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ACTION MEMORANDUM

TO: AA/TA, Dr. E. J. Long

THRU: TA/RES, Miloslav Rechcigl MR

FROM: TA/AGR, Leon F. Hesser LFHe.

SUBJECT: Microencapsulation of Pesticides

Problem: Current pesticide application to livestock for control of insects and ticks, which are vectors of disease, is a costly and repetitive process. Often, cattle must be dipped or sprayed at least weekly with insecticides. Even under such stringent regimes pest control is limited in effectiveness because of the tendency of insects to develop resistance to commonly used insecticides.

Purpose of Research: This proposal is designed to study the feasibility of microencapsulation of repellants or pesticides, particularly natural pyrethrum and synthetic analogues, to extend their viability for a longer length of time. The reasons for concentrating on pyrethrum or similar compounds is that they have not as yet shown the tendency of insect resistance common with hydrocarbon or organic phosphorus compounds, and they are biodegradable. While the principal concern is the control of tsetse flies, it could be equally effective against biting flies, ticks and other insects that prey upon grazing livestock.

This research is aimed at the identification of both materials and methods that can successfully be used to apply pesticides and repellents by the microencapsulation technique. The technique if successful will have a substantial impact on more effective livestock production at lower cost at all levels of farm animal operations.

Discussion: Microencapsulation of pesticides is a new and potentially productive system for reducing the volume of pesticides necessary for control, increasing the viability and length of actions of pesticides and, in this specific proposal, to enhance the effectiveness of the highly potent pesticide, pyrethrum, which has a short half life when exposed to sunlight.

Pyrethrum is a natural pesticide which has not yet shown evidence of producing resistance by insects including the tsetse fly. At the same time, it has demonstrated strong repellant characteristics and is thus an ideal candidate for formulations which may extend its activity.

Furthermore, pyrethrum is a valuable cash crop for small farmers. Successful extension of insecticide activity by the technique of micro-encapsulation would result in its expanded exploitation.

Rationale: Pyrethrum is one of the most effective arthropod pesticides known, yet it has an unfortunate characteristic of losing potency in exposure to sunlight. Pyrethrum is a naturally occurring plant Chrysanthenum cinerariaefolium in Africa and other parts of the world. It grows well on poor soil and is an ideal crop for small farm operations returning a relatively high income for very little investment. It is also ideally suited to a cooperative production, processing and marketing system.

Pyrethrum is a non-persistant bio-degradable insecticide/pesticide that meets all of the most stringent environmental protection requirements.

The exploitation of this crop has been considered by many donor agencies, and TA/AGR has long been interested in a way of "getting a handle" on how to use it effectively and at the same time capitalizing on our mandate to help the small farmer producer. TA/AGR solicited expressions of interest from the University of California and Oregon State University on microencapsulation or other means of exploiting this crop and has to date received no formal proposal. The attached unsolicited proposal from Pennwalt Corporation appears to fit very well into a small research proposal.

The target insects or ticks for toxicant or repellant activity are not present in the United States and thus the action of the delayed release materials cannot be evaluated in this country. The Israel Institute for Biological Research maintains colonies of these insects and tick species (particularly tsetse flies and Ornithodorus ticks) and is in a position to test the compounds developed at Pennwalt Corporation. A subcontract, details of which are to be drawn up for approval by AID, will control relations between AID, Pennwalt and the Israel Institute for Biological Research.

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Specific Products Expected to be Developed from the Proposed Research

The primary product expected to be developed from this research is a stable delayed release natural pyrethrum pesticide/acaricide. This microencapsulated product will be measured for efficacy against oth[illegible]layed release materials of known toxicity or repellancy. T[illegible]rial or the reference materials against which it is t[illegible] may replace currently used pesticides known to have certain ha[illegible]us toxicity levels and to have caused a development of resistance in some target insect species.

Capability of Principal Investigators: The principal investigator at Pennwalt Corporation are recognized authorities in the field of microencapsulation and delayed release of chemicals. The Corporation, under research guidance of the investigators, has produced a number of slow release pesticide formulations for agricultural use that are on the market today. The investigators at the Israel Institute for Biological Research are experienced at bio-assay techniques for chemical toxicity to target insects and ticks having carried out such investigations both at the laboratories in Israel and also at the International Center for Insect Physiology and Ecology (ICIPE). It is expected that the successful research technique resulting from this work will be extended to field trial operations on East African ranches under the direction and organization of ICIPE and the Kenya Pyrethrum Board.

Expert Review: This proposal has been discussed with the Research Office of TAB/AGR and with the TA/H Office. It has also been discussed with Dr. Virgil Freed of Oregon State University and with other personnel of the Pest Management Program. In addition, the draft proposal was discussed with the Pyrethrum Bureau in Kenya which enthusiastically supported the initial research and indicated interest in aparticipation in possibly subsequent field trails should the preliminary research prove fruitful.

The estimated cost of this research to determine the effectiveness of microencapsulated pyrethrum on African arthropods (ticks and tsetse flies) under laboratory conditions is expected to be $35,000. Pennwalt Corporation has indicated a capability and interest in carrying out this research. In the event that this research activity is approved, the work is to start on or about March 1977. It will take 12 months to complete the research.

Research proof that microencapsulation is found to be an effective method of applying repellants and pesticides for the control or eradication of vectors will represent a major breakthrough in AID's efforts in vector borne disease control.

Recommendation: That you approve this Small Research Activity at the level of $35,000.

APPROVED: Ernest J. Long

DISAPPROVED: _____

DATE : Feb. 18, 1977

Project Statement

A. Project Summary

1. Statistical

The use of microencapsulated repellents and pesticides to control or eradicate vectors causing parasitic diseases in cattle in East Africa.

Contractor:

Pennwalt Corporation
Central Research and Development
900 First Avenue
King of Prussia, Pennsylvania 19406

Status:

Small Research Activity: New

Total Estimated Cost:

Through AID/ta -- $35,000
(Research for 12 months)

Principal Investigators:

Mr. Joseph Simkin, Senior Research Chemist
Central Research and Development
Pennwalt Corporation
900 First Avenue
King of Prussia, PA 19406

Dr. A. Tahore, Research Chemist
Israel Institute for Biological Research
Neso-Ziona, Israel

Project Manager:

Nels Konnerup, TA/AGR

2. Narrative Summary:

The microencapsulation technique offers a unique means to deliver a repellent or pesticide at a more nearly optimum release rate. This results in cost savings and safety in the handling of such materials. In addition, because of their slow release characteristics, microencapsulated repellents and pesticides are significantly less toxic to mammals and the surrounding environment than the same products in natural form. The proposal, which is aimed at exploiting the advantages offered by microencapsulation in control and/or eradication of vectors causing parasitic diseases in cattle in East Africa, can be summarized as follows:

a. Microencapsulation of natural pyrethrum and other repellents and pesticides with a proven record of toxicity or repellency to the specific vectors, namely, biting flies and ticks.

b. Preliminary laboratory evaluation of the encapsulated products on suitable insects or arachnids to monitor wall parameters that determine the release rate of the active ingredients.

c. Laboratory evaluation of selected encapsulated materials on target vectors. This part of the program will be carried out at the Israel Institute of Biological Research (IIBR).

B. Research Purpose and Expected Products

1. A number of approaches for improving the technology of controlling pest infestations in agriculture have been developed in recent years. One of these novel techniques is referred to as microencapsulation.

Although eradication of blood-sucking insects using pesticides has been an attractive goal, the history of the programs to eradicate the tsetse flies in Africa suggests that more is needed than just an effective pesticide. Factors such as the economics of the region, the cattle-raising practices of the farmers, the particular procedures for conducting the programs, and the regional climate, all play an important role in determining the success of eradication programs. Moreover, if eradication programs are not conducted properly they can lead to the development of resistant strains of the vectors.

The uses of chemicals that can act both as repellents and pesticides is an attractive way to protect the livestock from the bites of vectors and hence from the diseases they transmit. Indeed, a pesticide formulation without repellent properties, although capable of eliminating the vectors after contact, may not be able to prevent initial biting by the vectors and thus transmittal of the disease. It is important, of course, that the repellent-pesticide combination be 100% effective, inexpensive, easy to handle, and safe to livestock and humans.

Natural pyrethrum is an excellent candidate for this application because it has been found to be both a very effective repellent and a toxicant for the vectors under consideration. However, it tends to decompose rapidly in ultra-violet light, thus losing its activity. It is believed that this shortcoming could be minimized by micro-encapsulation.

2. It is expected that this research may provide a mechanism for prolonging and extending the efficacy of a well proven effective pesticide with little or no hazards to other than the target pest species. The encapsulation technique also may significantly reduce the tendency of pesticide resistance by reducing second generation survival of pests through longer lethal action.

C. Significance and Rationale for the Research

Major parasites causing considerable damage to cattle in tropical areas are classified as hemoparasites. These parasites are transmitted to cattle and other mammals by vectors such as ticks and biting flies. For example, in some parts of Africa cattle become infected with "Nagama", a disease caused by Trypanosomes and transmitted by tsetse flies of the genus Glossina. A consequence of such infection is that about 4.5 million square miles of land in that continent cannot be used for cattle raising. Similarly, cattle in Africa are also subject to diseases caused by hemoparasites transmitted to them by infected ticks of the species of Ornithodoros and Rhipicephalus.

A variety of methods of physical, biological, and chemical control and/or eradication of vectors have been tried over the past several years. In addition, efforts have been made to treat infected cattle with drugs and healthy cattle with prophylactics to prevent infection. However, eradication of the vector appears to be the most practical control measure.

Chemical agents used to control or eradicate the vectors, i.e., biting flies and ticks, were, until recently, organochlorine compounds. Although the latter have been fairly effective in eradication of the vectors, cases of environmental damage in their use elsewhere have prompted evaluation of other insecticides. In one such evaluation, Hadaway compared 29 different pesticides and found that resmethrin and fenthion were among the most effective against tsetse flies. Natural pyrethrum was not included in this study. Galun studied the efficacy of some chemical repellents in preventing blood-sucking invertebrates from biting livestock and concluded that, with the exception of natural pyrethrum, the currently available repellents cannot be completely relied upon to prevent the vectors from biting livestock.

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Microencapsulation of insecticides prolongs their efficacy sufficiently to allow the number and rate of required applications to be reduced. Oral and dermal tests with laboratory animals indicate a significantly reduced mammalian toxicity for microencapsulated insecticides.

D. Plans to Coordinate and Link Research

This is a Small Research Project to be completed in approximately one year. Nevertheless, the prime contractor has coordinated research and research testing with an experienced research unit in Israel which has in turn important linkages with ICIPE and the Pyrethrum Bureau in East Africa. These linkages provide an avenue for expanded field testing of research results and possible application of more effective and safer pest control systems.

E. Plan to Facilitate Utilization of Research Results

This Small Research Activity may develop pest control systems more effective than those now existing. If this proves to be the case, ICIPE and the Pyrethrum Bureau have indicated an interest in an expanded field trial program. The results of this research will be incorporated in proposed Workshops in the Pesticide Management Program.

F. Management Considerations

The Livestock Division of TA/AGR will be responsible for project management. The project officer will coordinate activities of the prime contractor, the subordinate contractor and the interested institutions in East Africa.

An evaluation will be held before the termination of the contract and a team of experts will determine the level of research accomplishment in respect to extending the investigations to field level trials.

G. Technical Review

A technical review by the team of experts will indicate the future course of proposed action.

H. Research Project Design Method

The research design of this project is primarily to test the concept of microencapsulation as applied to pyrethrum.

A basic encapsulation technique has already been developed for these pecticides; therefore, tailoring of the capsules for optimum performance in the intended use should be relatively straightforward.

Preliminary screening of the encapsulated materials will be carried out at Pennwalt's facilities and will involve the use of common house flies and, possibly, ticks.

The more promising encapsulated materials, as determined by the preliminary in-house screening, will be sent to IIBR for testing against target vectors.

The more successful encapsulated compositions will be formulated for initial evaluation directly on the hides of cattle and other livestock. This work could be carried out in cooperation with ICIPE and/or IIBR. The products that show the best results would be considered for field tests in Kenya.

I. Budget

The budget for this project is for $35,000 for one year. The major budgetary allocation is for research at Pennwalt Corporation -- $25,000 -- and a subsidiary component of $10,000 for investigations on the efficacy of products developed at Pennwalt Corporation on insect colonies currently maintained at IIBR in Israel.

J. Environmental Impact

The basic premise for this research is to explore methods for reducing environmental hazards caused by the indiscriminate or repetitive use of chemicals or pesticides which are toxic or otherwise dangerous to non-target organisms. It is anticipated that the results of this research will improve the effectiveness of one of the least hazardous insecticides, increase the longevity of the pesticide to the specific pest species, and reduce the tendency of pest resistance to insecticides.