/COMMENTARY

by Bernard Dixon

OF YARDGOODS, PAPER, AND PLASTICS

Around the time ICI's Pruteen plant went on stream at Billingham in 1979, there were murmurs that animal feedstuffs were not the only products in the corporate mind of company chiefs in their Millbank, London, headquarters. Certainly they believed in a robust future for *Methylophilus methylotrophus* grown on methanol derived from natural gas (hopes later dimmed by changed economics, until the USSR's recent interest in licensing the process). But perhaps experience of running a huge and novel single cell protein plant was also needed as groundwork for another technology with which ICI was known to be experimenting—the production of microbial polymers?

Most observers considered such gossip quite barmy at the time. Yet ICI did announce its development of polyhydroxybutyrate just two years later, and today sees applications for this bacterial product ranging from biodegradable surgical sutures to telephone mouthpieces. Moreover, the case for using microorganisms to manufacture polymers of the sort desired by the textile industry has been enhanced in the intervening years by researchers such as Edward Atkins at the University of Bristol. His crystallographic studies have led him to argue that the capsules of *Klebsiella* and other genera offer an enormous range of polysaccharides that could provide cheap yet strong fabrics and plastics.

Arguably the most significant indication of the promise that may be held by microbial textiles, however, is a project now under way at the Shirley Institute in Didsbury, Manchester. One of Britain's oldest research associations, the institute is financed by funds from the U.K. textile industry, technical services, and contract work for firms in Britain and abroad. And one of its most intriguing projects at present is to scrutinize the microbial world for organisms that might be of value in producing non-man-made fibers. Supported by 15 industrial companies and the Department of Trade and Industry, the work is now about a third of the way through its projected three years. Although detailed results are available only to the sponsoring organizations, there are signs that the Didsbury researchers have made considerable progress. If their hopes are realized, they will have gone a long way towards replacing fibers made by spinning and weaving—which characterized Britain's first industrial revolution—with those grown by the microbial work-horses of the second, biotechnology revolution.

Brian Sagar and his Shirley Institute team are particularly interested in microfungi as providers of thread-like mycelium that can be "wet laid," as in paper-making, to give new varieties of cloth. These would be far cheaper and stronger than conventional non-woven textile fibers, and consist of hyphae a fifth of their diameter. Usually branched, the fungal mycelium is ideal for forming a dense mesh, and could find applications ranging from simulated leather to medical and sanitary textiles. The polymer composing the cell wall is normally a beta-1,3-glucan, probably reinforced by beta-1,6-cross linkages to give a thick, tough structure. Other common components are polymannoses and poly-N-acetylglucosamines similar to the chitin found in insects. Preliminary screening of several different fungi has confirmed that mycelium can be filtered out as a matt, which must be protected from drying out and deterioration by adding a chemical plasticizer. Among the organisms showing special promise is a species of *Penicillium*.

Another part of Dr. Sagar's strategy is to locate bacteria producing enzymes that can be harnessed to improve the wet strength and abrasion resistance of existing fabrics. He and his collaborators are concentrating on dextransucrase, which will transfer glucose from sucrose to a polysaccharide, thereby either extending the chain length or introducing branching into the molecule. Earlier research at the Shirley Institute has demonstrated the feasibility of "graft polymerizing" cotton by adding sucrose units on to the chain ends (although much of the cellulose remains inaccessible to the enzyme). And a patent has been registered for a process employing sucrase plus sucrose to double the bursting strength of paper manufactured from cotton fibers.

Because the structure of viscose is far less dense and compact than that of cotton, it could be a more fruitful substrate for enzymic modification. This possibility, together with the screening of *Lactobacillus*, *Leuconostoc*, and *Streptococcus* species for extracellular dextransucrases, is now on Brian Sagar's agenda. He anticipates that only a small proportion of the bacteria will produce enzymes capable of catalyzing the side-glucosylation and chain extension of cellulose. But there are high hopes that the search will bring to light previously unrecognized sucrases, whose efficiency can be boosted further by appropriate reaction conditions—and possibly also by chemical modification or site-directed mutagenesis to alter the structure of the enzyme molecule.

A third string to Dr. Sagar's bow is a foray for new biopolymers to be exploited not only as sizes and adhesives but also as specialty fibers. Impressed by the diverse applications of xanthan gum from *Xanthomonas campestris*—from carpet printing to oil well drilling—he and his colleagues have begun to investigate other polymers like the polyuronide alginic acid from *Azotobacter vinelandii* and the glucan pullulan from *Aureobasidium pullulans*. By strain selection and development, they believe, it should be possible to tailor such materials for a variety of uses in the textile industry.

Inviting participation from companies after the first exploratory year, the Shirley Institute team described their project as an exclusive club. Although at that stage the membership fee was more conspicuous than the prospective benefits, there seems little doubt that those subscriptions (secured without difficulty) will have been well worthwhile.

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