Ethanol Prospects Rise with New Yeast

The Canadian discovery of a yeast with a healthy appetite for five-carbon sugars — such as xylose — may spell an eventual breakthrough in ethanol economics. Used in gasohol, ethanol has become a popular, albeit controversial, gasoline extender (SN: 4/12/80, p. 234).

Ethanol is produced by fermentation of cereal grains and other carbohydrate-rich materials. Standard fermentation yeasts thrive on six-carbon sugars such as glucose. However, such sugars make up only 40 percent to 50 percent of the material in many wood wastes and agricultural residues. As much as 25 to 35 percent of the remainder may be five-carbon sugars — totally ignored by discriminating yeasts.

This in part explains the reason many engineers scoff at claims that ethanol is an attractive fuel. For example, although corn is a popular ethanol feedstock, the American Society of Mechanical Engineers notes that "even the most modern corn-to-ethanol plants being planned or under construction using energy-conserving technology are expected to result in the production of ethanol with about a one-to-one overall energy balance. That is, the energy required to grow and harvest corn plus the energy required to produce ethanol at the processing plant is about equal to the heating value of the ethanol." But a yeast able to metabolize both five- and six-carbon sugars could tip the energy balance. According to the Solar Energy Research Institute (SERI), such yeasts could yield 50 percent to 80 percent more alcohol from the same raw materials.

And after a three-year search, last December Henry Schneider of the National Research Council in Ottawa discovered *Pachysolen tannophilus* to be just such an omnivorous diner. Boasting of his fungal find, the biochemist says, "It can ferment xylose into ethyl alcohol better than any other yeast."

Since December, Schneider has been cataloging some of *P. tannophilus*'s unusual dietary quirks. For instance, yeasts normally dine in an oxygen-poor or even oxygen-free atmosphere. But Schneider says *P. tannophilus* won't begin to eat unless it has "continuous access to air." Once the yeast grows and establishes a "heavy culture," however, the air supply can be shut off. And it ought to be, if alcohol production is one's goal, because this yeast has a natural predilection for the sauce. It will not only begin making alcohol, but also consuming it so long as the dining ambience remains aerobic. Luckily, once fermentation begins, turning off the oxygen does not turn off the production of alcohol.

Though it eats more, *P. tannophilus* is not yet as efficient as brewer's yeast — its main competition. The latter is able to obtain 95 percent of the theoretical yield offered by its six-carbon-sugar diet, Schneider says, while *P. tannophilus* has so far been able to harvest only 80 percent of its theoretical yield.

Already Schneider has received inquiries from companies "all over the world." He expects "within a year, for certain," that NRC will engage one of those firms in a joint venture to run comparison tests of *P. tannophilus* and brewer's yeast under conditions found in the commercial industry.

Initially the new yeast may not work as well or as fast as brewer's yeast, or it might find conditions that inhibit its efficiency. But Schneider says, "I'm hopeful that in about six months we'll get results about as good or better than brewer's yeast." And "the reason I can say these things without blushing," he told SCIENCE NEWS, is that there is ample precedent for expecting that more productive mutants can be selected "in pretty short time." Penicillin, he says, is a good historical example.

Some researchers have taken a different route — genetic engineering — in their search for a yeast that eats five-carbon sugars. At SERI, researchers are attempting to implant a gene for metabolizing them into brewer's yeast. When the program began a year ago, "We didn't have a source for the gene within yeast," Karel Grohmann told SCIENCE NEWS, "so what we did was take it from a bacterium." He won't divulge which strain for proprietary reasons. Grohmann says genes have already been successfully cloned. "The next step would be to move the genes into a yeast and see if you get expression." That feat is scheduled for September. □

Compound 1080 ban: To be or not to be

A controversy rages where seldom is heard a discouraging word. At home on the range are cattle and sheep. So, too, are wild canine predators such as the coyote. The National Woolgrowers and National Cattlemen's Associations recently declared that predation of livestock by these wild canines has reached crisis proportions and that the U. S. Environmental Protection Agency should permit emergency use of predacide products containing the banned toxin Compound 1080. At least a dozen environmental groups disagree. The opposing parties clashed at recent hearings held by EPA to consider reinstating the use of the controversial 1080.

Compound 1080 proponents say they have tried to no avail fencing out, trapping and shooting coyotes. But U. S. Department of Agriculture tests have shown that electrified *enclosures keep canines out.*

USDA

Compound 1080 — or sodium monofluoroacetate (FCH_2COONa) — is a white, crystalline, powerfully toxic powder. Its recorded LD50 (a statistical estimate of the dosage that would be lethal to 50 percent of a large sample of the test species) for coyotes is 0.1 milligrams of toxicant per kilogram of body weight, and its estimated human LD50 is from 0.7 to 2.1 mg/kg. Lethality is achieved mainly via 1080's ability to block the citric acid (Krebs) cycle — an essential process for converting food into energy. Previously, this lethal toxin was widely distributed throughout the West in meat baits: aqueous solutions of the compound injected into whole carcasses or pieces of horses, mules or sheep. In 1972, however, EPA banned such use of 1080 because of findings that it posed "unreasonable risk to humans and nontarget [and sometimes endangered] wildlife." The cancellation of registrations for 1080-containing products passed uncontested.

Now, however, spokespersons for the livestock industry claim herders need the compound as a predator control tool. Since the 1972 disallowance of the toxin, "there have been alarming increases in livestock losses to predators," says 1080 proponent Raymond M. Momboisse of the Pacific Legal Foundation. For example, "In 1971, Colorado sheep growers lost 7.7 percent of their lambs to predators; in 1974, they lost 16.5 percent," he says.

But these statistics are meaningless — often obtained by questionnares that depend on the memory of ranchers who "didn't locate and examine the carcasses of their livestock," says Dede Armentrout of the Brownwood, Tex., National Audubon Society. "It's like sending out a questionnaire to people asking how many quarters they lost in a Coke machine last year," she says.

Also at issue is whether results of research conducted since 1972 could lessen the potential hazards and nonselectivity of 1080 use. Proponents of 1080 point to the research programs on a new delivery mechanism—a toxic collar worn by sheep around the neck where predators are likely to attack. Opponents of 1080, however, counter that the collar can be easily punctured by barbed wire, cactus and bushes, that animals can chew through their own collars and that predators can attack from the rear and not be poisoned.

These and other considerations now sit in the lap of an EPA review panel. The panel hopes to decide by mid-September "whether there is substantial new evidence concerning the risks and benefits of using 1080" that would warrant initiating hearings to consider lifting the ban. □

Pinpointing problems in test-tube tots

For a handful of childless couples, test-tube baby technology has triggered the births of healthy offspring, but "despite these truly remarkable achievements, the rate of success is disappointing," says the chief of the pregnancy research branch at the National Institutes of Health in Bethesda, Md.

Reporting in the Aug. 7 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, Gary D. Hodgen pinpoints some of the problems that keep the sperm and egg in a laboratory dish from becoming a thriving tot. He also introduces a few alternatives to test-tube fertilization (including a tiny incubator stitched just outside the mother's uterus) that may eventually bring children to more of the estimated 500,000 U.S. women now infertile because of blocked or diseased fallopian tubes.

Far more than a simple transport pipe linking ovary to uterus, each fallopian tube provides a rich, variable milieu of nutrients and gases necessary for timely development of an embryo. Damage to the tubes often prevents fertilization. Researchers trying to get around the problem can successfully combine egg and sperm outside the body, but they can't yet replicate the ingredients and environment of the fallopian tube.

The study conducted by Hodgen and Olivier Kreitmann at NIH showed that "monkey embryos developing *in vitro* kept pace with the expected time course for only about 24 hours." Because the mother's reproductive hormones work together with the fertilized egg to synchronize each step in development, a test-tube embryo's sluggish growth might be enough to desynchronize the system and prevent implantation, they say.

While scientists continue to search for the ingredients needed to nurture a test-tube embryo, Hodgen suggests a supplement to *in vitro* fertilization that might work for women with partially intact tubes. He and Kreitmann surgically blocked the fallopian tubes of 31 rhesus and cynomolgus monkeys near the ovary. By moving a ripe egg just past the blocked portion of the tube and permitting normal fertilization through intercourse, the researchers realized a 16 percent yield of apparently healthy infants — the same success ratio achieved through intercourse by couples with no blockage problems.

To possibly permit pregnancy in women who completely lack fallopian tubes, the team developed prototypes of an "egg-embryo chamber," a one-inch-long plastic container that could be temporarily anchored in the abdominal cavity for the nine days an embryo would normally spend in the fallopian tube. The peritoneal fluids that flow through the chamber, bathing the egg, seem to foster a normal growth rate, Hodgen says, though none of the monkey eggs fertilized in such chambers have yet been implanted in a uterus. At least two more years of research in animals are needed, Hodgen estimates, before testing of the egg-embryo chamber in women might begin. □

Adler on Nijinsky: Preface suppressed

His genius laced with madness, Vaslav Nijinsky bounded from the heights of dance stardom in 1917 to the depths of schizophrenic isolation. When the world couldn't meet his highest expectations, the Russian dancer began to doubt himself and covered his feelings of inferiority with a cloak of Messianic strivings. Or so writes psychoanalyst Alfred Adler in his preface to the artist's diary, God Nijinsky. *First published in the July* ARCHIVES OF GENERAL PSYCHIATRY, *the preface was suppressed for more than 30 years because Romola Nijinsky rejected a less than glorious analysis of her husband.*

Nijinsky in Petrouchka, 1911/The Bettmann Archive.

The universe: Still an open question

Combined studies of high energy physics and cosmology are providing a clearer vision of our universe as an infant, a seething, largely unorganized world of elemental particles. Of special interest to scientists and the authors of a paper in the June 15 ASTROPHYSICAL JOURNAL is the three-minute-old universe. At about that stage of things, freshly fused lightweight nuclei like lithium-7, hydrogen-2, helium-3, but particularly helium-4 began further coalescing to form the known elements.

In a synthesis of their own making, the authors, from the universities of Chicago and Delaware, culled from the professional literature the most recent values of certain key parameters that are now thought to have governed the universe's period of nucleosynthesis. Their wide-ranging conclusions seem generally to corroborate other evidence that our universe will expand outwardly without end, and also that at least one more (a fourth) species of neutrino exists than is now acknowledged by particle physicists.

Those few minutes leading to nucleosynthesis billions of years ago implicate modern theories of elementary particles, most notably quantum chromodynamics, and the standard (big bang) model of cosmic evolution. Various parameters endemic to each of those separately are now seen as brought together by the "multidisciplinary" process of nucleosynthesis. Four of them are singled out in the paper for their special physical significance: the lifetime of the neutron; the ratio of total baryon (a major class of strongly interacting particles, including principally the neutron and proton) and photon populations of the universe; the number of existing neutrino species (known are the electron and muon species; the tau is not confirmed, but generally accepted by particle physicists); and the fraction of the universe's mass that is helium-4.

In their paper, K.A. Olive, D.N. Schramm, Gary Steigman, M. S. Turner and J. Yang set out to evaluate the current data in search of the most likely values of those four parameters. Not unexpectedly, prevailing uncertainties force them in each instance to consider not any one value of the parameter, but a likely range of values. Interestingly, all but one of the possibilities encompassed by the uncertainties lead to our universe being open. One of the major possibilities that could intrude into their analysis and decisively alter that conclusion is the existence of massive neutrinos (the tau neutrino may turn out to be an example). These hypothesized mutations of an "idealized" neutrino have a rest mass, which if large enough—a few hundred-thousandths of an electron mass or so—could increase the universe's total mass density. Enough, even, to close it. □