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SHORT COMMUNICATION

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A NOTE ON THE PROTEIN DEFICIT AND ENVIRONMENTAL ENGINEERING

A conference on research and development in protein production has been recently held in Katowice, Poland, under the auspices of the Polish Academy of Science. The meeting has proved that food management scientists tend to overlook the possible revenues in nutrient recovery from pollution control processes.

The plenary session dwelt on the subjects of increasing the collection of aquatic marine protein, such as Antarctic krill, versus production — within the country — of protein food based on the single cell protein (SCP) technologies as well as protein from higher plants and animals. Subsequently, the meeting went on in six simultaneous sessions where close to ninety papers were presented and discussed. Two of the sessions dealt directly with the problems of environmental pollution control: ichtiology and mariculture [6].

Recent achievements were presented in utilization of thermal discharges for the increase of fish production. Both coarse (carp) and game fish (rainbow trout) raised in thermal discharges, indicated excellent results and economical benefits — exceeding all high-rate enterprises run in conventional manner. The papers overlooked, however, the fact that intensified fish production is in itself an important source of water pollution. The degradation of lake habitats because of intensive cage production of fish in situ has been, unfortunately, well documented by practice [8].

The note is aimed at stressing some of the recovery aspects of sanitary engineering treatment processes.

Interesting proposals were extended as to the utilization of wastewater treatment plant effluents for fish production. The balance of nutrients in biological effluents is so favourable that in several of the Polish fish ponds installations the yields exceeded 1000 kg/ha·a. An interesting additional benefit is the growing of ducks on Lemma minor (duckweed)— the yields usually oscillate around 500 birds per hectare. Certain municipalities in this country utilize also duckweed as direct hog feed additive [4].

The irrigation practice should primarily look for sources containing waste nutrients, such as municipal wastewater biological treatment plant effluents, nutrients — and microelements — rich municipal sludges, or animal wastes. The extensive experience with the use of food processing wastes, and safe accumulation of animal wastes for crop increase, is a fact very well documented in Poland also from the pollution control point of view. An international cooperation project is devoted solely to the description of this country's achievements in agricultural utilization of nutrients from wastes and wastewaters [2].

During the conference a proposal was made to combine excess activated sludge disposal with biomass culturing. The concept is not a new one, since this type of treatment has been applied for over 50 years in some small municipalities [4]. There is a need, however, to establish the technological and technical basis for incorporation of these systems into the sanitary enginnering optional treatment alternatives. The nutrient potential of wastewater effluents is tremendous and still remains untapped. The studies of planktons in

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warm climate ponds fed with animal manure as fertilizer, proved the standing crop to be 100–1000 times greater than in the nonmanured ponds, and contained 45–55 % of protein. The manured fish ponds in Israel produced experimentally fish yields as high as 30 kg/ha·day, which is twice the average yield of warm-water ponds receiving conventional feeds and 10 times the yields of ponds receiving neither feed nor manure [7].

The fish protein reserves in lakes are decreasing, while the river fisheries cannot be taken into serious consideration at present, due to the increased overfishing of resources and the decreasing quality of surface streams. This has been demonstrated at the conference as the disapearance of the once important natural protein source. Thus it seems that the intensive utilization of organic wastewaters in aquaculture, as suggested by environmental engineers, should be considered as the only solution for a rapid increase of the freshwater fish protein supply for the fodder market.

An analysis of technology and the economics of algae production have also been briefly presented at the Katowice meeting. The full-scale long-term experiments document, however, the need for an inexpensive carbon source, as the price of pure protein recovered from algae was calculated from pilot scale data to be equal to 60–80 % of that of the quality meats. Thus, it seems again that wastewater nutrients, overlooked by food scientists, could be utilized here with an additional benefit of polishing (tertiary) treatment of biological effluents. One has to note the fact that successful algae production on strong hog wastes has already been documented in Europe [3] and is currently researched as a means of N, P, K stripping from the large farms' effluents [5]. The amino acid spectrum of algae grown on swine effluents, namely the *Chlorella vulgaris* species, compares favourably with the protein obtained from the *Scenedesmus*, *Spirulina*, soy and milk. The *Chlorella* protein appears to be equivalent to milk protein, except for a deficiency in methionine [1].

A number of papers at the Katowice conference dealt with yeast fermentation of hydrocarbons obtained from coal and or crude oil. It is interesting to note that nothing was said about fermentation of wastewaters with yeast cultures. The practice of SCP extraction from wastewaters through yeasts of the *Torulla* and *Candida* types has been limited in this country to certain food processing wastes (e.g. breweries) and to cellulose plant effluents. The laboratory and full scale experiments indicate, however, the suitability of yeast fermentation as an SCP source based on animal manures and a dozen of other food processing wastes. Excellent yields of *Rhodotorulla glutinis*, *Candida utilis*, *Geotrichum candidum*, *Endomycopsis fibuliger* and other species were attained on effluents from the beet sugar industry, from malting, from distilling, breweries and from various potato processing operations. With average batch times of 24 hrs, the average substrate removals varied between 50 and 90 %, while crude protein production amounted from 26 to 64 % of the biomass [9]. There are proposals and studies on full scale recycling of animal waste nutrients through the SCP yeast production cycle [5]. These unaccounted for protein resources in effluents are seldom exploited, while their irresponsible stream disposal results in serious degradation of the aquatic environment.

REFERENCES

[1] Boersma L. et al., *Protein production rates by algae using swine manure as a substrate*, [In:] *Energy, agriculture and waste management*, Ann. Arbor Scien. Publ., pp. 475–493, 1975.

[2] Cebula J. et al., *Utilization of sewage sludges from combined treatment plants together with municipal solid wastes*, Project PL-5-532-8, jointly by Governments of Poland and United States, Wrocław 1978.

[3] De Pauw N., Leenheer L., *Mass culturing of marine and freshwater algae on aerated swine manure* (In English), Proceed. „Cultivation of fish fry and its live food", Conference, Szymbark, Poland, Sept. 23–28, 1977.

[4] Oleszkiewicz J., Oleszkiewicz M., *Water pollution control in Poland*, Environment Protection Engineering **4**, 1, 1978.

[5] Oleszkiewicz J., Koziarski S., Łukasińska A. et al., *Optimization of animal wastes treatment with reference to biogas and protein recovery*, Project JB-5-534-7, jointly by Governments of Poland and United States, Wrocław 1978.

6] Proceedings: *Research and development in protein production* (in Polish) March 10–11 1978 Katowice, Vol. I, II and III, 850 pp.

[7] SCHROEDER G. L., *Agricultural wastes in fish farming. A commercial application of the culture of single-celled organisms for protein production*, Water Research **11**, 419–420, 1977.

[8] State Lake Fisheries at Międzyrzecz: Private communications, Międzyrzecz 1977.

[9] TOMLISON E. J., *The production of SCP from strong organic waste waters from the food drink processing industries. 1 — Laboratory cultures. 2 — The practical and economic feasibility of a non-septic batch culture*, Water Research **10**, 367–376, 1976.