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FINNS USE CELLULASE TO INCREASE ALCOHOL PRODUCTION

LONDON—With just a single, state-owned institution making alcoholic beverages, Finland's microbiologists believe they are peculiarly well-positioned to move new techniques quickly from research into large-scale production.

Speaking at the Biotech 84 conference, Jaakko Oksanen from the Finnish State Alcohol Company described one innovation he is hoping to nurse across that boundary—the use of cellulase to heighten the production of alcohol by fermenting grain. In both laboratory experiments and industrial-scale trials carried out at an integrated fermentation/distillation plant, this fungal enzyme has boosted yields significantly *and* spawned unanticipated side benefits. The net result, Oksanen claims, is sufficient to offset the cost of cellulase, compensate for a concomitant reduction in the output of waste sold as animal fodder, and suggest that the process will prove economically viable.

Wheat, maize and other cereals contain relatively little cellulose (mostly under five percent). This and the high price of cellulase, Oksanen said, had militated against such efforts in the past. But because even small increases in alcohol yield were important, and with enzymes likely to become less expensive in future, he and his colleagues decided to investigate the value of cellulolytic organisms in increasing the amount of carbohydrate available for fermentation. They concentrated on a *Trichoderma reesei* strain developed at the Technical Research Center of Finland, and on "Econase", which the organism produces. As well as cellulase, this enzyme preparation has xylanase, alpha-amylase, protease, and amyloglucosidase activities.

For laboratory tests, Oksanen removed from the industrial process 500 ml batches of wheat mash (liquified and saccharified by alpha-amylase and amyloglucosidase) just before mashing commenced. He then fermented them for 72 hours with or without Econase. Although there was considerable variation, alcohol yields were always several percentage points higher in the presence of enzyme—with corresponding reductions of over 10 percent in dry matter remaining and over 25 percent in separable solids.

Production-scale trials were carried out first as a continuous group of 30 fermentations, the middle 18 of which had Econase added just ahead of the yeast, and then (with one-eighth the amount of cellulase originally thought necessary) in a similar series of 91 fermentations. Yield improvements were again modest. During the first series, ethanol rose from 52.27 and 52.59 g/100 g starch for the controls before and after enzyme addition, to 53.73 during the test runs. But cellulase brought several additional unexpected benefits. Oksanen believes that for the Finnish fermentation/distillation plant, and probably for similar units elsewhere, these add up to make the process economically attractive.

One operating nuisance at the Finnish plant is fouling surfaces in a heat exchanger, which uses vapor from the raw spirit distillation columns to pre-heat mash between fermentor and still. This impairs the efficiency of the heat exchanger, requiring it to be bypassed and cleaned regularly. Judging by the 10°C difference in temperature of mash leaving the pre-heater, inclusion of cellulase led to a substantial saving of energy in the heat exchanger. Likewise, stillage water coming from the separator could be evaporated to a far higher dry-matter content (up to 40 percent). Instead of removing water in a disc drier, therefore, Oksanen found that he could employ a much more economical multistage evaporator.

Apart from the cost of cellulase, the main drawback of the Finnish process appears to be a reduction in the output of waste for use as fodder. However, Oksanen pointed out, the reduction was likely to be accompanied by a related increase in nitrogen content. Among other proven advantages he listed were the shortening of fermentation time and a diminshed demand for raw material and amylases. Predicted reductions in the cost of cellulase, together with genetically engineered improvements in producer organisms, would render the process even more attractive, Oksanen said. **—Bernard Dixon**

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MORE AMINO ACIDS PRODUCED FROM WHEY

Sidney Brenner, Director of the Cambridge Laboratory of Molecular Biology, in his plenary address to Biotech 84 welcomed greater collaboration between universities and industry, but warned delegates: "The roles of the parties should never be confused. Scientists make terrible businessmen, and vice-versa. Make sure the areas of responsibility are clear and separate."

LONDON—Wheys and means of mopping up the liquid waste of the world cheese industry crossed the minds of several speakers during the Biotech 84 meeting. Not only is whey potentially a rich source of lactose and soluble proteins that goes largely unused, but it can also cause a serious effluent problem.

One biomass expert, Jim Coombs of Kings College, London, suggested whey would be one possible fermentable feedstock for a hypothetical European Community fuel alcohol program. Even disregarding the present unfavorable cost position of ethanol against oil, however, getting the ten individual states to agree on a realistic plan would be a notable achievement. And in that unlikely situation, the low concentration of fermentable solids, yielding only 0.03 kg ethanol/kh, make it an unpromising choice, he admitted.

Higher-value products such as amino acids present a more attractive solution. The natural souring of milk yields a racemic mixture of L and D lactate that could produce optically pure and economically useful L amino acids.

According to Christian Wandrey, of the West German Institute of Biotechnology of the Nuclear Research Center in Julich, the system originally developed for alanine has now been adapted to produce three others: methionine, leucine and phenylalanine.

With alanine, the system operates by conversion via pyruvate. The reaction is catalyzed by the D and L lactate