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15821

DP/ID/SER.A/752
22 September 1986
ENGLISH

CONSOLIDATION OF THE CAPACITY OF INSTITUTE OF FOOD TECHNOLOGY
THROUGH THE CREATION OF A NATIONAL FOOD PACKAGING CENTRE

DP/BRA/82/030

BRAZIL

Technical reports, Food processing*

Prepared for the Government of Brazil
by the United Nations Industrial Development Organization,
acting as Executing Agency for the
United Nations Development Programme

Based on the work of Theron W. Downes,
Expert in food processing

United Nations Industrial Development Organization
Vienna

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V.86-60012

TABLE OF CONTENTS

	<u>Page</u>
Summary-----	2
Introduction-----	3
Mission Objectives-----	7
Mission Activities	
1. Presentations-----	8
2. Project Evaluation-----	9
3. Tomato Packaging-----	12
Observations and Recommendations-----	14
References-----	18
Annex I: Job Description-----	20

SUMMARY

The primary objectives of this mission were to (1) present and promote technical interchange of information related to food packaging requirements, (2) evaluate existing and future project efforts, and (3) provide specific and detailed assistance to the Project, "Correlation between transport field testing and laboratory testing for tomato distribution package in Brazil".

All terms of reference were completed. Technical information interchange was conducted through five seminars and workshops held internally at ITAL and one external seminar in São Paulo in cooperation with the Brazilian Packaging Association. Meetings and discussions were held regarding specific projects. Detailed assistance was given to the tomato distribution packaging project through analysis of materials and methods, evaluation of statistical analysis, assistance in data analysis, preparation of conclusions, etc. Expanded comments regarding these activities are provided in the sections which follow.

Continued development of the packaging industry will play a critical role in the economic and social health of Brazil. A nucleus of trained personnel has been developed within the Packaging Section at the Institute of Food Technology (ITAL) in Campinas, S.P. Continued support and expansion of the activities in the Packaging area is vital for Brazil with implications for all of Latin America.

INTRODUCTION

The United Nations Industrial Development Organization, in cooperation with the United Nations Development program and the Brazilian Government, instituted a program in 1982 for the creation of a packaging center in Brazil. The purpose of this centre is to provide a focal point for technology transfer and solutions to industrial problems in food packaging. The activities would provide many benefits in terms of improvement in quality and adequacy of distribution of food products in Brazil through an integrated system of Government and Private Sector cooperation. These are goals which are almost universally admired, and certainly exist with high priority within the United Nations and the Brazilian Government.

It can be said that the science and technology of packaging has evolved to its present state over a relatively long period of time in the more developed nations. There is an urgent necessity to accelerate this process in Brazil (and in many other nations).

Imagine, as an analogy, the requirement to deliver goods and services to isolated outposts in the dead of winter in the Arctic Ocean north of Canada. Normal ships cannot reach their destinations because of the thickness of the ice which covers all of the open water. But ice-breakers, ships with powerful engines and specially designed hulls, can open passageways through which lesser ships can travel at greatly increased speed. Communication is the key, for the lesser ships must know what paths the ice-breakers have followed. The nucleus for the establishment of such a communications center in Brazil for packaging technology has been created in CETEA.

Kusuda (1986) has described the manner in which Japan has followed this course of action during the last 20 years. He describes a revolution in usage of packaging materials, from natural materials like bamboo, wood, and straw to modern materials like paper, metals, and plastics. He states; (Kusuda, 1986)

"The packaging industry (in Japan) was established in the last half of the 1960's, the scale of the industry expanded to the second largest in the world in 1970, and the level of the packaging technology almost reached the top level of the world in 1975".

The author of this report, a citizen of the U.S.A., is intrigued by the fact that Kusuda, writing in 1986, chose not to speculate about the level that the Japanese packaging technology had reached in the years following 1975. He does describe what he considers to be the important technologies which Japan imported from overseas. They include containers, e.g. aerosols, materials, e.g. PVDC, Nylon, PE, PET, PS, EVA, PVA, and PP, and systems, e.g. extrusion coating, stretch materials, and coextrusion technology. If Brazil is to succeed in its efforts to emulate Japan's rapid introduction of modern packaging technology, CETEA will need to play a vital role.

The Center for Food Packaging Technology, CETEA, is an expansion of the Packaging Section at ITAL. Creation of the Center is being implemented through the Project BRA/82/030, "Consolidation of the Existing Capacity of the Institute of Food Technology (ITAL) through the creation of a National Food Packaging Centre". Participating, and supporting this effort are the Government of the State of São Paulo, the Brazilian Federal Government (FINEP-EMBRAPA), the United Nations Development Program (UNDP), and the United Nations Industrial Development Organization (UNIDO). In addition to providing assistance to the food packaging industry in Brazil, a further objective of the Center would be to provide training and assistance in the area of food packaging to other Latin American and Caribbean Nations.

It is important to emphasize the words, "Existing Capacity", in the Project title. Effective organizations always are supported by a "three legged stool". The three legs are (1) people, (2) facilities, and (3) support, both financial and administrative. The most important of these are people. Nothing is ever accomplished without competent, motivated people. CETEA, today, has a well trained staff that includes 14 engineers and a 11 laboratory technicians. All of the engineers have sound undergraduate training and many have, or are completing Masters Degrees as well. In addition, the technicians have specific training on specialized equipment and methods and the engineers have participated in a well planned program of further training. This program has included special courses related to packaging offered by foreign experts who have travelled to ITAL with UNIDO support. It has also included study abroad in special courses, advanced degrees earned in Brazil and abroad, and study tours of foreign industry, government

institutions, and Universities. Special commendation should be given to Mr. Luis Fernando Ceribelli Madi, among others, for the administration of this program of continued professional development which has created a cadre of packaging professionals with the knowledge and experience to make the creation of a National Food Packaging Center possible.

The second leg of the stool, facilities, are also largely in place. A packaging laboratory has been constructed. Over US\$1,000,000,00 has been spent to acquire equipment appropriate for the testing and evaluation of packaging materials, containers, systems, and components. Food analysis capability for the evaluation of shelf-life also exists. Although well equipped, further acquisition is indicated in some areas. For example, modern electronically controlled shock and vibration equipment for testing and evaluation of the ability of containers and package systems to withstand the mechanical hazards of the distribution system is required if a center truly capable of addressing the needs on a national and international level is to be created. Further equipment needs are indicated in other areas as well and have been addressed in previous reports. (Chowdary, 1985, de Waal 1986)

The third leg of the stool is support, financial and administrative. Past support has been sufficient to create the nucleus for the establishment of a national center of excellence in packaging. This author's knowledge of similar efforts with many of the same objectives in other parts of the world leads him to state, without reservations, that CETEA can be taken as a model for addressing packaging technology needs in the developing world. It would be tragic if support, either financial or administrative, were removed or significantly diminished at this time. CETEA has begun to pay returns on the investments in people and facilities through seminars and training programs, participation in the development of standards and specifications, publications, quality control programs, testing, research and development programs, etc. But the return on investment (ROI) will be greatly limited if continued support is not forthcoming. The greatest returns still lie in the future, through integration of government and private sector activity. Significant among the potential benefits are improved balance of payments through export of value added, prepackaged food products to the developed nations. Success in

these competitive markets requires knowledge of the distribution system from the country of origin through various systems of storage, handling, and transportation to the ultimate consumer. It requires knowledge of the market behavior in the country of consumption, and it requires appropriate packaging for the ultimate market. Often, the appropriate packaging will be very different from the appropriate packaging systems in the country of origin, and differences will exist among the consuming nations as well. The opportunities in the export market for food are enormous (Fortune, 1986) and represent another justification for continued support of CETEA.

MISSION OBJECTIVES

The mission described in this report is just one small part of the program for professional development of the CETEA staff which has been described in the foregoing pages. The specific objectives of this one month effort are reproduced below and also offered as Annex I attached to this report:

1. Presentation of internal and external seminars and papers on such subjects as shelf-life, specification, product and consumer protection, and food packaging requirements;

2. Evaluation of CETEA's present and planned research and testing activity;

3. Assistance to the Project, "Correlation between field testing and laboratory testing for tomato distribution packages in Brazil"; and

4. Preparation of a final report in English regarding the activities of the mission.

The author feels confident in stating that all of the above objectives have been met. Specific evidence to support that claim is provided in the next section of this report.

ACTIVITIES

1. Seminars and Papers presented

A. Internal

Five internal seminars and workshops were provided as follows:

- I. August 11, 1986: "Food Package Integrity: Methods of Evaluation, Quality Control, and Technical Implications".
- II. August 13, 1986. "Organic Vapor Permeability of Polymeric Packaging Materials: Theoretical and Practical Considerations".
- III. August 15, 1986. "Food Packaging Trends in the North American Market: Technical, Economic, and Protection Implications".
- IV. August 18, 1986. "Workshop on Packaged Food Product Shelf-life I".
- V. August 19, 1986. "Workshop on Packaged Food Product Shelf-life II".

B. External

August 27, 1986. "Trends in Packaging for the North American Market and some Technical Implications. Held in São Paulo in cooperation with the Brazilian Packaging Association.

The presentation regarding package integrity critically analysed some of the accepted methods for evaluation of the ability of containers to maintain hermetic seals during distribution. Post process contamination of packaged foods by microorganisms is mostly an economic concern with high acid food products. It becomes a matter of public health significance with serious social and economic importance when dealing with low acid shelf stable packaged foods. Some implications for international trade were also discussed. A meeting was also held in the laboratory to evaluate presently used methods of evaluation of integrity in retort pouches of thermally processed low acid food products and other package systems.

The importance of providing protection from gain or loss of volatile organic compounds has been increasingly recognized during the last few years. (Mokney et. al., 1986). Quality deterioration

can be the result of flavor loss as is observed in fruit and fruit flavored products or it may be the result of the absorption of objectionable flavors from or through the package wall, as is observed with various candy products. While permeability properties are mostly concentration independent for permanent gases such as oxygen and carbon dioxide, profound concentration dependent effects are commonly observed when packaging polymers are called upon to provide protection from organic vapor gain or loss (Hernandez, 1984, Zobel, 1985). Theoretical and practical considerations in the measurement and specification of organic vapor barrier were presented.

The workshops on shelf-life of packaged food products focused on mathematical models for the prediction of quality degradation of oxygen and moisture sensitive food products in semi-permeable packaging. Zero, first, and second order kinetics were reviewed and their application for shelf-life prediction was discussed. Arrhenius temperature effects were discussed as was their application to experimental design. Some of the common problems and errors associated with accelerated testing were described (Labuza and Schmidl, 1985).

2. Project Evaluation

Thirty or more specific projects were in various stages of completion during this consultant's visit in August, 1986. Of these, specific evaluation was requested regarding the following:

- A. Study of the effect of metalization on the protective characteristics of food packaging materials.
- B. Study of the characteristics of bag-in-box packaging made in Brazil and its suitability for packing liquid products.
- C. Adequacy of the industrial technology for packing tuna in sterilizable flexible packaging.
- D. Specification, quality control, and training course for packaging of basic food products.
- E. Development of semi-rigid packaging for tomato paste.

Specific comments regarding each of the above projects are provided in the following paragraphs. Some general comments about

these projects and new efforts presently under consideration follow the specific comments.

A. Metalization

It is the autor's understanding that, at present, the deposition of a thin (0,5um) layer of aluminum on a plastic substrate is considered in Brazil to be mainly a cosmetic procedure intended to exhanche the physical appearance of the pouches or bags made from this type of material. The common practice is to ship the substrate in roll form to a vacuum metallizer, and then to laminate a heat sealable material to the metallized film so that the layer of aluminum is buried, like a sandwich between the two materials. Polythylene is commonly chosen for the heat seal layer. Unmodified polyethylene does not exhibit good adhesion characteristics to aluminum and the resultant material is very prone to delamination.

The primary objectives of this project were to evaluate the relationship between the thickness of the metal layer and the properties of the film, and to develop methods appropriate for quality control for measurement of the thickness of the metal layer. Metallizers provide three levels of metallization, standard, somewhat more than standard, and somewhat less than standard. Only three different levels of aluminum coating were available for the study. Methods used for evaluation included gravimetric, atomic absorption spectrophotometry, resistance measurement, and optical density. As expected, the best results were found with atomic absorption and optical density. All methods are indirect, in that some property (resistance, opacity, or quantity) related to thickness was measured. It would be useful to find a direct method of measurement to use for correlation, but it is recognized that finding access to an electron microscope may be difficult.:

The projects dealing with bag-in-box packaging and tuna in sterilizable flexible packaging, share the characteristic that an important objective was determination of the suitability of packaging materials and components produced in Brazil. Both projects have also suffered from difficulty in acquiring appropriate materials for testing purposes. In the bag-in-box project the problem was inability to attain a dispensing valve suitable for wine packaging. The valves available exhibited inadequate barriers to oxygen transfer.

Demonstration of the suitability of these package systems for the intended applications could be achieved through the use of substitute components, i.e. a non-dispensing valve of adequate oxygen barrier could be used to demonstrate that wine will have an acceptable shelf-life in this type of packaging. Such demonstrations are sometimes useful to provide evidence for a potential market which will then accelerate the necessary development efforts by suppliers. This reviewer must stop short of recommending this course of action because its effectiveness must be evaluated on a local level and its priority weighed against the other projects which compete for time and effort.

It is unlikely that a semi-rigid polypropylene container of reasonable wall thicknesses will provide enough barrier to oxygen transfer to protect a product like tomato paste long enough to allow for its introduction into normal distribution channels (e.g.) supermarkets. This does not mean that the project to evaluate this package system should necessarily be abandoned. Useful information regarding the production and evaluation of hermetic seals as well as determination of the barrier properties of the system will be generated. This will provide the basis for further cooperation with the industry in evaluation of the system for other, less labile, products where the protection requirements are not so stringent.

The project for FAE entails the development of specifications, quality control procedures, and related training courses for packaging used in the School Lunch Program. This is a program of national importance. The effectiveness of this program will be enhanced, and ultimately may depend upon, seeking and obtaining the active participation of suppliers and producers in the development of specifications and testing methods.

All of the above projects coincide well with the mission, goals, and objectives of the Packaging Section at ITAL. They also relate well to the creation of a National Center of excellence. The projects include various aspects of system evaluation and development with the potential for expanded markets. The FAE project includes a desirable phase of expansion of activities in the area of training and extension. The emphasis on industrial cooperation, potential national importance, and a total systems approach (as opposed to material evaluation alone) is highly desirable.

3. Assistance to the Project, "Correlation between field testing and laboratory testing for tomato distribution packages in Brazil"

The prevalent system for transport and distribution of fresh tomatoes uses a wooden box, "caixa K". Losses result in the form of tomatoes which are unacceptable for sale and also as a reduced price for damaged product. These losses have been estimated to be 20 - 30% (Madi, 1977). In 1983, total production of tomatoes was 1,547,000 tons (Ardito, 1986) so the economic value of these losses is large.

Alternative packaging, e.g. corrugated containers, may result in a reduction in these losses and it is likely that other system costs would be reduced as well. Demonstration of these advantages, however, is somewhat difficult. It is difficult and costly to obtain the necessary permits and cooperation to conduct field tests (Ardito, 1986). Further, the interpretation of the results of actual shipping tests is controversial. It is subject to both theoretical and practical difficulties and experts disagree as to the validity of the conclusions which may be drawn.

It is an accepted approach, therefore, to design laboratory tests for package design and for performance evaluation. As with field testing, it is not possible to perfectly define the mechanical environment but laboratory tests have significant cost advantages and they are reproducible. This provides sound theoretical information on which to base judgements and comparisons of package systems. The primary objective of this study was develop information to provide the basis for developing a laboratory test suitable for prediction and comparison of systems for distribution of fresh tomatoes in Brazil.

Assistance has been provided in all phases of justifying, planning, conducting, and evaluating this project. Here the author wishes to acknowledge the contributions also of Dr. Joseph Miltz, Professor at the Technion, Israel and visiting Professor at Michigan State University, and Dr. Julian Lee, Associate Professor in the School of Packaging at Michigan State University. Invaluable support and assistance was also provided by ITAL, and specifically Mr. Luis F. Ceribelli Madi.

The assistance has taken the form of advice on appropriate coursework and background material, identification of appropriate test methods and levels, experimental design and interpretation, and analysis of results. Specific details regarding this project can be found in Ardito (1986).

OBSERVATIONS AND RECOMMENDATIONS

It will be obvious to any reader who has read the introductory section of this report that the author applauds previous efforts and strongly supports continued development and expansion of the activities of the Packaging Section at ITAL. The creation of a "center of excellence" in packaging should be viewed as a capital investment and the return on that investment will be very large if continued attention is given to personnel and equipment development together with the needed financial and administrative support. The cash value which will be realized from the efforts of this group of packaging professionals will be largely in the following areas:

1. Expansion of domestic markets;
2. Reduced losses in the distribution system;
3. Improved efficiencies in production; distribution, and marketing;
4. Improved balance of payments through increased competitiveness in foreign markets.

There are also important social and public health benefits which will accrue as a result of the center of excellence in packaging. These comments are supported by evidence of a general industry and government consensus (ITAL, 1982, Cabral, et al., 1984). In the paragraphs which follow the author will provide some general, and a few specific comments about direction, activities, and priorities which are felt to offer the greatest potential for maximizing the return on the investments which have been made in people, facilities, and programs in the Packaging Center at ITAL.

VALUE ENGINEERING:

Many opportunities are lost (in developing and more developed nations) because of a rigid view of packaging as a cost center in the production system. All too often container cost minimization is assumed to be the same as system cost reduction. Profit (or efficiency) optimization requires a systems approach which includes the impact of package system selection on quality, protection, convenience, production requirements, retail requirements, merchandizing, marketing, value added, profit and finance. There is a healthy

trend toward projects which include development activities with a systems approach at SEMB. There is a danger that too much emphasis will be placed on more routine activities such as material and container properties. It is to be expected that industry will seek this type of assistance because of the immediate impact of the information generated. The long term effectiveness of the packaging group will depend upon striking the appropriate balance between short term and long term projects.

Effectiveness in applying a systems approach to packaging development and technology will require continued training of the staff, especially with regard to marketing and financial aspects. It will also require further capital investment in equipment. Noteworthy in this regard is the absence of equipment for design and performance testing of packages for distribution. Utilization of the somewhat outdated facilities at IPT in São Paulo cannot be taken as an adequate solution to these needs.

It seems appropriate while discussing a "systems" approach to address the question of the definition of the sphere of activity of the packaging group. As a Packaging Section at the Institute of Food Technology it has been logical for the activities to center around foods and beverages. This definition does not mean that there are not ample opportunities for the group to make important contributions as 50 to 60% or more of packaging materials are used by the food beverage industry in Brazil (Madi, 1986). It does raise the question of whether or not the effectiveness of the group is limited by restricting activities to these industries. Certainly, information and expertise related to such areas as evaluation of package integrity, closure performance, and protective characteristics would be useful for other industries, notably pharmaceuticals and cosmetics.

It is clear that restriction to activities related to foods and beverages places some artificial limitations on the effectiveness of the group. A judgement on whether or not such a restriction is justified would require further information this author does not possess.

STANDARDS DEVELOPMENT:

Participation in standards development is clearly an activity with long term benefits for producers and consumers. It is sometimes

extended and difficult work but quality and efficiency improvement are worth a reasonable effort by the staff. Attention should be paid to specification and definition development, testing methods, and regulations. Specific efforts with corrugated containers and migration, including residual solvents, have good potential to pay dividends in the near future.

TRAINING EXTENSION:

Information developed or acquired by the packaging section, when extended to industry and government workers who need it, is multiplied many times in its usefulness. It is recognized that a program of seminars, training programs, publications, and specific assistance already exists. There is much room for improvement with the most immediate need related to expansion of the information and documentation services in the area of packaging. This is a significant expense and probably requires additional personnel, as well. The returns on this investment are high, however, through improved technology transfer and market expansion. Effectively competing in foreign markets requires knowledge of the appropriate technologies, the markets, and compliance with local regulations.

FINANCIAL SUPPORT:

In the long run, the packaging section will need to generate more of its own support if it is to remain effective. It is obvious that industry has been receiving a true bargain when they have contracted with the group for services because overhead and capital expenditures have been funded by the State and National Governments and by outside agencies like the United Nations.

It has been entirely appropriate for the group to finance their activities in this way during the development phase. In the future, it will become necessary to prepare budget estimates for projects which more accurately reflect the true costs of the project.

Another method of generating funds is to charge annual fees to organizations in the private sector. The motivation for a private concern to pay these fees is participation in the definition of the priorities for, and results of, the activities of the group.

With or without membership fees, it is recommended that serious consideration be given to the development of a "Industrial Advisory Group". The title of this group is chosen to reflect the objective of the group, which would be to assist in the elucidation of programs and activities of industrial and commercial importance. The group could, and should, include appropriate government personnel. The group should be constituted so that the major sub-sectors of the food and beverage industry are represented.

The first meeting of the group should probably last two days and be held at ITAL. The first day would be devoted to a tour of facilities and a review of activities and programs. The second day would be devoted to workshops and presentations whereby the industrial advisors could develop and communicate their views. A foundation for this approach has been laid during the "Ciclo de Debates" (ITAL, 1982).

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ANNEX I

SECRETARIA DE AGRICULTURA E ABASTECIMENTO
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Job Description

Title: Expert on Food Processing

11.03

Period: August - September (1 month)

Activities:

The expert is expected to work with the technical staff of the center under the supervision of the Project Coordinator to develop the following activities:

1- Internal and external seminar for the food packaging industries related to the area of shelf-life and food packaging specification;

2- Presentation of papers to the technical staff of the center as well to the food and packaging industries concerning to food packaging protection;

3- Evaluation of the main projects being executed in this area as well as to orient in the establishment of future projects;

4- Assistance to the Project "Correlation between transport field testing and laboratory testing for tomatoes distribution packages in Brazil", that has been conducted at CETEA;

5- Prepare a final report in English regarding the activities of the mission.