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BIOTECHNOLOGY & CASTOR OIL

ISSUE: Scientists are transforming common plant oils (such as soybean) into castor oil equivalents using enzymes or microbes.
IMPACT: If commercially viable, laboratory production of castor oil equivalents will eliminate the need to import castor oil from the Third World. Over $208 million in Third World export earnings per annum are at stake.
COUNTRIES AFFECTED: Brazil, India and China are the world's leading exporters of castor oil.
PARTICIPANTS: U.S. Department of Agriculture, Union Camp Corporation (Princeton, New Jersey, USA), North Carolina State University (Raleigh, North Carolina, USA).

History of Castor Oil

Castor (Ricinus communis L.) has been known and used by humankind for millenium: its seeds, leaves and roots for medicinal, culinary and animal feed purposes; its oil for perfume and lighting.

While the Ethiopian-East African region is recognized as the center of origin of the species, wild and weedy varieties of castor are found all over the tropical and temperate areas of the world. It is an easily cultivated and adaptable plant, suitable to all different levels of farming systems. Through plant breeding, castor cultivation and harvesting are now completely mechanized in the Soviet Union; in parts of India, much of the crop is picked from wild stands, dried in the sun, threshed by beating sticks or by the treading of bullocks and winnowed by hand.[1]

Modern Day Production and Uses of Castor Oil

Today, castor is one of five leading plants oils used for industrial purposes. The others are coconut, soybean, linseed and tall (a lumber industry by-product).[2] Each is important because it yields unique acids which fulfill special requirements of industry. Castor oil contains exceptionally high concentrations (90%) of ricinoleic, a unique hydroxy fatty

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acid, and an essential ingredient for many industrial uses. It is an ingredient in lubricants, plasticizers, coatings, surfactants and pharmaceuticals. Ricinoleic acid derivatives (such as sebacic acid) are consumed in polyster, polyamide and urethane polymers, cosmetics, flavorings and fungistats. Waxes and high-pressure greases are obtained from the hydrogenation of ricinoleic acid from castor oil.

The world's leading exporters of castor oil are India, Brazil and China. The USA, the EEC countries, Japan and the USSR are the major importers of castor oil. Worldwide production of castor oil in 1989/90 is expected to reach 400,000 metric tons[3], with exports valued at approximately $208 million.

Castor oil is of minor importance in world trade, contributing only 0.5 to 1.0% of the total world oilseed production.[4] But it continues to be important for many technical products and industrial demand for castor oil has remained constant over time. There is, in effect, a specialty market for castor oil. Responding to that market, China has doubled and India almost quadrupled their production of castorseed since 1970.[5] Valued at US $1200 per metric ton,[6] castor oil commands a profitable niche market for Third World exporters.

CasChem (Bayonne, New Jersey) is the largest U.S. processor of castor oil, with sales of $300 million a year.[7] CasChem annually imports 45,000 metric tons of castor oil from Brazil for use in such disparate products as cosmetics, urethane adhesives and coatings, electrical encapsulants and such automotive products as paints and primers, polishes, gasket compounds and safety glass. Similiarly, Union Camp Corporation (Princeton, New Jersey) processes "enormous amounts"[8] of castor oil into esters for the cosmetics, plastics, lubricants and detergent industries.

Industrial buyers and processors of castor oil are anxious to find substitutes for imported castor oil as a means of eliminating their dependence on costly imports. According to one industry representative, "Everybody in the business of importing natural products is looking at alternative sources."[9]

Biotechnology, New Plant Substitutes and Displacement of Castor

Biotechnology offers many opportunities to alter the molecular composition of fatty acids to create entirely new substitutes for traditional oils and fats. Castor oil is just one target of current biotechnology research. In the United States, enterprises in both the public and private sectors are engaged in post-harvest modification of oils using enzymes and microbes. However, because of patents pending, researchers and company officials are reluctant to answer questions about current research and progress on biotechnological substitutes for castor oil. The following section provides general information about current research efforts and the enterprises involved.

Ultimately, commercialization of castor substitutes will depend upon whether quantities of hydroxy fatty acids can be produced from domestic oils, such as soybean, at a price competitive to imported castor oil.

U.S. Department of Agriculture (USDA) scientists based at the Northern Regional Research Center in Peoria, Illinois, have chemically analyzed some 8000 plant species in pursuit of new economically valuable plants, including new oil crops.[10] Researchers have discovered a plant, Lesquerella (bladderpod) that contains unsaturated fatty acids (like those found in castor oil). Lesquerella is a member of the Cruciferae family and native to the arid parts of western North America. Lesquerella oil could be used in all applications where castor oil is currently employed, with the advantage that it does not contain toxic protein found in the castor bean.

"The market potential for the oil," writes George White of USDA/ARS, "is sufficiently high to justify extensive agronomic and breeding efforts."[11] Commercialization of a wild plant is, of course, a difficult, time-consuming process. Long-term breeding programs are needed to bring about the domestication of new crops. Since the development of an improved variety of a well established crop normally requires 8 to 10 years,[12] the development of novel crops could take significantly longer.

Within the USDA's Agriculture Research Service (ARS) post-harvest program on product utilization, there is also substantial focus on converting plant oils, such as soybean, to specialty chemical products. A stated goal of the ARS program is "to find substitutes for imported oils and to enhance the return on investment to the U.S. farmer and agribusiness."[13] Researchers have already identified several strains of a microbe, Nocardia, which convert oleic acid to 10-hydroxystearic acid.[14] The product, 10-hydroxystearic acid, is a fatty acid related to those usually derived from castor oil. Its potential application in the production of detergents, greases and fragrances could greatly reduce reliance on imported castor oil.

The USDA process, currently under evaluation for commercial applications, was inspired by research conducted by scientists at the Battelle Columbus Division in Ohio. Using a bacterium, Rhodococcus rhodochrous, Battelle researchers successfully modified the fatty acids of some plant oils to produce an isomer of ricinoleic acid. Ricinoleic acid is an important material in the synthesis of sebacic acid which is used in paints, perfumes, hydraulic fluids and resins.[15] The research was conducted under an agreement with Union Camp Corporation which now owns the process.

At North Carolina State University, a biochemistry professor is seeking patent protection for another bacterial enzyme which produces hydroxy fatty acids from common plant oils.[16]

Conclusion

New biotechnologies have the potential to eliminate or displace traditional Third World export crops, resulting in the loss of foreign exchange earnings, dislocation of agricultural workers and increased economic instability in the South. Castor is one more case of the potential for transfering production from the Third World to laboratories and factories in the industrialized world. Biotechnological advances in the oils and fats industry, coupled with industry discontent with the need to import and a USDA strategy "geared toward capturing markets for U.S. agricultural commodities through greater product diversification",[17] may eventually eliminate the market for imported castor oil.

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1 Handbook of Agriculture, a publication by the Indian Council for Agricultural Research, p.952

2 G.Robbelen, Downey,R.K., Ashri,A., Oil Crops of the World, 1989 Mc-Graw Hill, Inc., p.88

3 Figures from Al Holz of USDA reading from selected issues of Oil World, Z.Mielke, ed. Hamburg, Germany

4 Oil Crops of the World, op.cit. p.438

5 Oil Crops of the World, op.cit., p.438

6 Al Holz, op.cit.

7 "CasChem pushes for more buyouts" in Chemical Week, January 28, 1987 p.38

8 Dr Robert Lazar, Senior Project Planner, Union Camp Corp., Research and Development Div., in telephone conversation February 13 1990

9 John H. Litchfield, Research Leader, Battelle Columbus Division, Ohio, in telephone conversation February 1, 1990.

10 Oil Crops of the World, op.cit., p.518

11 David S. Seigler, ed., Crop Resources, 1977, Academic Press, p.21

12 Oil Crops of the World, op.cit., p.521

13 Ruxton H. Villet, National Program Staff, USDA/ARS, "Industrial Uses of Vegetable Oil", 1989 Annual Meeting Abstract

14 Bioprocessing Technology, October 1987, p.6

15 Bioprocessing Technology, August 1986, p.2

16 Techne, a publication of the North Carolina Biotechnolgy Center, Fall 1989, p.8

17 Ruxton Villet, op.cit.