maturing in thousands of acres of orchards in the southwestern United States and other countries. The trees live more than 150 years and yield an annual crop of the nut-sized seeds that contain an average of 50% jojoba oil.

The "natural-green-environmental" phenomena and the declaration of the sperm whale as an endangered species have each contributed to jojoba's increased use and marketing success. The natural segment of the cosmetic industry is growing three times faster than the industry as a whole according to a study by Allan Mottus, a cosmetic industry consultant. Jojoba, a natural by anyone's definition, is also environmentally friendly. Commercial jojoba "oil" production utilizes the plant's intricate enzymatic systems, carbon dioxide from the air and the sun's energy to photosynthesize large quantities of this renewable resource. The xerophytic (dryness loving) plants save precious desert water, prevent soil erosion and help conserve non-renewable petroleum.

The only other source of liquid wax esters is the sperm whale, like Moby Dick. The esters from these



**Caption No. 4** The Active Oxygen Method (AOM) compares the oxidative stability of several seedoils and jojoba. Air is bubbled into the solution and as oxidation occurs the peroxide level is recorded over time.



**Caption No. 5** After 14 years of agri-research and experimentation, jojoba production is now steadily growing.

magnificent creatures had been widely used for cosmetics and lubricants for a hundred years, until the whales became an endangered species in the early 1970s. Today natural ester suppliers are harvesting jojoba, rather than harvesting whales.

Over the past 14 years jojoba has overcome many of the barriers still facing other new natural materials. Methods of cost-effective production and high-quality processing have been developed to provide a reliable supply at a reasonable cost<sup>28,29</sup>. The precise methods of quality measurements approved by the American Oil Chemist Society during the past year are now achieving even tighter quality control and product consistency. Jojoba's safety, oxidative stability, emolliency and moisture control have been demonstrated. Jojoba is already widely used in many oil-in-water emulsions for lotion and cream moisturizers, with sunscreens and in eye treatments as well as nail and hair products. Decision makers are weighing all of these factors as they take another look at jojoba for a broad range of new applications.

### Bibliography

1. Kono, Y., K. Tomita, H. Katsura and S. Ohta, Shiseido Laboratories, Proc. IV Inter. Conf. Jojoba (1980)
2. Wisniak, J., The Chemistry of Jojoba Oil, Am. Oil Chem. Soc. (1987)
3. Libby, H. R.H. Purdy, R.L. Realine and T.A. Lugtu, Cosmetics Based on Jojoba Oil, Oxidative Stability, Proc. VI Inter. Conf. Jojoba (1985)
4. Jojoba Oxidation Data from Omnion Corporation (1993)
5. Darr, D.J., Biology of Oxygen Free Radicals, Inter. Conf. on Cutaneous Aging (1988)
6. Danno, K., Investigative Dermatology (1984)
7. Black, H.S., Potential Involvement of Free Radical Reactions in UV Light-Mediated Cutaneous Damage. Photochem. Photoiol. 45: 213-221 (1987)
8. Ueda, H., and H. Sugiura, Lipid Peroxide and Superoxide Dismutase in Human Skin, Cutaneous Aging edited by Albert M. Kligman p450
9. Thompson, J.E., and R. Legge, The Role of Free Radicals in Senescence and Wounding. New Phytol. 105: 317 (1987)
10. Wolfram, L.J., and L. Albrecht, J. Soc. Cosmet. Chem. 82: 179-191 (1987)
11. Wolfram, L.J., "Hair Research", C.E. Orfanos, W. Montagna and G. Stuetgen), Springer Verlag, Berlin: 482-485 (1981)
12. U.S. Patent 4,393,043, Koulbanis et al (1983)
13. Konl, Y., K. Tomita, H. Katsura and S. Ohta, Shiseido Laboratories, Proc. IV Inter. Conf. Jojoba, Hermosillo, Mex. (1980)
14. Hirai Y., N. Tonooka, T. Tanigawa and K. Ito, Pola R&D Laboratories, VII Inter. Conf. Jojoba (1988)
15. Goldemberg, R.L., and C. De La Rosa, Correlation of Skin Feel of Emollients to Their Chemical Structure, J. Soc. Cosmet. Chem. 22 (1971)
16. Orkin, M., H.I. Maibach and M.V. Dahl, Dermatology (1991)
17. Mathers, W.D., Ocular Evaporation in Meibomian Gland Dysfunction and Dry Eye, Ophthalmology, Vol. 100, No. 3 (Mar. 93)
18. Christensen, M.S., and E.W. Packman, Skin Surface Softening Effects of Jojoba and Its Derivatives, VII Inter. Conf. Jojoba, Am. Oil Chem. Soc. (1988)
19. Packman, E., Project 6822, Institute for Applied Pharmaceutical Research, Ltd., Merion, PA 19066
20. Taguchi, M., and T. Kunimoto, Toxicity Studies on Jojoba Oil for Cosmetic Uses, Cosmetics and Toiletries, Vol. 92 (1977)
21. Johnson, W., Safety Assessment of Jojoba Oil and Jojoba Wax, J. Am. Coll. Toxicol. (USA) (1992)
22. Packman, E., Project 6822, Institute for Applied Pharmaceutical Research, Ltd., 214 Sycamore Ave., Merion, PA 19066, Acute Skin Irritation with Repeated Insult Patching followed by a Challenge Application to Test for Sensitization.
23. Mosovich, B., Treatment of Acne and Psoriasis, VI Inter. Conf. Jojoba (1985)
24. Kligman, A., Personal Communication (1993)
25. McClatchey, K., et al, Dept. of Pathology, Univ. of Michigan, IV Inter. Conf. Jojoba 1980
26. Miwa, T.K., Structural Determination and Uses of Jojoba Oil, JAOCS, Vol. 61, N° 2 (1984)
27. The Jojoba Association, Harvest Surveys (1985-92)
28. Purcell, H., and H. Purcell Jr., Jojoba Crop Improvement Through Genetics, Proc. VII Inter. Conf. Jojoba, Am. Oil Chem. Soc. (1988)
29. Purcell, H., Jojoba Seed and Oil Standards, Proc. VI Inter. Conf. Jojoba, Ben-Gurion Univ. of the Negev, Beer-Sheeva, Israel (1985)

**Hal C. Purcell, M.D. is the president of Purcell Natural Jojoba**, a leading jojoba production and marketing company. He studied chemistry and genetics at the University of California at Berkeley, medicine at the University of Iowa and ophthalmology at Wake Forest. He practiced ophthalmology for 19 years before turning his full attention to the budding jojoba industry in 1985.

Purcell Natural Jojoba began a cooperative research project with the University of California in 1982 to improve the cost effectiveness of producing jojoba. His company now produces 17% of the jojoba consumed.

Dr. Purcell is the past president of the international *Jojoba Association*. He chaired the *Jojoba Quality Standard Committee* for that organization and the *American Oil Chemists Society*. He has presented papers at international meetings on quality standards, jojoba production techniques and genetic improvement.

Recently he began organizing the Jojoba Research Council to study the functionality of jojoba. He spoke on jojoba efficacy at the HBA 93, Global Expo in New York City, in May of 1993.