RAFI COMMUNIQUE

July, 1991

UPDATE -- Vanilla and Biotechnology

In 1987 RAFI first reported on the efforts of two U.S.-based biotechnology companies to produce natural vanilla flavor in the laboratory using plant cell cultures (see *RAFI Communique*, "Vanilla and Biotechnology," January, 1987). We warned that, if commercially successful, this new technology would displace over 70,000 small farmers who grow vanilla beans on the island nation of Madagascar, and seriously disrupt that country's already ailing economy. Madagascar accounts for three-quarters of the world's vanilla bean production. This *RAFI Communique* provides an update on the efforts of biotechnology companies to commercialize a bio-vanilla product, and the outlook for Third World vanilla bean growers.

Introduction

Two U.S.-based companies claim that they can routinely produce vanilla flavor in the laboratory from plant cell cultures. The basic formula involves taking tissue cuttings from the vanilla plant (*Vanilla Planifolia*), and growing the plant cells in a special solution of liquid and solid nutrients so that it results in a large mass of cells that produce vanilla flavoring. This technique eliminates the need for traditional cultivation of the vanilla orchid and the labor-intensive harvest of vanilla beans. The big question remains, is large-scale production of bio-vanilla economically viable? Can it compete with the real thing--vanilla beans grown by over 100,000 small farmers in Madagascar, Reunion, the Comoros and Indonesia?

Update on Company Activities

Escagenetics Corporation, a small biotechnology firm based in San Carlos, California (USA) now claims that it can produce bio-vanilla at a fraction of the cost of natural vanilla extract.[1] According to a recent report in *Bioprocessing Technology*:

> "The vanilla plant cell culture is difficult and tedious, but on the plus side, Escagenetics's technique yields natural vanilla at a low enough cost to sell it for approximately $25/lb. Natural vanilla runs about $1200/lb. While synthetic vanilla costs about $6/lb., it doesn't have the superior flavor of natural vanilla."[2]

Escagenetics has applied for patents on its "PhytoVanilla" and "PhytoVanillin" products. It claims that these products are in the process of being scaled-up, and samples are under evaluation by potential corporate collaborators.[3] Since Escagenetics is a small biotechnology company with limited resources, its ability to attract financing from a large corporate partner will be the key factor in determining whether its proprietary PhytoVanilla will eventually reach the market. Escagenetics has 64 employees and devotes approximately $4.3 million annually to research and development. In 1990, the company suffered a net loss of $2.7 million.[4]

David Michaels & Co. (Philadelphia, USA) is a private company specializing in flavors and fragrances that has been working on bio-synthesis of vanilla since 1985, in collaboration with the Univ. of Delaware. In addition to cell culture research, the company is also attempting to breed hardier strains of vanilla plants with the goal of extending the cultivation of vanilla outside of tropical climates. The company refused to answer RAFI's questions about the cur-

rent status of their work and outlook for commercialization.

Particularly noteworthy is the recent disclosure by the Danish food industry giant, **Danisko A/S**, that it will *discontinue* its research on the production of vanilla from plant cell cultures.[5] The company initiated work on vanilla in the mid-1980s. No explanation was given about why the company chose to discontinue this work.

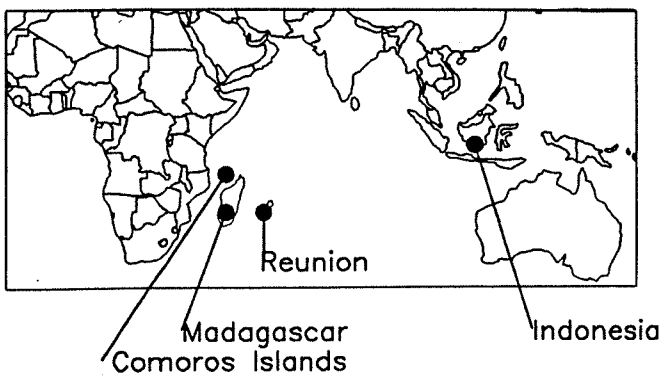
Financial Stakes

The food processing industry's use of flavors and fragrances is projected to reach a market of $2.8 billion by 1992. Vanilla is the flavor industry's largest segment, making it an attractive target for cell culture production. From 1987-89, the average annual value of vanilla bean exports was approximately (US) $100 million.[6] The largest exporters are Madagascar, Indonesia, the Comoros and Reunion. Worldwide, the market for vanilla flavoring (both natural and synthetic substitutes) is approximately $200 million.

The Bottom Line

Early reports by industry on commercialization of bio-vanilla were overly-optimistic and undoubtedly exaggerated. Nevertheless, research on vanilla continues to advance, patents are pending, and there is a good chance that Escagenetics' "PhytoVanilla" will be marketed commercially before the end of the decade. If it's true that Escagenetics can produce a natural bio-vanilla at a significantly lower cost than natural vanilla, then the major obstacle to commercialization is finding a corporate partner who will finance the high costs of scaling-up and marketing.

Top Vanilla Producing Nations
Account for Over 95% of World Vanilla Bean Exports



Outlook for Third World Vanilla Exporters

RAFI's conclusion remains the same. If commercially successful, this new technology will displace vanilla bean exports on a massive scale, eliminating the need for traditional cultivation of the vanilla orchid, and many thousands of jobs related to vanilla bean cultivation and harvest. For vanilla bean growers in Madagascar and elsewhere, the only consolation is that these countries may have a few extra years to plan for the loss of a major export crop and the urgent need to diversify their agricultural economies.

FOOTNOTES

1. Knight, P. 1989. "Engineered Fruit and Vegetable Crops," Bio/Technology, Vol. 7, No. 12, December, p. 1234. This article claims that ESCAgenetics's "Phytovanilla" will sell for one-fifth the price of natural vanilla extract.
2. Anonymous. 1991. "Cell Culture System to Produce Less-Costly Natural Vanilla," Bioprocessing Technology, January, p. 7.
3. ESCAgenetics Corporation, 1990 Annual Report, p. 3.
4. Bioscan, Vol. 5, April, 1991, p. 259.
5. Personal communication with Jytte Mollerup Andersen, Laboratory Manager of Danisko Maribo Biotechnology Copenhagen, May 23, 1991. Danisko is a major food conglomerate formed by the merger of three Danish food corporations in early 1989.
6. FAO Trade Yearbook, Vol. 43, 1989, p. 212.

Madagascar at a Glance

* world's largest exporter of vanilla beans
* ranked as 12th poorest country in the world.
* per capita GNP is (US) $190.
* approx. 88% of Malagasy people work in rural areas, 65% live at subsistence level.

Ironically, one U.S. biotechnology representative refers to Madagascar as "the OPEC of vanilla." According to World Bank, Madagascar is now trying to re-gain lost market share in vanilla from Indonesia.

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July, 1991

Update: Genetically Engineered Oilseed Plants

Past issues of *RAFI Communique* have reported on genetic modification of oilseed plants and efforts by industry and academic groups to improve and modify vegetable oils for both food and industrial applications. See *RAFI Communiques*: "Biotechnology & Vegetable Oils: Focus on Oil Palm" (June, 1988); "Cacao & Biotechnology" (May, 1987); Biotechnology & Castor Oil" (Jan./Feb., 1990).

With a worldwide market of over $35 billion, the potential market for modified vegetable oils is enormous. *Genetic Technology News* estimates that the market for vegetable oils improved by genetic engineering is (US) $630 million per annum in the United States alone. One goal is the engineering of oilseed plants grown in temperate climates of the North (maize, soybean, rapeseed) so that they produce industrial oils equivalent to tropical oil imports (palm, palm kernel, coconut). Scientists also are attempting to engineer edible oils lower in saturated fats, for health conscious North American consumers. The end result is increased competition and loss of market share for imported tropical oils. Below, RAFI briefly examines recent developments in genetic modification of Northern oilseed crops.

"After many years of hard-nosed biochemical research on genetic modification of oilseed crops, the fruits of this work are just coming to the forefront. You can expect to see many exciting breakthroughs in the coming months and years." - Daniel Wagster, Calgene, Inc.

California Biotech Company Clones LAURATE Synthesis Gene

Calgene, a plant biotechnology company based in California (USA), has successfully cloned the laurate synthesis gene, which codes for an essential enzyme in the formation of lauric acid in plants. This discovery is significant because laurate is produced by coconut and oil palm trees, but is absent in European and North American oilseed crops. The enzyme was purified from the seeds of the wild California bay tree.

According to Calgene scientists, the isolation of the laurate synthesis gene represents a major step toward the production of lauric acid in Northern oilseed crops like rapeseed (*Brassica napus*). Approximately 500 million lbs. of laurate is used in the United States each year in the production of detergents, soaps, lubricants and other industrial products, an estimated market of $200 million annually. If lauric acid can be produced by Northern oilseed crops, tropical oils will lose this lucrative industrial oil market.

According to Calgene's vice-president, Daniel Wagster, the company expects to go to field trials with genetically-engineered rapeseed in the latter half of 1991. "We don't anticipate a product before 1995, but closely thereafter."

Calgene's research on rapeseed and laurate synthesis is supported by **Procter & Gamble** (Cincinnati, USA), one of the world's largest buyers and sellers of oils and fats. In 1990, Procter & Gamble ranked 15th on *Fortune's* list of the largest U.S. industrial corporations, with annual sales of (US) $24.3 billion.

Low-Palmitic Acid Soybean Developed

Pioneer Hi-bred International, the world's largest seed corporation, recently obtained an exclusive license for a low palmitic acid soybean variety developed by biotechnologists at Iowa State University. The oil from the patented soybean is significantly lower in saturated fats, making it comparable nutritionally to competing canola oils (edible rapeseed) which are gaining in popularity amongst health-conscious North American consumers. Iowa State University has a variety of biotech research programs focusing on soybean. Their goal is to engineer new varieties with improved nutritional and functional properties, allowing soybean to maintain its position as the number one vegetable oil in the world.

Pioneer Hi-bred says that its low-palmitic acid soybean will produce oils for the commercial market in 1993. Dr. James Miller of Pioneer told *AgBiotechnology News* that, "If results of the test marketing of the oil

is favorable, Pioneer could see a demand for 2-3 million acres of beans." (ABN, March/April, 1991, p. 5.)

ACC Gene Discovered

In related news, scientists at Iowa State University (USA) recently announced the discovery of a gene that may control the amount and types of oils produced by plants. The acetyl-CoA carboxylase (ACC) gene, which was isolated from the carrot plant, catalyzes the first step in the fatty acid biochemical pathway. The discovery of the ACC gene is significant because it is one of the key genes controlling the amount of oil being made by the plant. Ultimately, manipulation of this gene will help scientists discover how plants produce oil. According to *Genetic Engineering News*:

> "A key goal of plant genetic engineers is to introduce the ACC gene into soybeans to increase the plant's production of vegetable oil. -- GEN, May, 1991, p. 14.

Discovery of the ACC gene, though significant, is really only the first step in a complex process of genetic manipulation. There are 50-100 genes involved in plant oil production. Iowa State scientist, Dr. Eve Wurtele, says that genetically-engineered, high-yielding oilseeds will not be available for 5-15 years.

Miscellaneous Vegetable Oil News

* Calgene recently formed a new partnership with Novamont, a division of **Ferruzzi-Montedison** (Italy), for the joint development of lubricant products derived from processed canola (edible rapeseed) and sunflower crops. Ferruzi-Montedison is a giant transnational chemical/pharmaceutical and energy corporation with annual sales of about (US) $30 billion.

* **DuPont** (Wilmington, Delaware, USA) and **DNA Plant Technology Inc.** (USA) have formed a new company, InterMountain Canola Co., for the commercialization of canola (edible rapeseed oil) products.

* **Frito-Lay**, the largest snack food company in North America, a subsidiary of **PepsiCo**, announced last year that it plans to incorporate canola oil with improved fatty acid composition into its food processing operations. The new canola varieties were developed by **Allelix Crop Technologies** (Ontario, Canada) under contract to Frito-Lay. The company will reportedly begin using canola for food processing operations by 1993.

IN RELATED NEWS...EARLY WARNING

Agrigenetics Co. of Wisconsin (USA) recently applied to the U.S. Department of Agriculture to conduct a small-scale field test of genetically engineered rapeseed. The plants are engineered to contain the toxic protein of the bacteria, *Bacillus thuringiensis* (Bt), which is toxic to certain insects. The U.S.-based National Wildlife Federation (Washington, D.C.) warns that the proposed field test poses environmental risks because rapeseed (*Brassica napus*) has many weedy relatives in the United States.

According to Dr. Jane Rissler of the National Wildlife Federation, the transfer and expression of foreign genes in weedy species is a major environmental threat from transgenic crops. She explains that, unless controlled by appropriate containment measures, gene flow from engineered rapeseed could confer considerable advantage to wild plants. If weedy relatives receive the Bt insect-toxin gene from transgenic rapeseed, it may become resistant to attack by certain insects. According to Dr. Rissler, this could increase population density of weeds, possibly leading to the displacment of native species and/or exacerbating weed control problems.

The issue of transfer and expression of genes in weedy species is of special relevance and concern in the Third World, where wild and weedy relatives of many agricultural crops are found. For this reason, the environmental threat posed by some transgenic crops could be much greater in certain developing countries.

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Meeting Human Needs???

Despite industry claims that biotechnology will cure AIDS and feed hungry people--the first target for emerging biotech products is the affluent clientele of the North. Consider this important breakthrough:

Food industry giant Nabisco Brands, Inc. has just received U.S. patent # 4,997,661 for its "chewy dog snacks." According to *Industrial Bioprocessing*, it is a "semiplastic, nonporous, microbiologically stable dog food."

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