IICA
PM-A1/SC
no.90-05

NORTH AMERICAN FOOD PROCESSING TECHNOLOGIES

IICA - CIDA Project

June 1990

PROGRAM IV: MARKETING AND AGROINDUSTRY

WHAT IS IICA?

The Inter-American Institute for Cooperation on Agriculture (IICA) is the specialized agency for agriculture of the inter-American system. The Institute was founded on October 7, 1942 when the Council of Directors of the Pan American Union approved the creation of the Inter-American Institute of Agricultural Sciences.

IICA was founded as an institution for agricultural research and graduate training in tropical agriculture. In response to changing needs in the hemisphere, the Institute gradually evolved into an agency for technical cooperation and institutional strengthening in the field of agriculture. These changes were officially recognized through the ratification of a new Convention on December 8, 1980. The Institute's purposes under the new Convention are to encourage, facilitate and support cooperation among the 32 Member States, so as to better promote agricultural development and rural well-being.

With its broader and more flexible mandate and a new structure to facilitate direct participation by the Member States in activities of the Inter-American Board of Agriculture and the Executive Committee, the Institute now has a geographic reach that allows it to respond to needs for technical cooperation in all of its Member States.

The contributions provided by the Member States and the ties IICA maintains with its twelve Permanent Observer Countries and numerous international organizations provide the Institute with channels to direct its human and financial resources in support of agricultural development throughout the Americas.

The 1987-1991 Medium Term Plan, the policy document that sets IICA's priorities, stresses the reactivation of the agricultural sector as the key to economic growth. In support of this policy, the Institute is placing special emphasis on the support and promotion of actions to modernize agricultural technology and strengthen the processes of regional and subregional integration.

In order to attain these goals, the Institute is concentrating its actions on the following five programs: Agricultural Policy Analysis and Planning; Technology Generation and Transfer; Organization and Management for Rural Development; Marketing and Agroindustry; and Animal Health and Plant Protection.

These fields of action reflect the needs and priorities established by the Member States and delimit the areas in which IICA concentrates its efforts and technical capacity. They are the focus of IICA's human and financial resource allocations and shape its relationship with other international organizations.

The Member States of IICA are: Antigua and Barbuda, Argentina, Barbados, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominica, the Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, the United States of America, Uruguay and Venezuela.

The Permanent Observer Countries of IICA are: Arab Republic of Egypt, Austria, Belgium, Federal Republic of Germany, France, Israel, Italy, Japan, Netherlands, Portugal, Republic of Korea and Spain.

ISSN–0534–5391

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BV004739

IICA
PM-A1/SC
no.90-05

00000700

SERIE PUBLICACIONES
MISCELANEAS

ISSN-0534-5391
A1/SC-90-05

San José, Costa Rica
Junio, 1990

"Las ideas y planteamientos contenidos en los artículos firmados son propios del autor y no representan necesariamente el criterio del Instituto Interamericano de Cooperación para la Agricultura".

Presentation

One of the objectives of the joint project between the Inter-American Institute for Cooperation on Agriculture, Agriculture Canada and the Canadian Agency for International Development, in the area of Marketing and Agroindustry, is to enhance knowledge in the Latin American and Caribbean countries of the North American markets, so as to augment opportunities to develop trade and commercial relations.

To this end, the present monograph entitled "North American Food Processing Technologies," by Drs. Paul Muller and Rene Riel, makes a significant contribution.

The authors identify, summarize and evaluate a total of 37 new and commercially proven technologies that are currently shaping the nature of agribusiness products in the North American market. Furthermore, they provide conclusions and recommendations for their adaptation to conditions prevailing in countries of Latin American and the Caribbean.

We are hopeful that the document will be of value to the professionals in the field, the industrialist and the agribusiness community in general.

Rodolfo Quiros Guardia
Director, Program III: Marketing and Agroindustry

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INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE (IICA)

MARKETING AND AGRO-INDUSTRY PROJECT

NORTH AMERICAN FOOD PROCESSING TECHNOLOGIES REPORT

I. INTRODUCTION

In December 1988, the Inter-American Institute for Cooperation on Agriculture (IICA) commissioned a Marketing and Agro-Industry Project to develop and implement a methodology that would permit it to assume an important role to contribute towards the expansion of exports of processed food products from Latin American and Caribean (LAC) countries to North American markets. The project also included the identification and facilitation of joint venture business opportunities between LAC agro-industrial enterprises and North American food processing/ marketing/distribution companies.

The first phase of the project consisted of pilot appraisals and initial surveys in both, selected LAC countries and in North America.

The surveys in LAC countries included an analysis of the current status, opportunities and constraints of expanded agro-industrial product exports, details of currently available promotion and facilitation services, and the identification of existing potentials for joint venture business development.

The surveys in Canada and the U.S. included an analysis of the extent and availability of the facilitation and promotion of services available to LAC food processing companies, current trends and future potential for imported agro-industrial products, new and proven food processing technologies applicable for adoption by LAC enterprises, and potential interest in joint business venture arrangements between LAC and North American companies.

The pilot study was restricted in scope to four countries in the LAC region, namely Costa Rica, Equador, Jamaica, and Uruguay. These countries were considered because of their size, geographical location, relatively open economies, and the level of agro-industrial developments.

Local consultants in these countries were contracted to collect information from private companies involved in agro-industrial exports or strongly considering such activities, international and bilateral development agencies, export promotion organizations and banks.

INMARINT was commissioned by Agriculture Canada to identify new and proven North American food processing technologies that would be applicable for adaptation by food processors in LAC countries. Due to time constraints, an initial list of suitable current and potential food products for processing was established with the assistance of the agricultural attachés of the four pilot countries. Subsequently, a search for new and proven technologies suitable for these products was undertaken.

At the same time, the LAC country consultants conducted interviews with a selected number of processors and collected relevant information not only of the companies' current and future processing/exporting/marketing opportunities, constraints, and future intentions, but also of existing and promising food products which offered the greatest opportunities of exports in processed form (IICA Pilot Phase Report, Appendix II: LAC Private Sector Survey Form).

The LAC list of identified products was subsequently consolidated with that compiled previously with the assistance of the consular authorities in Canada and used for the INMARINT report.

Upon the review of the initial report, the late Dr. Brian Perkins, Canadian Coordinator of the project, felt that an expansion of the identified food products from the four original pilot countries to all LAC countries might be beneficial in the preparation of a more comprehensive report covering the export potential for the entire LAC region. With the consent of the IICA Directorate, additional promising food products were added. At the same time, the original list of selected process technologies was also expanded to include process opportunities for these additional food products thus covering opportunities for the entire LAC region.

The expanded report, as a part of the overall IICA Marketing and Agro-Industry Project, thus becomes a valuable reference document for the food processing/packaging companies and exporters for the entire LAC region. It will greatly assist in the selection of the most appropriate technologies for the export of processed food products from the LAC region and potential LAC/North American technology transfer and joint venture business opportunities.

In order to meet a subsequent specific request from Dr. Rudolfo Quiroz, Director of Program IV of IICA, an additional eleven more advanced food technologies were added in a special section. The information of these technologies, some of them rather sophisticated, will essentially be used to familiarize progressive LAC food processors with some of the latest processes. Where these technologies could be used for selected LAC agricultural products, some of the processors may initiate applied research programs and market evaluations to establish their applicability and utilization leading to additional potential export opportunities of processed food products from the LAC region.

II. OBJECTIVES AND SCOPE

The identification of clear objectives of a project and its scope are of primary importance in order to initiate and execute a systematic workplan, establish feasible conclusions, and develop recommendations which are implementable and thus offer major benefits to the client.

The following objectives which have been discussed with the principal contractor and Canadian Coordinator of the project, are summarized below:

- Identify, evaluate and summarize new and proven food processing technologies/packaging methods and materials which are shaping the nature of agribusiness products and have been launched on the North American market in the past few years.
- Evaluate the above technologies in the light of their suitability for selected LAC food products and for the extension/up-take by LAC processing firms.
- Identify changes, if any, in technological and marketing specifications for imported processed agribusiness products requested by North American processors/manufacturers and food wholesalers/importers/brokers as a result of market pressures and/or changes in legislation/standards etc. Determine impact of such changes for supplier firms in LAC countries.
- Provide conclusions and develop recommendations for the adaptation of selected technologies by LAC country food processors for the export markets and potential joint ventures with North American food processing/marketing/ distribution companies.

The scope of the study is to include specific processes and technologies pertaining primarily to products from tropical and sub-tropical country sources. The details are to include the following steps:

- Develop a long list of new and proven food processes in North America outlining the opportunities to food processing companies in LAC countries. Sources may include international CISTI and Agricola data bases, Canadian and international food technology trade journals, company releases, etc.
- Develop a matrix correlating food processing technologies with respective food products or product groups.
- Prepare a short list of processes eliminating those which may not be suitable for various reasons. In the course of the elimination, indicate reasons why some processes were dropped from the long list.
- Prepare a profile of each identified and selected process with relevant particulars including originator of process and details, know-how, possibilities of technology transfer. Technologies should include food processing, packaging, preservation and temperature and gas controlled processes.

Following the completion of the initial report, the following steps should be undertaken:

- Identify current or future technological capabilities of identified LAC food processing companies to utilize identified technologies.
- Identify changes in market forces, product standards and/or legislation which may require adaptations in product or technology specifications for North American markets.
- Coordinate the food processing activities and exports with potential North American food processors.

III. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. Summary and Conclusions

This report is a part of the IICA-AGRICULTURE CANADA-CIDA Marketing and Agroindustry Project. It includes relevant background information on the North American food processing technologies as a basis for the selection of technologies applicable to LAC country food processing companies, the identification of exports of selected processed food products, and the development of potential joint ventures with appropriate North American food processing/marketing/distribution companies.

The objective of this section was to identify and evaluate new and proven food processing technologies and packaging methods launched on the North American market during the past few years which would offer feasible opportunities for food processing and packaging firms in Latin American/Caribbean (LAC) countries. For the pilot phase, the four countries of Costa Rica, Jamaica, Uruguay and Equador were selected.

The project was initiated by developing background information to establish a rationale for the selection of suitable process technologies. This rationale was then used to establish a "long list" of proven food processes. A matrix was subsequently developed to correlate processing technologies with initially identified tropical food products. This was followed by a comparison of these food processes with the needs of food processors in LAC countries.

The "long list" of applicable food processes, developed within the matrix to compare process technologies and product groups, resulted in the identification of sixty eight processes within ten major food processing groups.

From the total of ten groups, seven were selected offering the most appropriate opportunities to LAC country processors. Through a systematic elimination process, taking into consideration relevant factors such as supply quantities, market applications, consumer demand, extent of technologies used in LAC countries and in North America and several other factors, the sixty eight processes were reduced to a "short list" of twenty six processes offering particular opportunities and benefits for LAC processors in entering or expanding export markets and initiating joint ventures with North American food processing/marketing/distribution companies.

The twenty six process technologies as shown in Table 1, (also shown as Table 14 in Section VIII) can be classified into three principal groups. The first group consists of processes that do not transform the commodities; it includes the five packaging processes and irradiation. The second group transforms commodities or parts thereof into processed products and consists of the concentration, texturization and drying groups; it includes the three membrane, the freeze drying as well as the four texturization processes. The third and by far the largest group includes the use of commodities for new food products using the extraction and fermentation processes including a total of thirteen technologies. Some of the processes even utilize waste products such as bagasse, citrus and apple pomace and may represent interesting business opportunities. Furthermore, waste products such as, for instance, food processing waste for cattle feed (which was successfully researched by INMARINT for Agriculture Canada), although not within the scope of this project, should also be considered to increase the efficiency of the food processing industry and, simultaneously, provide urgently needed environmental solutions.

Some of the additional, subsequently evaluated technologies may be rather advanced. They may encourage progressive food processors, to initiate applied research programs to establish their applicability and utilization and thus leading to additional export opportunities of processed food products from the LAC region.

In the course of the identification of process technologies, attempts were made to give priority to Canadian-developed process technologies. Unfortunately, only a limited number could be found because several Canadian companies are subsidiaries of major U.S. food processing corporations.

TABLE 1: SHORT LIST OF PROMISING TECHNOLOGIES FOR LAC FOOD PROCESSORS

PROCESSING AREAS	SPECIFIC PROCESSING TECHNOLOGIES
Packaging	Aseptic Packaging Modified Atmosphere Packaging Vacuum-Cooking Technology Intermediate Moisture Food Technology
Irradiation	Gamma and Electron Beam Technology
Concentration	Membrane Processing Freeze Concentration Fruit Juice Concentration Technology
Texturization	Surimi Processing Extrusion Technology Restructured Meat Technology Microencapsulation Technology
Drying	Freeze-Drying Technology
Extraction	Essential Oils Technology Vegetable Protein Technology Natural Food Colour Extraction Citrus and Apple Pomace Technology Super Critical Processing Crystalline Fructose Technology
Fermentation	Flavours and Aromas Enzyme Production Yeast Production Lactose Hydrolysis Monosodium Glutamate Fermented Soybean Products Technology Lactulose Technology

A matrix was also developed to correlate the combined selected food products from the entire LAC region, their consumption in various forms, and the respective processing technologies required. In many cases, the processing of a particular food product can be achieved by utilizing one of the identified process technologies. In other cases, two processes may be used simultaneously to achieve the desired result, e.g. the utilization of the ultra high temperature sterilization combined with aseptic packaging, or irradiation with low heat treatment. A third possibility is the sequential utilization of two or more technologies, e.g. the concentration of juices with membrane processing and subsequent citrus pomace technology.

The principal conclusions derived from this study indicate that there exists a considerable number of relevant food processing technologies in North America applicable to LAC processing companies. The selection of technologies with which the LAC processors either are familiar or have the technical capability and professional confidence to implement and apply towards the development of joint LAC/North American business ventures, would bring substantial benefits to the LAC economies. Suggestions and recommendations on the implementation are listed in the next section.

2. Recommendations

Since the findings of this report represent an essential link between the LAC food processors and their counterparts in Canada and the U.S. as potential joint venture export partners, it is imperative to undertake the proper steps to utilize the information for the greatest benefit.

The utilization would also meet the requirements as indicated in the Pilot Phase Report on the "Work Breakdown Structure for the Remainder of the Contract Duration", detailing the Activity 725 to include a "Further Analysis of Joint Venture Potentials and Requirements" (Deloitte, Haskins and Sells: Pilot Phase Report, July 1989, Annex I).

The proposed Activity 725C specifies that "Through discussions with technology manufacturers and users, based on LAC supplier capabilities, specific technologies best suited to the production and packaging of identified products [are to be determined]".

To meet these requirements, we offer the following recommendations:

- A copy of this report should be forwarded to each of the 17 LAC processors (originally contacted by the LAC consultants) for their thorough review of the technologies.
- In view of the rather large number of selected food products listed for exports, LAC food processing companies should priorize the products and select the most promising ones based on availability, processing opportunities, export market potential, joint venture opportunities and other criteria.
- Based on the export potential of their current and future product selection, current process utilization, projected applications, technical capabilities and professional confidence, the companies should select the technologies most appropriate for their current and future utilization. This selection would be expected to further reduce the twenty-six selected processes to the ones which really offer major benefits within a relatively short term period.
- The LAC processors would provide (in addition to the general corporate information already provided (as shown in the "LAC Private Sector Survey" (Annex II of Deloitte, Haskins and Sells July 1989 Report) the following additional details:
  - Annual volumes and values of each identified food product for processing; these estimates should include current as well as future planned food products for processing.

  - Seasonality of each product.
  - Details of processes currently used for the respective products.
  - Details of processing installations and equipment presently used for the respective food products.
  - Technical capabilities (e.g. production, quality control, technical staff).
  - R&D capabilities and staff and laboratories.
- The above information and details should form the basis for meetings with the corporate Canadian and American originators or holders and users of the respective technologies and to solicit their interest in a possible collaboration, technology transfer, licensing, and potential joint venture opportunities.
- The final results should be fully documented, reported on and presented at the planned regional IICA seminar.

IV. METHODOLOGY

The methodology of this project included a number of distinctive steps.

Contact was first established with the embassies of the four pilot countries of Costa Rica, Jamaica, Uruguay and Equador to receive details on the cultivation of major food products for domestic consumption but also particularly suitable for exports.

Subsequently, a general literature review was undertaken dealing with the current food processing industry in and new potential food processing technologies for Latin America and Caribbean areas including processing alternatives, regulatory requirements, and other relevant documentation.

This was followed by an evaluation of new processing opportunities for exports of tropical food products taking into account the diversity, quality and adequacy of supply of local food products primarily with high value-added proportions.

Three major considerations were used to establish a rationale for the subsequent evaluation of more specific new and proven food technology processes for adaptation in LAC countries as follows:

- The first was a review of the advantages and disadvantages facing tropical food exporting countries as shown in Table 2 below taken from the "Food Technology" Publication, May 1987 issue. Some of the items listed in the advantages were used in the development of the rationale.
- The second consideration was the ratio of value-added proportions in the food processing industries as shown in Table 3 below taken from the "Food Technology" Publication, May 1988 issue.
- Third, some consideration was given to the methodology. We also enclose a check list for food export development as taken from "Food Technology", May 1987 issue as shown in Table 4 .

TABLE 2 —Advantages and Disadvantages *facing tropical food exporting countries*

Advantages	Disadvantages
Benign climate, long growing season	Climate equally favorable to insects, pests, diseases, and weeds. High temperatures and/or humidity favors food deterioration
Altitude variation, microclimates permit crop, cultivar, and harvest distribution to extend season. Species diversity promotes a wide range of food crops	Rugged terrain complicates food handling and transportation. Comparatively little time-consuming breeding or cultivation information available on potential crops
Abundant, low-cost labor available for production and processing of labor-intensive crops	Lack of skilled labor constrains adaptation of highly mechanized practices. Government labor policies may discourage flexible hiring practices
Small-scale, versatile, low-capital production/processing operations can evolve	Attendant small-scale manufacture of containers, ingredients, and supplies increases unit costs. Export demand may be too large too soon
Governments recognize urgent need for agriculture-based export earnings	Currency and equipment/supplies controls can make maintenance and repair inefficient, complicated, and costly
Realistic food standards and regulations can promote new products and processes	Without an existing tradition of quality control and regulatory enforcement, inferior products are the norm
Influx of imports provides a transportation network for backhauling of exports	Form, capacity, and schedule of transport may not match export needs. Customs clearance apt to be slow and inefficient
Exotic foods have market appeal at premium prices	Unknown or "strange" foods must compete with traditional foods in established markets
Newer processes and modular plants are readily adaptable to novel foods	Initial investment, processing throughout or related logistics can be too large or complicated for small entrepreneurs
Land often plentiful and cheap	Location may be remote from transportation, utilities networks, and labor force
Experience gained with one commodity applicable to others	Large, integrated operations can outcompete small pioneer processors—a disincentive for innovation
Evolving technology, communication, and transportation networks facilitate international trade	Current and projected slump in farm income in developed countries represents a backlash to agricultural imports (protectionism increasing)
Small producers/processors can respond rapidly to changing demands and marketing conditions	Test runs and sample marketing demands exceed volume capabilities of small industry. Large competitors can move later but stronger
Technical assistance to LDCs available from many national and international sources	Proprietary information difficult to develop and keep from potential competitors
World Bank, Bank for International Development, and other international funding agencies encourage agricultural development and export earnings in LDCs	Agricultural policies in the U.S. and other developed countries promote their own export market development with LDCs as potential customers (favors importation of raw materials instead of higher-value end products)

TABLE 3—The Food Processing Industries, Ranked by Intensity of Value Added, 1985

Industry	Value Added per Dollar of Shipments 1963	1985
	Percent	
1 Breakfast cereals	58.4	69.9
2 Cookies and crackers	54.5	64.9
3 Flavorings	54.8	64.2
4 Bread, rolls, cakes	53.4	61.2
5 Pet foods	NA	57.9
6 Pasta	43.1	54.5
7 Miscellaneous foods	46.8	51.3
8 Confectionery	44.3	50.7
9 Spirits	57.2	48.4
10 Dried fruits and vegetables	36.4	47.0
11 Beer	55.6	46.5
12 Frozen specialties	35.5[a]	45.9
13 Canned specialties	46.3	45.0
14 Flour mixes	44.9	42.8
15 Sauces, pickles	36.8	41.3
16 Frozen fruits and vegetables	35.5[a]	40.6
17 Canned fruits and vegetables	37.6	40.4
18 Soft drinks bottling	55.8	39.2
19 Wine and brandy	37.2	38.5
20 Coffee	33.0	36.6
21 Canned fish	38.6	32.6
22 Wet corn milling	46.8	32.5
23 Prepared milk	15.4	30.8
24 Ice cream	25.2	29.9
25 Meat processing	26.4	29.9
26 Beet sugar	35.6	29.3
27 Poultry processing	18.3[b]	29.1
28 Poultry dressing	18.3[b]	27.7
29 Other fats and oils	33.3	27.4
30 Cane sugar	23.6	27.3
31 Frozen fish	30.4	27.1
32 Fluid milk	31.4	25.2
33 Cottonseed oil	18.2	24.9
34 Rice	19.2	24.6
35 Flour	17.1	22.3
36 Cooking oils and margarine	25.4	21.9
37 Animal feeds	20.0	21.2
38 Cheese	13.4	17.3
39 Meatpacking	15.3	13.8
40 Soybean oil	10.3	8.3
41 Butter	13.5	6.2
Total	31.9	34.5

[a]Frozen fruits and vegetables and frozen specialties were combined in one industry in 1963; the ratio for frozen specialties was probably slightly higher than the ratio reported here.

[b]The two poultry industries were combined in one industry in 1963, but the ratios shown in this table are quite representative of actual values in 1963.

TABLE 4 —A Checklist for Food Export Development

Factor	Situation/Response
Government	Favorable foreign-exchange and import/export regulations. Important impact on most other factors cited
Food standards and regulations	Realistic; evenly enforced domestically; rigid adherence to those of importing countries
Labor	Abundant, flexible, trainable, reasonably priced, with a good balance of skills (particularly mechanical)
Producers	Reliable farmers using safe cultivation/husbandry practices and aware of environmental hazards affecting crop yield and quality
Environment	Predictable seasons with favorable soil and rainfall and absence of insects and highly contagious plant or animal diseases
Processor	Innovative, quality conscious, with a long-term commitment to processing ventures
Raw material	High-quality, uniform, priced equitably, and available at the right time and place for processing
Equipment and facilities	Ample for the volume needing processing at a scale and throughput which complement manual labor
Supplies and ingredients	Adequate to avoid processing bottlenecks and production inefficiencies
Transportation	All-weather road/rail/ship network capable of getting raw material, equipment, and supplies to processing facilities and finished products to export point. Sufficiently reliable and rapid to meet international shipping schedules and prevent raw material/processed product deterioration
Technology	A mixture of local and international expertise which meets the present and projected needs of the export industry
Personnel	Local entrepreneurs and innovators; managers and technologists who understand all facets of the domestic and international food industry
Marketing studies	Development of strategies and continual promotion of local foods for export
Processed products	Built upon local competitive advantage; well researched and of high quality
Communication	Adequate to maintain contact and liaison with suppliers, competitors, and customers globally
Finances	Local and international financing at reasonable rates; managers who understand the global, regional, and local food business
Customers	Buyers interested in stable, long-term sources of supply and willing to provide technical and marketing assistance and feedback
Local food processing industry	Existing operations (even modest-scale) with an appreciation of quality and safety
Public relations	Mechanism for informing all parties—local and national governments, trade associations, and buyers—regarding export potentials, products, and quality image
Early warning system	Current information on markets and global trends in processes and products
Cooperatives	Producers or groups with adequate organization, capability, and knowledge to meet market demands
Cooperators	Can range from equitable transfer management to wholesalers or brokerage firms on a licensing or franchising basis. Access to capital, advanced technology, and DC markets
Location	Not too remote from markets. If remote, then possessing good, high-volume transportation network

An initial matrix of major food processing technology areas and major product groups was established. Sub-matrices were developed for the most promising processing areas identifying more specific technologies within each of the product groups. A rating from 0 to 5 was used to provide an estimated weight indicating the potential of specific processes for particular commodities or products.

These matrices were then used to identify the most promising processes. This required considerable research of scanning relevant trade journals to develop, identify, review, evaluate and select from a large number of processes the most promising ones and prepare rather comprehensive, individual profile summaries of the short-listed processes.

The profiles include the following sections: Rationale, Product Process, Raw Materials, Products, Legislation, Contacts and References. Scientific articles and/or applications for each of those processes are available in INMARINT's files for further review.

For the final analysis, a matrix was developed comparing the major selected processed food products and their transformation into consumable end products and the process technologies required for their transformation. This comparison, combined with the individual Technology Profiles, will form the basis for the final selection of the most appropriate technologies by the LAC food processing companies.

V. IDENTIFICATION OF MAJOR PROCESSED LAC PRODUCTS

Contacts were established initially with agricultural or diplomatic representatives of the four target countries of Costa Rica, Jamaica, Uruguay and Equador. Personal meetings were undertaken with the Costa Rican and Uruguayan Embassies in Ottawa, telephonic and written contact established with the Jamaican Trade Office in Toronto and with the Equadorian Commercial Attaché in New York.

For the final consolidation, the list of selected food products obtained by the consultants from LAC food processing companies were incorporated with those developed in Canada.

As indicated in the Introduction, supplemental products were subsequently added to cover the entire LAC region's major agricultural products.

The consolidated list of food products, summarized in Table 5, shows the major product groups and individual products.

TABLE 5: SELECTED FOOD PRODUCTS

Product Groups	Products
Tropical Fruit	Papaya, mango, pineapple, orange, tangerine, ortanique, grapefruit, lime, melon, naiseberry, pawpaw, pineapple, soursop, sweetsop, avocado, figs, passion fruit, guava, tree tomato, babaco, naranjilla, chips (banana, bread-fruit, etc.).
Temperate Fruit	Blackberries, raspberries, boysenberries, etc.
Vegetables (Regular, tropical, ethnic, contraseason)	Practically all vegetables, including cauliflower, broccoli, snowpeas, asparagus, ocra, sweet cucumber, breadfruit, yam, dasheen, plaintain, ackee, calaloo, irish moss, andeau potatoes, quinoa, heart of palm, etc.
Fish	Saltwater and freshwater fish, mackerel, sardines, tuna and others, including fish-vegetable dinners.
Shellfish	Lobster, lobster tails, shrimp, squid, octopus, molusks.
Spices	Pepper (black, red, hot, sweet, etc.), pimento, curry, cinnamon, vanilla, nutmeg, etc.
Coffee/Cocoa	Fresh, roasted, powder, freeze-dried.
Juices and Nectars	Orange, apple, pineapple, milo, lime, ortanique, apricot, guava, peach, tamarind, etc.
Flavourings	Vanilla and others.
Meat and Poultry	Practically all meat and poultry products plus goat, rabbit, beef jerky, meat extracts; including meat-vegetable dinners.
Oilseeds and Oleo Products	Fermented products from soybeans.
Corn	Fructose
Processing by-products	Molasses, bagasse, orange rind, apple pomace, etc.
Others	Cashew, macadamia nuts, tomato paste, baby foods.

VI. RATIONALE OF SELECTION

A rationale for identifying and selecting major emerging food technologies particularly suitable for food processors in LAC countries was established.

This rationale is presented for their potential applications or development in Latin American countries. It is not exhaustive as there are several other new technologies in emergence today but which have been considered less appropriate for the countries under consideration.

The rationale is based on the following criteria and assumptions:

- Current or potential availability of food raw materials in sufficient quantity and with strict quality standards to justify adoption of new technologies.
- Application of stringent post-harvest technologies to maintain product freshness.
- Limitations of refrigerated means of handling, storage and transport of unstable raw materials for processing purposes.
- Needs to process raw materials for long life stability, reduced weight, ease of handling and shipping, and maximum value-added.
- Knowledge and strict adherence to standards of sanitation, composition, quality and labeling of the products for the markets of destination.
- Availability of qualified personnel all along the system chain from production to retailing.
- Identification of market demand for the products and ingredients to be produced.

VII. IDENTIFICATION AND PREPARATION OF "LONG LIST" OF FOOD PROCESSING TECHNOLOGIES

Several matrices were prepared correlating various food processing technologies with various product groups. Rather than indicate with a checkmark whether or not a certain technology would be applicable for selected food products we established a scale from 0 to 5 in order to quantify the potential and thus assist in the selection of the most promising desirable applications for specific products.

First, an overall matrix was established, identifying ten major processing technology areas (Table 6). Thermal technology processing shows good opportunities for meat, dairy products, fish, shellfish, as well as beverage juices and purées. Packaging shows good opportunities for practically all product groups identified. This would also hold for the drying processes as well as extraction.

Subsequently, several sub matrixes were established for the major processing areas identifying specific technologies. In total, some 68 technologies were identified.

Within the thermal processing group (Table 7), eight technologies were identified with a wide number of applications for the particle sterilization and, to a lesser extent, the tetrapak technology, for a large number of product groups. The liquid sterilization and tetrapak of course show considerable applications for beverages, juices and purées.

Freezing has several applications for meats, fish, fruits, vegetables and also for beverages, juices and purées. It is a relatively established technology with the exception of freeze-drying which is covered in that respective section.

Emerging packaging technologies (Table 8) appear to apply to specific product group niches with the exception of atmospheric technology which applies pretty well throughout the selected product groups. Several of the six technologies identified appear to be particularly applicable to fruits and vegetables but to a much lesser degree for the other products. The same

TABLE 6: SUMMARY MATRIX OF MAJOR FOOD PROCESSING TECHNOLOGIES AND PRODUCT GROUPS

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Thermal	5	3	3	5	3	3	0	2	2	0	2	5	1	5	5	5
Freezing	4	5	5	3	4	5	0	0	0	0	0	0	0	4	4	4
Packaging	4	4	4	4	5	5	3	3	3	4	2	3	2	3	3	3
Concentration	0	0	0	4	0	0	1	3	3	3	0	0	2	1	5	5
Drying	1	1	4	5	4	4	4	5	5	4	5	4	4	4	0	0
Extraction	1	2	3	4	3	3	5	4	4	5	4	2	5	0	1	1
Fermentation	0	0	0	5	0	0	0	0	0	2	0	1	1	4	0	0
Irradiation	3	4	3	0	3	3	0	0	0	5	4	1	0	0	0	0
Texturization	1	1	1	1	1	2	2	0	0	0	0	5	0	0	0	0
Agglomeration	0	0	0	3	0	0	0	1	1	2	0	0	1	0	0	0

0 to 5 = Level of Application

TABLE 7 : FOOD THERMAL PROCESSING TECHNOLOGIES

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Cooking	4	3	1	1	2	2	1	2	2	0	3	3	2	0	0	4
Pasteuriza-tion	1	1	1	5	0	0	2	0	0	0	0	0	0	0	0	0
UHT	2	2	1	5	0	0	1	0	0	0	0	0	0	0	0	0
Liquid Sterilization	0	0	0	5	0	0	3	0	0	0	0	0	0	5	4	4
Particle Sterilization	3	4	5	0	5	5	0	4	4	4	4	0	0	0	0	0
Tetrapak	0	0	0	5	0	0	1	0	0	0	0	0	0	5	5	4
Pouch	4	3	2	1	4	4	0	0	0	0	2	2	0	0	0	1
Retort	5	5	4	3	5	5	0	0	0	0	0	0	0	1	0	3

0 to 5 = relative level of application

TABLE 8: FOOD PACKAGING TECHNOLOGIES

COMMODITY / PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Atmospheric	5	1	1	2	3	3	5	1	1	5	3	5	5	5	5	5
Controlled Atmosphere	5	5	5	4	5	5	1	1	1	1	3	0	0	0	3	3
Modified Atmosphere	3	3	2	0	5	5	0	0	0	0	0	0	0	0	0	0
Vacuum	3	2	2	0	2	2	0	5	5	0	4	0	0	0	0	0
Inert Gas	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Vacuum-Cooked	3	3	1	0	5	5	0	0	0	0	0	0	0	0	0	0
Cans	2	2	2	1	3	3	2	4	4	1	3	1	0	4	4	2
Bottles	0	0	0	1	1	1	5	4	4	5	3	0	0	3	3	4
Plastics	1	1	1	5	1	1	3	1	1	1	1	1	0	2	2	1
Paper	1	1	1	3	1	1	0	0	0	0	0	4	5	1	0	0
Aseptic	1	1	1	5	1	1	0	0	0	1	0	0	0	5	5	5
Squeezable	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Microwave-able	4	4	3	0	3	3	0	0	0	0	0	0	0	0	0	0
Intermediate Moisture	5	4	4	3	5	5	1	0	0	0	0	3	0	0	0	0

0 to 5 = relative level of application

niches for packaging apply to the various packages themselves such as cans, bottles, paper, etc. The recent technology of the aseptic packaging is very popular for beverages, juices and purées as well as for dairy products.

New concentration technologies are replacing older ones which, due to energy required, are very costly to concentrate or to extract liquid from food products. Of the six technologies shown in Table 9, reverse osmosis, freeze concentration, crystalline fructose technology and other juice concentration processes seem to be the most efficient and fairly widely used technologies applicable to beverage, juice and purée processing industries. The technology has been substantially improved in the past few years.

Of the ten identified industrial drying processes, shown in Table 10, it appears that freeze-drying not only has the widest but also the largest application for the identified products including, of course, coffee and cocoa, as well as for spices and flavourings, fruits, vegetables and dairy products as well as meats, fish and shellfish. Fluid bed drying also has considerable applications although at a slightly lower potential.

Industrial extraction systems shown in Table 11, include six individual technologies of which some appear to represent considerable opportunities especially the super critical extraction for a large number of product groups. It is interesting to note that with the exception of salt extraction, the other five technologies appear to represent substantial opportunities for the spices and flavourings.

A completely different pattern emerges for the thirteen identified fermentation technologies shown in Table 12 which apply, with a few exceptions, strictly to fruits, dairy products, sugar and corn. Several fermentation technologies have been identified and will be described in the individual profiles.

A somewhat similar pattern emerges for the eleven industrial texturization technologies applicable primarily for meat, fish, vegetables and snacks and candies shown in Table 13. It appears

TABLE 9: CONCENTRATION: INDUSTRIAL MEMBRANE AND OTHER TECHNOLOGIES

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Reverse Osmosis	0	0	0	4	0	0	3	3	3	1	0	0	3	4	4	4
Ultra-filtration	0	0	0	5	0	0	3	2	2	1	0	0	1	4	4	3
Micro-filtration	0	1	1	4	0	0	3	1	1	2	0	0	4	1	2	4
Crystalline fructose	0	0	0	0	0	5	0	0	0	0	0	5	5	5	0	0
Freeze Concentration	0	0	0	4	0	0	0	5	0	0	0	0	0	4	5	3
Juice Concentrate	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	3

0 to 5 = relative level of application

TABLE 10: INDUSTRIAL DRYING

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Spray Drying	0	0	0	5	0	0	1	5	4	4	0	0	0	4	0	0
Freeze-Drying	5	5	5	5	5	5	2	5	5	5	4	1	0	1	0	0
Fluid Bed Drying	3	3	3	4	3	3	2	3	3	4	0	0	0	4	0	0
Drum Drying	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
Tray Drying	1	1	0	4	4	4	1	0	0	0	0	4	0	0	0	0
Tunnel Drying	1	1	0	4	4	4	1	0	0	0	0	4	4	0	0	0
Microwave Drying	2	2	1	2	4	4	3	1	1	1	1	5	0	0	0	0
Tumble Drying	1	1	2	0	1	1	5	3	3	2	3	1	4	0	0	0
Dispersion Drying	0	0	0	0	0	0	1	0	0	4	1	1	3	0	0	0
Explosion Puffing	2	2	2	1	4	4	0	2	2	2	0	0	0	0	0	0

0 to 5 = relative level of application

TABLE 11: INDUSTRIAL EXTRACTION SYSTEMS

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Cold Pressure	0	1	0	0	0	0	5	1	1	5	0	0	4	0	5	4
Solvent	2	4	2	0	3	3	5	4	4	5	1	0	0	0	0	0
Salt Extraction	3	3	2	3	0	0	0	0	0	1	0	0	0	0	0	0
Steam Distillation	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Diffusion	0	0	0	0	0	0	0	0	0	3	0	0	5	0	0	0
Super-critical	4	4	4	5	3	3	4	5	5	5	3	0	0	0	0	0

0 to 5 = relative level of application

TABLE 10: INDUSTRIAL DRYING

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Spray Drying	0	0	0	5	0	0	1	5	4	4	0	0	0	4	0	0
Freeze-Drying	5	5	5	5	5	5	2	5	5	5	4	1	0	1	0	0
Fluid Bed Drying	3	3	3	4	3	3	2	3	3	4	0	0	0	4	0	0
Drum Drying	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
Tray Drying	1	1	0	4	4	4	1	0	0	0	0	4	0	0	0	0
Tunnel Drying	1	1	0	4	4	4	1	0	0	0	0	4	4	0	0	0
Microwave Drying	2	2	1	2	4	4	3	1	1	1	1	5	0	0	0	0
Tumble Drying	1	1	2	0	1	1	5	3	3	2	3	1	4	0	0	0
Dispersion Drying	0	0	0	0	0	0	1	0	0	4	1	1	3	0	0	0
Explosion Puffing	2	2	2	1	4	4	0	2	2	2	0	0	0	0	0	0

0 to 5 = relative level of application

TABLE 11: INDUSTRIAL EXTRACTION SYSTEMS

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Cold Pressure	0	1	0	0	0	0	5	1	1	5	0	0	4	0	5	4
Solvent	2	4	2	0	3	3	5	4	4	5	1	0	0	0	0	0
Salt Extraction	3	3	2	3	0	0	0	0	0	1	0	0	0	0	0	0
Steam Distillation	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Diffusion	0	0	0	0	0	0	0	0	0	3	0	0	5	0	0	0
Super-critical	4	4	4	5	3	3	4	5	5	5	3	0	0	0	0	0

0 to 5 = relative level of application

TABLE 12: FERMENTATION TECHNOLOGIES

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Enzymes	1	3	1	4	5	1	1	0	0	0	0	0	5	0	0	0
Yeasts	1	3	1	4	5	1	1	0	0	0	0	0	5	0	0	0
Bacterial Cultures	1	1	1	5	1	1	1	0	0	0	0	0	3	0	0	0
Flavours	0	1	0	5	4	1	1	0	0	0	0	0	5	0	0	0
Glutamate	0	0	0	4	4	0	0	0	0	0	0	0	5	0	0	0
Amino Acids	2	2	0	4	4	0	0	0	0	0	0	0	5	0	0	0
Proteins	2	2	2	5	4	1	1	0	0	0	0	0	5	0	0	0
Alcohol	1	1	1	5	4	1	1	0	0	0	0	0	5	0	0	0
Methane	1	1	1	5	4	1	1	0	0	0	0	0	5	0	0	0
Food Chemicals	1	1	1	4	4	2	1	0	0	0	0	0	5	0	0	0
Fermented Foods	3	2	1	5	4	4	3	0	0	0	0	0	5	0	0	0
Lactulose Technology	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Fermented Soybean	0	0	0	0	0	4	5	0	0	0	0	0	0	0	0	0

0 to 5 = relative level of application

TABLE 13: INDUSTRIAL TEXTURIZATION TECHNOLOGIES

COMMODITY PROCESS	MEATS	FISH	SHELLFISH	DAIRY	FRUITS	VEGETABLES	OIL SEEDS	COFFEE	COCOA	SPICES FLAVOURINGS	NUTS	SNACKS CANDIES	SUGAR	BEVERAGE	CONC. JUICES	CONC. PUREES
Extrusion	4	4	4	3	5	5	4	0	0	0	1	5	0	0	0	0
Flaking	3	3	3	0	4	4	4	0	0	0	5	4	0	0	0	0
Baking	4	4	4	1	0	0	0	0	0	0	0	5	0	0	0	0
Toasting	0	0	0	0	2	2	0	4	3	0	3	3	0	0	0	0
Puffing	2	2	2	1	4	4	0	2	2	2	0	0	0	0	0	0
Frying	5	5	4	1	1	1	0	1	0	0	3	1	0	0	0	0
Kneading	3	3	1	0	0	0	1	0	0	0	0	4	0	0	0	0
Sheeting	4	4	1	0	2	2	0	0	0	0	0	4	0	0	0	0
Laminating	4	4	1	0	2	2	0	0	0	0	0	4	0	0	0	0
Filling	2	2	2	0	3	3	0	0	0	0	1	5	0	0	0	0
Coating	4	4	4	0	2	2	0	0	0	0	5	5	2	0	0	0

0 to 5 = relative level of application

that the extrusion, flaking and puffing processes have applications for several food products.

Irradiation represents a substantial opportunity for food processors in LAC countries primarily with a distinct Canadian opportunity of offering either gamma and/or electron beam irradiation. Further details are described in the Profile.

VIII. DEVELOPMENT OF A SHORT LIST

1. Current Technologies

The original list of some sixty-eight food technologies (classified by ten major groups as shown in the previous Section) was subsequently further reduced in order to meet the basic criteria of identifying new and proven technologies readily adaptable by potential LAC food processors.

A detailed analysis and individual evaluation reduced the number of suitable technologies to twenty technologies which appeared to be more specifically suitable and readily adaptable for the four pilot LAC countries of Costa Rica, Equador, Jamaica and Uruguay.

At the suggestion of the late Dr. Brian Perkins, this list was subsequently expanded to twenty-six technologies in order to also accommodate additional products from the other than the four initial LAC pilot countries.

Each of the technologies was examined and evaluated according to a combination of criteria including the overall rationale; extent, abundance and low cost raw material supplies; technological capability requirements of LAC processors; relative technological advantages; economic feasibility; export potential; present and future North American demand for processed products; shelf life; increased value-added benefits; better quality products; replacement of synthetic with natural products; utilization of food processing residues and others.

The list of the twenty-six promising technologies is shown in Table 14. The rationale of each technology is summarized in Table 15.

Profiles of each selected food technology are shown in the Current Technologies Section of Appendices A to G. They include the summaries of the rationale, technology, raw materials, processed products, legislation, contacts and references. Additional background material and details are contained in the Project's files and available for further review in the course of the priorization process as outlined in Section III of the Recommendations.

TABLE 14: SHORT LIST OF PROMISING TECHNOLOGIES FOR LAC FOOD PROCESSORS

PROCESSING AREAS	SPECIFIC PROCESSING TECHNOLOGIES
Packaging	Aseptic Packaging Modified Atmosphere Packaging Vacuum-Cooking Technology Intermediate Moisture Food Technology
Irradiation	Gamma and Electron Beam Technology
Concentration	Membrane Processing Freeze Concentration Fruit Juice Concentration Technology
Texturization	Surimi Processing Extrusion Technology Restructured Meat Technology Microencapsulation Technology
Drying	Freeze-Drying Technology
Extraction	Essential Oils Technology Vegetable Protein Technology Natural Food Colour Extraction Citrus and Apple Pomace Technology Super Critical Processing Crystalline Fructose Technology
Fermentation	Flavours and Aromas Enzyme Production Yeast Production Lactose Hydrolysis Monosodium Glutamate Fermented Soybean Products Technology Lactulose Technology

TABLE 15: SUMMARY OF SELECTED FOOD PROCESSING TECHNOLOGIES

Packaging Group

Aseptic Packaging:

Aseptic packaging is the newest development in the area of packaging as it permits the production of high quality products which are shelf stable. The technology offers many advantages over hot-fill and retort techniques, and it applies to particulates as well as to liquid products. In Latin American countries many products need to be sterilized for facilitating transport, exports and distribution of fruits and vegetables, dairy and meat products.

Modified Atmosphere Packaging Technology:

Although modified atmosphere principles have been known for a long time, new interest has been stimulated in recent years with advances made in the design and manufacture of polymeric films which have a wide range of gas permeability characteristics. Latin American countries wishing to export exotic fruits and vegetables to temperate countries should seriously consider the technology of modified atmosphere packaging.

Vacuum-Cooking Technology:

The technology of "cuisson sous-vide" has been developed in France during the last decade. It had a rapid development in Europe and is now being introduced in North America. It is a technology for connaisseurs, professionals of food preparation and quality restaurants and institutions. Latin American countries surely have a market for this new technology for various food products.

Intermediate Moisture Food Technology:

Intermediate moisture food is a new technology based on old processes. They were first intended to preserve foods without refrigeration in countries where refrigeration was not easily accessible and where the climate was hot. However, the popularity of this technology is increasing in industrialized countries as well as for energy saving purposes.

Irradiation Group

Gamma and Electron Beam Technology

Irradiation of food has four major objectives to:

- Ensure the microbiological safety of foods.
- Contribute to reduce food losses by spoilage.

- Lengthen the shelf life of fresh foods.

It is obvious that these objectives are of great interest to Latin American countries wishing to increase their exports of many fresh as well as processed food products to North American and other markets.

The Canadian government has just approved irradiation for a number of products.

An assessment of business opportunities of food irradiation in developing countries was undertaken in 1987/88 by Gamma Processing Intl. for the CIDA Industrial Cooperation Division. A priority list was established based on six criteria including industrialization, involvement of private industry, infrastructure, post harvest technology, exports, and legislation (see attached Summary). For Latin America, the following countries were selected: Mexico, Brazil, Argentina, Peru and Chile.

Application Research with gamma irradiation is undertaken at the Canadian Irradiation Centre in Laval, Quebec and at the St. Hyacinthe Food Research Lab of Agriculture Canada.

Recent efforts in application research of accelerator beam irradiation of food were initiated by AECL's Accelerator Unit in Pinawa, Manitoba and at the Mevex Corporation, Canada's first privately-owned facility. The size of the Mevex accelerators can be tailored to various through-put capacities.

A Position Paper to compare the characteristics of gamma and electron beam irradiation has been prepared by INMARINT Ltd. Electron beam irradiation, using electricity as an energy source, may offer interesting opportunities for selected applications for smaller or medium-sized food processing companies in LAC countries.

<u>Concentration Group</u>

<u>Membrane Technology</u>

Membrane filtration is a new separation technology for liquids which has been associated with a large number of applications in food processing, pure water production and processing waste treatment and recovery. It has become a must in most food processing plants for reasons of economics, better quality products and ingredient production. This technology can be applied in Latin American processing of fruits, vegetables, dairy, meat and fish products, beverages, citrus oils, etc.

Freeze Concentration Technology:

The removal of water by freezing is becoming increasingly attractive for products which are sensitive to heat; freeze concentration is particularly applicable for high quality products. New developments in this technology make it economically feasible. It applies particularly to fruit juice concentration.

Fruit Juice Concentration and Sterilization Technology:

The technology to produce high quality fruit juice concentrates has been improved considerably over the years. Considering the ever increasing popularity of fruit juices in most countries of the world, the future of the juice industry can only be bright. Countries with abundant supplies of citrus fruits (e.g. Brazil and others) could benefit from the latest technologies to produce high quality fruit juice concentrates.

Texturization Group

Surimi Process Technology:

The food industry of North America has discovered only recently the advantages of the old Japanese surimi or fish deboning technology. It is an excellent way to add value to underutilized fish species and to produce a wide selection of similar food products. The fishing industry of Latin American countries has an interest in picking up the surimi technology with all the latest improvements.

Extrusion Technology:

The potential of the extrusion-texturization technology is enormous. The composition of the products can be adapted to consumer preference in terms of flavour, texture and nutritive value. Being in low moisture form, the products have long life properties without refrigeration. It is a technology quite appropriate to Latin American countries to produce low cost nutritious foods for domestic use as well as for exports from fruits, vegetables, grains, etc.

Restructured Meat Technology:

The manufacturing of steaks from cuts traditionally used for ground meats or stews or roasts is an excellent way to add value to cheaper meat cuts while providing boneless steak meats at relatively low prices. The meat industry in Latin American countries would benefit from the restructuration technology in creating higher-value products from trimmings and poor cuts.

Microencapsulation Technology:

Microencapsulation of minute food particles is a more recent development. Good techniques have been developed and tested on the industrial scale. The potential to produce unique foods is great. Latin American countries are designated for this technology because of their resources of food ingredients, such as spices, vitamins, oils, as well as raisins, nuts, etc.

Drying Group

Freeze-Drying Technology:

The dry form is recognized as the best method to protect foods over long periods and it offers many advantages for storage, transport and utilization. Freeze-drying is among the rare processes which do not use heat for drying and consequently offers a better protection to nutritional and eating qualities of foods. The technology has now become feasible for large-scale operations and could find applications in Latin American countries to export high quality exotic products such as fruits, vegetables and particularly a wide variety of shellfish.

Extraction Group

Essential Oils Technology:

Food flavourings are among the most essential ingredients used in the fabrication of foods at the industry, institutional and home levels. The food flavour and fragrance industry is an ever prospering industry. Natural flavourings have currently greater consumer appeal than artificial flavourings. Since Latin American countries are a good source of aromatic materials, such as citrus, tropical fruits, spicy herbs and vegetables and even food processing wastes including citrus peels, etc., essential oil production could become a flourishing industry.

Vegetable Protein Technology:

World protein requirements could be met easily if consumers would learn to use more of the plant proteins in their diet. Since Latin American countries have access to several proteinaceous crops such as cereals, oilseeds, legumes, etc., the development of a vegetable protein industry would be appropriate primarily for domestic consumption but also for exports.

Natural Food Colour Technology:

There is a growing interest in North America as well as in the world for the utilization of natural colourant in food processing. This has come about since the banning of several synthetic colourants for safety reasons. The list of synthetic or certified food colours is getting shorter with time and their production is subject to strict control by federal agencies. As a result of this natural colour technology is developing at a rapid rate and this could well be the time for Latin American countries to exploit the industry of colourants from exotic crops, fruits, flowers, leaves and many other products as well as even insects.

Citrus and Apple Pomace Technology:

Citrus peel and apple pomace usually are embarrassing wastes from the juice industry. They are costly to dispose of and often are a source of pollution. The trend is toward technologies to salvage and add value to those residues. Latin American countries could benefit from technologies aimed at waste reclamation.

Supercritical Fluid Technology:

The supercritical technology has a great future in the food industry where the trend is to go after high value components in plant and animal materials. It is likely to replace the conventional methods of separation utilizing organic solvents or heat. Since the basic materials of interest (coffee, tea, exotic fruits, herbs and vegetables) are found in large supply in Latin American countries, it is appropriate to consider the application of this technology for those countries.

Crystalline Fructose Technology:

Fructose, also called the corn sweetener, has several industrial advantages over the common sucrose or dextrose made from cane sugar. Crystalline fructose is 80% sweeter than sucrose and has 20% fewer calories. It has been produced for many years as a solution in water. The liquid fructose is convenient where transportation by tank is practical. For long distance transport, however, the dry form is more desirable. The crystalline fructose technology is welcome in countries where corn is an easy and plentiful crop.

Fermentation Group

Flavours and Aromas by Fermentation Technology:

The flavour and aroma of many food products are developed by microorganisms and enzymes present in or added to them. They should be used in biological models for the production of flavours and aromas. The field is wide open for any country to select appropriate systems utilizing their respective food processing residues such as molasses, bagasse, cheese whey, etc.

Enzyme Production Technology:

The use of enzymes in the food industry is developing at a fast rate. There are some 20 enzymes which are currently used in food. The need is for thermostable enzymes and also for a greater variety. There are some 70 manufacturers of enzymes in the world. The success belongs to those who can produce them at the lowest cost. Latin American countries have an abundance of raw materials such as papayas, pineapples, figs, and animal materials appropriate for enzyme production.

Yeast Production Technology:

The use of yeast in food is as old as breadmaking. Yeast is almost synonymous to fermentation for the production of alcohol (winemaking, brewing, distilling) or carbon dioxide (breadmaking). Today, yeast production technology is becoming attractive for additional purposes, as a source of protein and vitamins, as contributor and enhancer of flavours, and for its functional textural properties. Since Latin American countries have abundant supplies of yeast substrates, the development of the yeast industry in those countries represents a sound potential.

Lactose Hydrolysis Technology:

A new technology of immobilized lactose to produce hydrolyzed lactose has been developed in recent years. The technology is of interest for those countries where there is a high incidence of lactose intolerance or where the volume of whey available could make the process attractive.

Monosodium Glutamate Technology:

There are two types of substances which are produced on a large scale to enhance the flavour of foods, the nucleotides(inosine 5'-monophosphate, guanosine 5'-monophosphato and salts of glutamic acid. The monosodium glutamate is by far the most in demand. Since substrates (e.g. molasses, bagasse, sulfite liquor, etc.) used for its production are abundantly available in Latin American countries, it would be appropriate that the manufacturing be close to the source of raw materials.

Fermented Soybean Foods Technology:

In addition to the numerous food ingredients which are derived from soybeans, several oriental foods have been produced from soya by fermentation. Although these foods have been prepared in the Orient for centuries, their properties are becoming more and more attractive to Westerners. Consequently, the market is developing for several products.

Lactulose Technology:

Lactulose is a sugar derived from the major milk sugar, lactose. Small amounts can be found in cow's milk and in human milk. Applications of this sugar in infant nutrition, pharmaceutical uses and selected food products should be appealing to most countries.

Although processing technologies derived from dairy products were eliminated in the development of the short list, lactulose technology was retained at the suggestion of the Canadian coordinator due to its pharmaceutical and infant nutrition applications of benefit to both domestic and export markets.

2. Additional Technologies

An additional number of technologies, which, at first analysis, appeared suitable for food processing companies in LAC countries, were reviewed. A closer evaluation, however, showed that, due to various reasons, their introduction and applicability in LAC processors' operations may be somewhat delayed. Reasons included factors such as limited supplies of raw materials, current saturation of North American markets for specific products, limitations of scale, pricing, fierce technological competition, sophisticated technologies requiring suitable infrastructure and others.

At the specific request of Dr. Rudolfo Quiroz of the IICA, these technologies were nevertheless added in this report with the primary purpose to familiarize selected progressive LAC food processing companies with some of the latest food processes. Where these technologies could be used for specific products, progressive processors may wish to initiate applied R&D programs and market evaluations to establish their applicability.

The eleven additional technologies are listed in Table 16. Profiles of each process including the rationale, technology, raw materials, processed products and other relevant details are shown in Appendix H for Additional Technologies.

3. Low Calorie Sweetener Technology

In view of consumer dissatisfaction with some artificial sweeteners such as saccharine, aspartame, accrulfame and others, the discovery of natural, low calorie sweeteners represents a great business opportunity for some LAC countries. In a recent survey by the Grocery Products Manufacturers of Canada, for instance, the sugar content and number of calories in food products were the first two of fourteen criteria consumers were looking for when buying food.

TABLE 16: ADDITIONAL TECHNOLOGIES FOR LAC FOOD PROCESSORS

Meat Fermentation Technology
Modified Dairy Ingredients
Milk Protein Hydrolyzation (Hydrolysis)
Milk Fat Fractionation
Casein Manufacture Technology
Microfiltration Technology
Lecithin From Oilseeds
Edible Films and Coatings Technology
Skin Packaging Technology
Ultra High Temperature Processing (UHT)
Tissue Culture Technology

Derived low calorie sweeteners include sucralose, maltilol, isomalt cyclodextrins and polydextrose. These are derived from sucrose or starch and several are still in the clearance process for human use.

During the past few years several plants with potent sweetening substances have been discovered. Of particular interest is the plant Stevia rebaudiana, currently cultivated in Brazil, Paraguay, Japan, Thailand and other Asian countries. It contains substances up to 300 times sweeter than sugar.* Thailand is negotiating a technology agreement with the Quebec Government and Agriculture Canada's St-Hyacinthe Food Research Centre to develop the extraction technology and thus facilitate the full commercialization of the natural stevioside sweetener.

Other examples of sweet plants are the hydrangea from the Orient, the licorice producing Glycerrhiza from Europe and Central Asia, the Lo Han Kuo fruit of southern China, and the Lippia dulcis from tropical countries. The plant with the most exceptional sweetening agent, which is 100,000 times sweeter than sugar, is the Thaumatococcus danielii; the plant, however, reportedly will not bear fruit outside of its natural habitat in Ghana and the Ivory Coast.

The reason why this low calorie potent sweetener technology was not included in our "short list" was that some of these plants need to be passed first through the agronomic phase of adaptation to climatic and soil conditions in LAC countries before becoming available in abundant supply in the LAC region. Since the Stevia rebaudiana is a plant native to elevated terrain on the borders of Brazil and Paraguay, it would represent a logical first choice for extensive cultivation trials in selected LAC countries.

Although a recommendation to evaluate the cultivation of a new cultivar in LAC countries is beyond the terms of

*Source: Biotechnology and Natural Sweeteners, Rural Advancement Fund International, in Development: Seeds of Change, 1987: 4 33, and other sources.

reference for this project, we would nevertheless strongly suggest that IICA agronomists evaluate the cultivation of some of these plants in selected LAC countries for two reasons.

First, the economic benefits from a local cultivation due to the considerable increase of the North American demand for natural low calorie sweeteners and the follow-up and finalization of the sweetener extraction technology could be substantial for some LAC countries and food processing companies.

Second, the development of low-calorie potent sweeteners (currently a $900 million market in the U.S. alone), is projected to lead to a further massive displacement of Third World cane sugar markets which were devastated by the introduction of the high fructose corn syrup. Thus, the sooner that LAC countries' agricultural economics switch to alternative crops, the faster the recovery will be from the cane sugar demise.

IX. RESULTS OF COMBINED PRODUCT SELECTION AND TECHNOLOGY EVALUATION

The initial list of food products compiled in Canada was consolidated with the list subsequently received from the LAC food processing companies through the LAC consultants. It was also expanded to cover selected food products from additional LAC regions other than the four pilot countries which resulted in a fairly comprehensive summary list as shown in the previous Table 5. We do not foresee that all products can be considered for processing and exporting at this initial pilot phase. The number of products should be reduced to the most promising ones and priorities established for their needs of processing technologies in the light of the potential for export markets, technology transfer and joint business venture opportunities.

The next step was to correlate the selected technologies with the identified products which is shown in Table 17 indicating the products, their utilization and the respective proposed processing technologies. In many cases the processing can be achieved by utilizing one of the identified process technologies. In other cases two processes may be used simultaneously to achieve the desired result, e.g. the utilization of the ultra high temperature sterilization combined with aseptic packaging or irradiation with mild heat treatment. A third possibility is the sequential utilization of two or more technologies, e.g. the concentration of juices with membrane processing and subsequent citrus pomace technology.

This matrix should form the basis for the LAC processors to select the respective technology or technologies for products currently being processed or new products planned for future processing. We would expect that that analysis and evaluation would result in an elimination of processes not to be considered at the present time for various reasons. The final list of major promising processes selected by the LAC processors would thus be expected to number no more than, say, 3-4 or at most, 6 processes.

Upon that decision, the Canadian originators or owners of the respective technologies, as shown in Table 18, would be contacted to elicit their interest in technology transfer, licensing and potential joint venture opportunities. Where the processes are held in the U.S., originators or owners should be contacted at their respective addresses.

TABLE 17: MATRIX OF SELECTED LAC FOOD PRODUCTS, PRODUCT UTILIZATION, AND PROPOSED PROCESSING TECHNOLOGY APPLICATIONS

PRODUCTS	UTILIZATION	PROPOSED PROCESSING TECHNOLOGIES (COMBINED, SEQUENTIAL OR ALTERNATIVES)
A. Fruit and Fruit Products		
Tropical Fruit Juices, Nectars and Fruit Juice Concentrates (citrus, mango, papaya, passion fruit, guava, pineapple, etc.).	Bulk shipments for export; dehydrated shipments for wholesale rehydration or retail sale; rehydrated retail sale.	. Membrane technology for concentratior . Low temperature evaporation. . Freeze concentration. . Tetrapack (e.g. aseptically transferred bulk quantities to tetrapack). . Irradiation (EB or Gamma) depending on quantity, season, throughput. . Essential Oils technology for citrus only. . Citrus pomace technology. . Enzyme production (selected fruit).
Tropical Fruit Purees, Concentrates and Pulps (citrus, mango, papaya, passion fruit, guava, pineapple, bananas, etc.).	Desserts, pie fillings, yoghurt and ice cream flavourings, etc.	. Membrane technology for concentration. . Low temperature evaporation. . Freeze concentration. . Aseptic packaging. . Irradiation (EB or Gamma) depending on quantity, season, throughput,etc. . Citrus pomace technology. . Essential oils technology for citrus only. . Enzyme production (selected fruit).
Tropical Fruits; assumed processed whole or partial (soursop, passion fruit, bananas, pineapple, coconut, sweetsop).	Consumption as whole fruits, additions of parts in trail mixes, breakfast cereals,etc.	. Freeze-drying. . Modified atmosphere packaging (bulk and retail). . Intermediate moisture food technology.

PRODUCTS	UTILIZATION	PROPOSED PROCESSING TECHNOLOGIES (COMBINED, SEQUENTIAL OR ALTERNATIVES)
Exotic Tree Fruits; assumed processed whole (babaco, naranjilla, tree tomato, taxo).	Consumption as whole, packaged fruits.	. Modified atmosphere packaging (bulk and retail). . Freeze-drying. . Irradiation ? . Intermediate moisture food technology.
Banana and Plantain Products (dried, flaked, semi-dried, etc.).	Snack foods, health foods, additions in trail mixes, breakfast cereals.	. Freeze-drying (for dried consumption or rehydration).
Temperate Fruits, Processed (blackberry, raspberry, strawberries, melon, etc.).	Desserts, pie fillings, etc.	. Membrane technology for concentration. . Aseptic packaging for berries.
Gourmet Jams, Jellies, Sauces	Bulk or retail export shipments.	. Membrane technology for concentration. . Aseptic packaging. . Freeze-drying for sauces only.
B. Vegetables		
General and Special Vegetables, assumed processed and Contra-Season Prepared and Packaged Vegetables.	Bulk or retail export shipments.	. Modified atmosphere packaging (bulk and retail). . Freeze-drying technology.
C. Meat Products		
Meat Extracts (boullon etc.).	Seasoning in meals, soups, etc.	. Membrane technology for concentration. . Restructured meat technology for residuals if any?
Beef Jerkey and Dried Meat Products	Direct consumption snack foods.	. Regular drying process? . Freeze-drying process? . Restructured meat technology for residuals? . Intermediate moisture food technology.

PRODUCTS	UTILIZATION	PROPOSED PROCESSING TECHNOLOGIES (COMBINED, SEQUENTIAL OR ALTERNATIVES)
Portion-Controlled Meat-Based Dinners	Direct consumption as meals.	. Vacuum-cooking technology, fresh or frozen. . Freeze-drying.
D. Fish Products		
Fish and Shellfish Products, Shrimp, Mollusks, and Other Seafood Products	Dried consumption	. Freeze-drying technology. . Electron Beam or Gamma irradiation (depending on volume, season, throughput requirements). . Surimi process for residuals. . Intermediate moisture food technology.
Portion-Controlled Fish-Based Dinners	Direct consumption	. Vacuum-cooking technology. . Electron Beam or Gamma irradiation (depending on volume, season, etc.). . Freeze-drying.
D. Other Products		
Spices and Flavourings	Wholesale or retail sales.	. Irradiation for spices only (EB or Gamma) depending on quantity, season, throughput, etc. . Micro-encapsulation technology for spices and flavours. . Freeze drying for flavourings only. . Essential oils technology for herbs. . Supercritical fluid technology (extraction of oleo resins, etc.?). . Monosodium Glutamate.
Quinoa, or High Protein Indigenous Grain	Direct health food consumption and/or vegetable protein extraction for compounding.	. Vegetable protein technology. . Extrusion technology.

PRODUCTS	UTILIZATION	PROPOSED PROCESSING TECHNOLOGIES (COMBINED, SEQUENTIAL OR ALTERNATIVES)
Processed Cheeses	Direct consumption.	. Membrane technology for concentration. . Aseptic packaging. . Flavours and aromas by fermentation.
Baby Foods	Direct consumption	. Membrane technology for concentration. . Aseptic packaging. . Lactose hydrolysis. . Lactulose technology.
Oilseeds and Oleo Products (soybeans, copra, etc.)	Fermented soybean foods (e.g.	. Fermentation.
Corn	Commercial sweeteners.	. Crystallized fructose technology.
Liquors, Rum, etc.	Direct consumption	. Membrane technology for concentration and blending. . Flavours by fermentation from molasses, bagasse.

TABLE 18: LIST OF CANADIAN COMPANIES INVOLVED IN SPECIFIC PROCESSING TECHNOLOGIES

PROCESSING TECHNOLOGY	COMPANY NAMES, ADDRESSES, CONTACTS, TEL.NO.
Aseptic Packaging	Tetra-Pak, Toronto, 416-865-9480 Alfa-Laval, Toronto, 416-299-6101 Lassonde & Fils, Rougemont, Quebec, 514-469-4926
Modified Atmosphere Packaging	Dupont, Kingston, 613-544-6000 Hoechst (Markus Stamm), 4045 Cote Vertu, Montreal, 514-333-3522 Air Liquid, 1155 Sherbrooke ouest, Montreal, H3A 1H8, 514-842-5431 (M. Lozon) Bilopage, 485 rue Lavoie, Ville de Vanier, Quebec, G1K 7X1, 418-687-2840
Vacuum-Cooking Technology	Cuisi-France, Bois Brillant, 514-437-4003
Freeze-Drying Technology	Lyosan Inc., Lachute, Quebec, 514-562-8525 (Equipment Mfg. & Processor)
Membrane Processing	Zenon Corp., Burlington, Ont., 416-825-1492
Gamma and Electron Beam Technology	Nordion Int'l., Gamma Processing Int'l., AECL Acc. Div., Mevex.
Surimi Processing	Terra Nova Fishery, Saint Johns, Nfld.
Extrusion Technology	Kraft Foods (Glen Nelson), 220 Yonge St., Toronto, M5W 1J6 (and Cobourg, Ont.), 416-484-5498 (prev.: General Foods). Labatt Co., London, Ont., 519-667-7500 St-Hyacinthe Food Research Centre
Restructured Meat Technology	Canada Packers (Bern Schnyder), 2211 St. Clair Ave. W., Toronto, M6N 1K4, 416-761-4046 J.M. Schneider (Mrs. Gail Holland), 321 Courland Ave. East, Kitchener, 416-231-2286
Restructured Meat Technology (cont'd)	Labatt Co., London, Ont., 519-667-7500
Microencapsulation Technology	
Essential Oils	Huiles Essentielles Cedarome (Claude Cusson), 200 St.François Xavier, Local 115, Delson, Quebec, J0L 1G0 514-638-3337 Flavour Mfg. Assn. Can., Weston, Ont. 416-233-0007

Vegetable Protein Technology	Griffith Laboratories, Scarborough, 416-288-3050
Natural Food Colour Extraction	Hoffman-La-Roche, 401 West Mall, Suite 700, Etobicoke, Ont., 416-620-2896 Chemical Dye Co., Kingston
Citrus and Apple Pomace Technology	
Super Critical Processing	Norac Technology (Abe Leron), 4222, 97 Street, Edmonton, T6E 5G2, 403-401-7163
Flavours and Aromas	Food Pro National, 2610 Deschamps Blvd. Lachine, H8T 1C9, 514-636-3121
Enzyme Production	Diversified Lab (Weston Foods) (Ross Lawford), 1047 Yonge St., Toronto, 416-922-5100
Yeast Production	Lallemand Inc. (pres. Chagnon), 514-522-2133
Lactose Hydrolysis	Agropur, Granby, Quebec, 514-375-1991
Monosodium Glutamate	
Intermediate Moisture Food	Quaker Oats Company
Freeze Concentration	
Fruit Juice Concentrate	McCain Food Co., Florenceville, N.B.
Crystalline Fructose	
Fermented Soybean Products	
Lactulose Technology	Technilab Inc., Montreal, Canada.

APPENDICES A-G

CURRENT TECHNOLOGIES

ASEPTIC PACKAGING TECHNOLOGY

Rationale

Aseptic packaging is the newest development in the area of packaging as it permits the production of high quality products which are shelf stable. The technology offers many advantages over hot-fill and retort techniques, and it applies to particulates as well as to liquid products. In Latin American countries many products need to be sterilized for facilitating transport, exports and distribution of fruits and vegetables, dairy and meat products.

Process/Technology

- Aseptic technology implies the sterilization of products before packaging followed by aseptic filling in sterile containers.
- High temperature short time sterilization provides a high-quality product provided it is coupled with an efficient aseptic packaging system.
- Containers in a choice of materials are usually formed and sterilized just prior to filling and sealing, although preformed containers are also used.
- Container materials must be correlated with the product to be filled.
- Sterilizing agents are either hydrogen peroxide, hot air, UV or steam.
- A recent advance is the dual approach in which labile essence and aroma are cold sterilized by filtration whereas the basic juice is heat sterilized.

Raw Materials

- Fruits and vegetables to be processed are widely used in aseptic system.
- Milk and products that can be pumped or gravity filled.
- Processed meats and fish.
- Beverages of all kinds.

Products

- Juices from fruits and vegetables, either concentrate, fluid, drinks, purées.
- Particulate products such as berries, fruit pieces, vegetable pieces, meat and fish chunks in sauces or gravies.
- Ultra high temperature (UHT) milk or cream.
- Dairy and fruit blends.
- Bulk products aseptically transferred into retail packages.

Legislation

- Aseptically packaged products are widely accepted in U.S. and Canada.
- Manufacturers must comply to each country's regulations concerning sanitation, composition and labelling.
- In addition, container material coming in contact with the food must be approved as safe.

Contacts

- Lassonde & Fils, Rougemont, Que., Canada (Phone: 514-469-4926).
- Alfa-Laval, Toronto, Ont., Canada (Phone: 416-299-6101).
- TetraPak, Toronto, Ont., Canada (Phone: 416-865-9480).
- Brik Pak, Dallas, Texas, U.S.A.
- Combibloc, Columbus, Ohio, U.S.A.
- Knouse Foods, 800 Peach Glen Rd., Peach Glen, PA, 17306, U.S.A. (Phone: 717-677-8181).

References

- Carlson, V.R., 1984. Current aseptic packaging techniques. Food Technol., 38(12): 47-50.
- Tillotson, J.E., 1984. Aseptic packaging of fruit juices. Food Technol. 38(3): 63-66.

MODIFIED ATMOSPHERE PACKAGING TECHNOLOGY

Rationale

Although modified atmosphere principles have been known for a long time, new interest has been stimulated in recent years with advances made in the design and manufacture of polymeric films which have a wide range of gas permeability characteristics. Latin American countries wishing to export exotic fruits and vegetables to temperate countries should seriously consider the technology of modified atmosphere packaging.

Process/Technology

- Modified atmosphere packaging is the packaging of food products in gas-barrier film where the gaseous environment has been modified to slow down respiration rates, reduce microbiological growth and retard enzymatic spoilage to extend the shelf life.
- It is not to be confused with controlled atmosphere storage which refers to facilities where the levels of gases, the temperature and the humidity are continually monitored in a storage room.
- It is also different from edible films and coatings which contribute to retarding moisture and gas migration but are not substitute to modified atmosphere packaging.
- Choice of the polymeric film appropriate to each particular product is the major element of that technology.
- Absorbers of gases and moisture can also be used to better control the atmosphere composition.
- Modified atmosphere packaging applies to shipping containers as well as to retail packages.

Raw Materials

- Fruits and vegetables are the commodities receiving the greatest attention particularly since metabolic processes differ with each.
- Meats, fish, and dairy products are nonrespiring commodities and have different requirements.

- Bakery, pasta and confectionery products represent different group requirements.
- Ready-to-eat products and meals.
- Beverages have container requirements of their own.

Products

- Modified atmosphere packaging is applicable to most food products, whether fresh or processed, and where time is a parameter of quality.
- The technology should be part of appropriate food systems from harvest to the table.
- Export foods in particular can benefit greatly from adequate control of environment all along the food chain.

Legislation

- Regulations in U.S. and Canada are concerned with the safety of the packaging material coming in contact with the food.
- White paper containers have recently been banned for food packaging.
- It is advisable to ensure authorization with U.S. Food and Drug Administration, U.S. Department of Agriculture and Health and Welfare Canada.

Contacts

- Dupont Canada Inc., P.O. Box 660, Station A, Montreal, Que., Canada, H3C 2V1 (Kingston Office 613:544-6000).
- ICI Americas Inc., New Murphy Rd., Wilmington, DE, 19897, U.S.A. (Phone: 302-575-3123).
- Canadian Liquid Air, 6880 Louis H. Lafontaine, Anjou, Que., Canada, H1M 2T2 (Phone: 514-842-5431).
- Hoechst Canada Inc., 4045 Côte Vertu Blvd., Montreal, Que., Canada, H4R 1R6. (Phone: 514-333-3522).
- Campbell Soup Co., Campbell Place, Camden, NJ (and Leamington, Ont.).

References

- Zagory, D. and Kader, A.A., 1988. Modified atmosphere packaging of fresh produce. Food Technol., 42(9): 70-77.
- Lioutas, T.S., 1988. Challenges of controlled and modified atmosphere packaging: A food company's perspective. Food Technol., 42(9): 78-86.

VACUUM-COOKING TECHNOLOGY

Rationale

The technology of "cuisson sous-vide" has been developed in France during the last decade. It had a rapid development in Europe and is now being introduced in North America. It is a technology for connaisseurs, professionals of food preparation and quality restaurants and institutions. Latin American countries surely have a market for this new technology for various food products.

Products/Technology

- Ready-to-eat dishes have now three classes: sterilized (can, pouch, flexible), frozen and fresh. The most recent development is the fresh ready-to-eat dish ("plat cuisiné frais").
- Dishes are prepared under the direction of professional chefs with the best quality food items.
- They are packaged under vacuum in flexible material cooked in its package, cooled immediately and kept at 1-3°C (up to 3 weeks).
- Cooking is usually done in hot water as for hard-boiled eggs.
- In addition to providing high quality fresh foods, they are a substantial saving for restaurants and institutions.

Raw Materials

- A wide variety of meat cuts, chicken pieces, etc.
- Vegetables requiring cooking.

Products

- Dishes are packaged by commodity and by small portions (300 g).
- Since cooking does not reach sterilization temperatures the products are treated like fresh products.
- The products have the properties (flavour, texture, colour, nutrition)of fresh products.

- Product life is extended to three weeks.

Legislation

- Regulations are bound to be similar to those for fresh products.
- Labelling should require clearance from the federal agencies.

Contacts

- Restauration Peugeot-Talbot, Poissy, France
- Christian Toupin, Food Research Centre, St-Hyacinthe, Quebec, Canada. (Phone: 514-773-1105)
- Cuisi-France Inc., 570 Curé Boivin, Bois Brillant, Quebec, J7C 2A7.

References

- Auliac, A. 1988. Le conditionnement des plats cuisinés sous vide: un choix stratégique. Ind. Alim. Agr., 105(4): 271-273.
- Dreano, M. 1988. Cuisson de plat cuisinés sous vide. Ind. Alim. Agr., 105(4):277-279.

INTERMEDIATE MOISTURE FOODS

Rationale

Intermediate moisture food is a new technology based on old processes. They were first intended to preserve foods without refrigeration in countries where refrigeration was not easily accessible and where the climate was hot. However, the popularity of this technology is increasing in industrialized countries as well as for energy saving purposes.

Process/Technology

- The principle of this technology lies in the lowering of the free water in the food to an activity where bacterial growth is inhibited, usually to a water activity below 90% of the original water content.
- The required water activity for safe preservation must be known or determined for each type of food. In this regard many data are available in the literature.
- Water activity of a food can be adjusted by composition formulation, by partial drying or by additives such as salt, glycerin, sugars, water binding agents or others.
- Keeping quality is usually enhanced by controlling other factors such as pH, mild heat treatment, surface drying, mold preservatives, vacuum packaging, etc.

Raw Materials

- Intermediate moisture technology applies to a large number of foods.
- Fruits and vegetables.
- Pastry and bakery products.
- Meat products (beef, pork, chicken).
- Fish products.
- Dairy products.
- Confectioneries.

Products

- The final products can have different applications.
- They can be ingredient materials to be used in other food formulations such as fillings.
- They can be ready-to-eat foods. A typical example is biltong, a South African dried meat dating back to the Boers War.
- Certain products may require salt removal, flavouring or reconstitution to suit consumer appeal.
- Pet foods are also examples of wide use.

Legislation

- Since we are dealing with food products, it is required to have the process approved by regulatory authorities in the destination countries.
- Special hygiene guidelines are essential since the products are in the original or raw state.

Contacts

- General Foods Corp., 220 Yonge St., Toronto, M5W 1J6, 416-484-5498.
- Quaker Oats Company, Toronto, Ont., Canada.
- Dr. François Castaigne, Food Science Department, Laval University, Quebec, Canada.
- Dr. Marc LeMaguer, Food Science Department, Guelph University, Guelph, Ont., Canada.

References

- Bone, D.P., 1987. Practical applications of water activity and moisture relations in foods. In: Water activity: Theory and applications to food. U.S.A. New York: Marcel Dekker: 369-395.
- Leistner, L. 1987. Shelf-stable products and intermediate moisture foods based on meat. In: Water activity: Theory and applications to food. U.S.A. New York: Marcel Dekker: 295-327.

IRRADIATION TECHNOLOGY

Rationale

Irradiation of food has four major objectives to:

- Ensure the microbiological safety of foods.
- Contribute to reduce food losses by spoilage.
- Facilitate the trade of insect-free foods between countries.
- Lengthen the shelf life of fresh foods.

It is obvious that these objectives are of great interest to Latin American countries wishing to increase their exports of many fresh as well as processed food products to North American and other markets.

The Canadian government has just approved irradiation for a number of products.

An assessment of business opportunities of food irradiation in developing countries was undertaken in 1987/88 by Gamma Processing Intl. for the CIDA Industrial Cooperation Division. A priority list was established based on six criteria including industrialization, involvement of private industry, infrastructure, post harvest technology, exports, and legislation (see attached Summary). For Latin America, the following countries were selected: Mexico, Brazil, Argentina, Peru and Chile.

Application Research with gamma irradiation is undertaken at the Canadian Irradiation Centre in Laval, Quebec and at the St. Hyacinthe Food Research Lab of Agriculture Canada.

Recent efforts in application research of accelerator beam irradiation of food were initiated by AECL's Accelerator Unit in Pinawa, Manitoba and at the Mevex Corporation, Canada's first privately-owned facility. The size of the Mevex accelerators can be tailored to various through-put capacities.

A Position Paper to compare the characteristics of gamma and electron beam irradiation has been prepared by INMARINT Ltd. Electron beam irradiation, using electricity as an energy source, may offer interesting opportunities for selected applications for smaller or medium-sized food processing companies in LAC countries.

Process/Technology

- Irradiation in this context refers to the exposure of foods to low ionizing energy produced by gamma rays emitted from Cobalt-60 and to electron-beam irradiation from linear accelerators.

- Cobalt is nothing more than a source of energy, like heat, microwave, ultraviolet light and the sun.

- That energy acts by activating water molecules which in turn inactivate the organisms and the enzymes responsible for food spoilage.

- There is no apparent change in the food. No method has yet been found to detect if a food has been irradiated.

- Based on 30 years of research a joint FAO/IAEA/WHO Expert Committee recognized in 1980 the safety of foods irradiated up to 10 kGy.

- There are small groups of ill-informed consumers who are confusing irradiation with nuclear reactors. It has been shown that those fears can be dissipated through education.

- Latest developments are concerned with combination treatments for food preservation.

Raw Materials

- Sprouting inhibition at 0.15 kGy of potato, yam, Jerusalem artichoke, beet, turnip, carrot, onion, garlic.

- Inhibition of post harvest growth at below 0.5 kGy of asparagus and mushrooms.

- Insect disinfestation at below 0.75 kGy of spices, herbs, flour, grains, fruits and vegetables, flowers, particularly fruit flies from sub- and tropical countries. Also in dry products (fish, raisins, dates).

- Delayed ripening of some tropical fruits (banana, mango, papaya) at below 0.5 kGy.

- Control of post harvest diseases in fruits and vegetables at 1.75 kGy.
- Inactivation of pathogenic organisms (Salmonella, Listerin, and others) at 3 to 10 kGy in meats, particularly poultry, and fish. Frozen foods can support high doses.
- Extrusion of shelf life of many fruits, vegetables, meats and fish.
- Control of Trichina in pork at dose below 0.2 kGy.
- New applications are in continuous development, such as waste sterilization.

Products

- Irradiated tubers, roots and bulbs which are sprouting free.
- Insect free spices, herbs, fruits and vegetables, flour, etc.
- Shelf life extension for fruits, vegetables, meats and fish.
- Pathogen-free meats and fish.
- Exportability of many products.

Legislation

- A list of numerous food products approved for irradiation in 33 countries has been published by the Joint FAO/IAEA Div. of Isotope and Radiation Applic. of Atomic Energy for Food and Agric. Dev.; Intl. Atomic Energy Agency, Vienna, in April 1988.
- Food and Drug Administration in the U.S. and Health and Welfare in Canada have regulations which must be satisfied for the safe use of radiation.
- For additional uses the potential industrial applicant must file a petition with those agencies. Efficacy testing and safe processing are the major requirements.
- For meat and poultry, the petition must also go to the Food Safety and Inspection Service of U.S.D.A.
- Since 1985, a U.S. regulation permits irradiation of only fresh pork within a dose range of 0.3 to 1 kGy to control Trichina spiralis.

- The Canadian Government has passed an order-in council on March 23, 1989 to come into effect April 14, 1989, legalizing the irradiation of meat, vegetables and fruit, in addition to wheat, flour, potatoes, onions and spices approved already many years ago.

Contacts

- NORDION International Inc., 447 March Road, Kanata, Ont., Canada, K2K 1X8 (Phone: 613-592-2790).
- Accelerator Business Unit, AECL Research Company Ltd., 436B Hazeldean Road, Kanata, Ont., Canada, K2L 1T9. (Phone: 613-831-2882).
- Mevex Corporation, West Carleton Industrial Park, 108 Willowlea Road, P.O. Box 1778, Stittsville, Ont., Canada, K0A 3G0. (Phone: 613-831-2664).
- Gamma Processing Intl., 120 Holland Avenue, Suite 201-A, Ottawa, Ont., Canada, K1Y 0X6. (Phone: 613-722-2655).

References

- Kader, A.A. 1986. Potential applications of ionizing radiation in post harvest handling of fresh fruits and vegetables. Food Technol., 40(6): 117-121.
- Giddings, G.G., 1984. Radiation processing of fishery products. Food Technol., 38(4): 61-65, 94-97.

NOTE: There exists an abundance of Canadian, U.S. and overseas references covering thirty years of research on and application of food irradiation (for instance, the CIDA Irradiation Feasibility Report for Jamaica contains a bibliography of 43 pages).

MEMBRANE TECHNOLOGY

Rationale

Membrane filtration is a new separation technology for liquids which has been associated with a large number of applications in food processing, pure water production and processing waste treatment and recovery. It has become a must in most food processing plants for reasons of economics, better quality products and ingredient production. This technology can be applied in Latin American processing of fruits, vegetables, dairy, meat and fish products, beverages, citrus oils, etc.

Process/Technology

- Membrane technology refers to semipermeable membranes designed to separate components according to the size of their molecule.
- Since the pore sizes of the membranes are very small, the fluid must be under pressure to effect separation into two streams: permeate and concentrate.
- Three classes of membrane are differentiated according to their pore sizes: reverse osmosis, ultrafiltration and microfiltration.
- Reverse osmosis will let through only water and the odd ion.
- Ultrafiltration will let through water, salt and small sugar molecules.
- Microfiltration has the largest pores for retaining only the larger particles.
- Within those classes, different membrane porosities can be selected to effect finer separations.
- Since membrane separation is performed without heat, heat damage to components is avoided in addition to energy saving.

Raw Materials

- Membrane technology applies to materials in most food processing industries: fruits, vegetables, dairy, meat, fish, oilseeds, cereals, egg, alcoholic and non-alcoholic beverages.

- Processing waste components reclamation.
- Water purification.

Products

- Concentrated juice, concentrated milk.
- Lactose, proteins and salts fractionation.
- Separation of fat from protein.
- Clarified wine and beer.
- Sugar, protein and salt reclamation from wastes.
- Cheese making from ultrafiltrated milk.
- Water reclamation in processing plants.
- Brine recovery from plant effluents.
- Beer recovery from sludge.
- Many more applications.

Legislation

- Membrane is an accepted process in North America. There are no regulations that control its use.

Contacts

- Zenon Corp., Mississauga, Ont., Canada (416-825-1492).
- Osmonics, Inc., 5951 Clearwater Drive, Minnetonka, MN, 55343, U.S.A.
- Separa-Systems Ltd., 317 Brokaw Rd., Suite A, Santa Clara, CA, 95050, U.S.A. (Phone: 408-289-0952).

References

- Paulson, D.J., Wilson, R.L. and Spatz, D.D., 1984. Crossflow membrane technology and its applications. Food Technol. 38(12): 77-87.
- Lawhon, J.T. and Lusas, E.W., 1984. New techniques in membrane processing of oilseeds. Food Technol. 38(12): 97-106.

FREEZE CONCENTRATION TECHNOLOGY

Rationale

The removal of water by freezing is becoming increasingly attractive for products which are sensitive to heat; freeze concentration is particularly applicable for high quality products. New developments in this technology make it economically feasible. It applies particularly to fruit juice concentration.

Process/Technology

- In this process water is crystallized by freezing it in a crystallizer. The ice crystals are then removed from the liquid phase by different means.

- A "scraped surface heat exchanger" can be used as crystallizer to produce small crystals in a first stage.

- In a second stage, small crystals are fed to a recrystallizer to allow for crystal growth.

- It is possible to produce ice crystals containing no product.

- Separation of the crystals can be performed in wash columns, by expellers or by centrifugation.

Raw Materials

- The process applies to any liquid extract where there is a need for water removal.

- It has been applied to a variety of fruit juices such as orange, grapefruit, strawberry, raspberry, blackberry, blueberry, as well as to coffee extracts, wine, cider, beer, vinegars.

- It is the preferred process because it retains flavour and nutritional qualities in a concentrate.

Products

- The concentrates obtained by this technology can exceed 50% solids.

- They are high quality products in terms of flavour and nutritive properties.

Legislation

- If esthetic and sanitary considerations are respected regulatory authorities will have no objection for the use of this technology.

Contacts

- Grenco A.G. Inc., 1100 Circle 75 Parkway, Suite 725, Atlanta, Georgia, 30339, U.S.A.
- General Mills, Inc., 9000 Plymouth Avenue N., Minneapolis, Minnesota, 55427, U.S.A.

References

- Van Pelt, W.H.J.M. and Swinkels, W.J. 1986. Recent developments in freeze concentration. In Food Engineering and Process Applications. Vol. 2. Unit Operations. GBR Barking, Elsevier Applied Science Publishers.
- Van Pelt, W.H.J.M. 1983. Economics of multi-stage freeze concentration processes. Congrès Intern. du Froid. Paris Institut Intern. du Froid 1984, 159-163.
- Valente, M. 1985. Séparation Glace - Concentré par pressurage continu en cryoconcentration. Ind. Alim. Agr. 102(11): 1179-1183.
- Merle, R.K., Kozlik, R.F. and Sapakis, S.F. 1986. A new freeze concentration device. In Food Engineering and Process Applications. Vol. 2. Unit Operations. GBR, Barking, Elsevier Applied Science Publishers.
- Valente, M., Missirian, C. and Daumas, C. 1986. La cryodessication par le procédé IRFA. Cahier ingénierie, No. 21, 3-4.

FRUIT JUICE CONCENTRATION AND STERILIZATION

Rationale

The technology to produce high quality fruit juice concentrates has been improved considerably over the years. Considering the ever increasing popularity of fruit juices in most countries of the world, the future of the juice industry can only be bright. Countries with abundant supplies of citrus fruits (e.g. Brazil and others) could benefit from the latest technologies to produce high quality fruit juice concentrates.

Process/Technology

- In the fruit juice industry, the technology is oriented towards flavour retention, nutrition protection and product stabilization through enzyme control and pasteurization.
- In certain cases it may be desirable to remove oxygen and some bitter and acidic compounds to ensure greater stability and to improve taste.
- The traditional process of hot-filling juice in containers to produce shelf-stable products is now being replaced by newer technologies.
- Low temperature evaporators to concentrate juices are also being substituted by more rapid methods where juice is exposed to heat for only minutes instead of 1-2 hours. The new temperature-accelerated short time evaporation (or TASTE system by Gulf Machinery Co., Clearwater, Fla.) is, today, the standard process.
- Further advanced techniques include the use of membrane technology to achieve cold sterilization, freeze concentration, combination of cold and hot processes, accompanied by aseptic filling technology and irradiation technology.

Raw Materials

- The new concentration processes are applicable to all universal and tropical fruits.

Products

- Shelf-stable juices or concentrates.
- Chilled juices or concentrates.

- Frozen juices or concentrates.
- Packaging is either individual portions (bottles, cans or flexible containers, e.g. tetrapacks), family size portions, institutional packaging or industrial bulk packaging.
- Most juices are marketed as single flavour brands. However, excellent blends of various compatible juices (e.g. tropical blends, etc.) are gaining in consumer appeal.

Legislation

- Process and plant sanitation are requisites in juice production. The use of hydrogen peroxide as sterilizing agent for containers is no more prohibited in North America.

Contacts

- McCain Food Co., Florenceville, N.B., Canada.
- Lassonde & Fils, Rougemont, Quebec, Canada. Phone: 514-469-4926.
- Del Monte Food Ingredients Group, One Market Plaza, P.O. Box 3575, San Francisco, CA, 49119. Phone: 415-442-5231.

References

- Tillotson, J.E. 1984. Aseptic packaging of fruit juices. Food Technol., 39(3): 63-66.
- Sizer, C.E., Waugh, P.L., Edstam, S., and Ackermann, P. 1988. Maintaining flavor and nutrient quality of aseptic orange juice. Food Technol. 43(6): 152-159.

SURIMI PROCESS TECHNOLOGY

Rationale

The food industry of North America has discovered only recently the advantages of the old Japanese surimi or fish deboning technology. It is an excellent way to add value to underutilized fish species and to produce a wide selection of similar food products. The fishing industry of Latin American countries has an interest in picking up the surimi technology with all the latest improvements.

Process/Technology

- Surimi is essentially deboned fish flesh. The product is abundantly washed with water. Cryoprotectants are usually added if the product is to be frozen before use.
- Consequently surimi is a base to manufacture other products. That is why in modern days it is customary to keep it under frozen conditions.
- The technology originates from Japan several centuries ago. In earlier times, surimi was processed immediately into kamaboko products.
- A recent part of the technology is the discovery of suitable cryoprotectants (sugar, sorbitol, polyphosphates) to protect the functional properties of the proteins during frozen storage.
- Deboning is now done mechanically and washing with chilled water is done to remove virtually all the water-soluble proteins and enzymes to produce a base which is odorless and colourless.
- The technology is of recent introduction into Canada and the U.S. and is expected to be further developed and adapted to American requirements.

Raw Materials

- The aim of surimi manufacture is mainly to add value to under-utilized fish species.
- Common fish species used for surimi production are red hake, cod, carp, pollock, tuna, mackerel, shark, sardines, and many others.

- It is recognized that many Latin American countries are not fully utilizing their fishing potential and that the application of surimi technologies could be beneficial to some of them.

- Consideration could be given to the establishment of shore plants to access fresh raw materials.

Products

- The quality of surimi will be affected by fish freshness, species and season.

- Manufacturing process must be appropriate and tailored to fish species.

- The main properties sought in surimi are gel ability, elasticity, chewiness, water-binding capacity, cohesiveness, bland colour and flavour.

- Kamaboko products are surimi base which have been ground with salt and spices, given a shape and then steam or broil or fry cooked.

- Texture and gel strength of surimi can be improved by addition of starch and egg white.

- The new generation of surimi-based products are texturized products making use of extrusion, single or double, depending on the texture sought or using a fiberization technique.

- High value simili lobster, shrimp, crab and scallop can easily be created by either blending surimi with the real meat or utilizing flavour extracts.

- Food analog products which can be derived from surimi are subject to the highly functional properties of the surimi protein.

Legislation

- The North American legislation does not object to the production and utilization of surimi for food purposes. Standards of production with regards to sanitation and esthetics must be complied with as for other food processing.

Contacts

- Terra Nova Fishery, Newfoundland, Canada.

- JAC Creative Foods Inc., 3050 E. 11th St., Los Angeles, CA 90023, U.S.A. (Phone: 213-263-3344).

- Technical Institute of Fish Technology, Halifax, N.S., Canada.
- SeaFest Products, 9449 Science Centre Drive, New Hope, MN 56428, U.S.A. (Phone: 612-340-3851)
- Sea Legs, 100 Pine St., San Francisco, CA 94111, U.S.A., (Phone: 415-956-6600)

References

- Lee, Chang M., 1986. Surimi manufacturing and fabrication of surimi-based products. Food Technol. 40(3): 115-124.
- Lee, C.M., 1984. Surimi process technology. Food Technol. 38(11): 69-80.

EXTRUSION TECHNOLOGY

Rationale

The potential of the extrusion-texturization technology is enormous. The composition of the products can be adapted to consumer preference in terms of flavour, texture and nutritive value. Being in low moisture form, the products have long life properties without refrigeration. It is a technology quite appropriate to Latin American countries to produce low cost nutritious foods for domestic use as well as for exports from fruits, vegetables, grains, etc.

Process/Technology

- Extrusion is a technology to impart a new texture to raw ingredients. It is one of several texturization processes.
- Extrusion can be performed in cold or hot environment. Extruders can be single-screw, twin-screw, spineret type or hydrodynamic. The twin-screw cooking extrusion is currently the most expanding technology.
- Blended raw ingredients are prepared as a dough with water or steam. Within the screw compartment, the product is cooked under pressure and modified to a new molecular configuration, passing from granular to plasticized mass.
- Unfolding of protein molecules and their parallel alignment provide a fibrous structure which simulates meat.
- The texture and the shape of the extruded food is largely determined by the die configuration.

Raw Materials

- Dough prepared from grains, fruits, vegetables, etc. for extrusion usually contains vegetable protein or starch as major ingredients.
- Alginate, caragheenan or other polysaccharides are often added as binder.
- Depending on the final product which is desired, a choice of additives are added as minor constituents: fat, sugar, flour, colour, salts, vitamins, fruits, vegetables, meat, etc.

Products

- Products obtained by extrusion vary in composition, texture, flavour and shape to unlimited extent.
- They can be slices, balls, cubes, circles, alphabets, animals, sticks, etc. and this in different sizes.
- Typical products are the wide range of snack foods, breakfast cereals and pet foods.
- The potential is great for new product development, particularly more health and nutritious foods.

Legislation

- Extruded products are widely used in North America and manufacturers must comply to proper sanitation, composition and labelling requirements.

Contacts

- Most manufacturers of extruders (Wenger, Baker-Perkins, Creusot-Loire, etc.) do welcome product testing.
- St-Hyacinthe Food Research Centre has a twin-screw extruder from Baker-Perkins available for product development (514-773-1105).
- General Foods (Canada), Cobourg, Ont., Canada. (Toronto Office: 416-484-5498)
- Labatt Co., London, Ont., Canada.

References

- Harper, J.M., 1986. Extrusion texturization of foods. Food Technol. 40(3): 70-76.
- Clark, J.P., 1986. Texturization processes in the cereal foods industry. Food Technol., 40(3):91-95.

RESTRUCTURED MEAT TECHNOLOGY

Rationale

The manufacturing of steaks from cuts traditionally used for ground meats or stews or roasts is an excellent way to add value to cheaper meat cuts while providing boneless steak meats at relatively low prices. The meat industry in Latin American countries would benefit from the restructuration technology in creating higher-value products from trimmings and poor cuts.

Process/Technology

- In the meat industry there are lower value cuts and trimmings which are traditionally used for ground meats or sausages.
- A restructuration technology developed in recent years allows for changing the composition and the form of those cuts for higher quality meats.
- The bones and undesirable parts of the cuts are removed and then the meat is grossly chopped or sliced or diced or flaked.
- After adding the desired ingredients and particularly binders, the mass is given a shape by one of several machines.

Raw Materials

- The technology applies to any kind of meats: beef, pork, lamb, chicken, turkey, veal and others.
- Small portions of mechanically deboned meats could possibly be incorporated, although the recommendation is to use good quality tissues.
- Ingredients could include fat, flavouring, colouring, salts, seasonings, spices, binders.

Products

- Restructured steaks, restructured pork chops, restructured chicken are examples of the type of products.
- The products can be battered or breaded.
- They are usually retailed in frozen form.

Legislation

- Canada and U.S. have regulations concerning processing of meat and meat products. Also non-meat ingredients which are permitted are strictly regulated. Manufacturers are advised to familiarize themselves with those regulations at Food and Drug Administration, U.S.A. and Health and Welfare Canada.

Contacts

- Canada Packers Ltd., 2211 St. Clair Ave. W., Toronto, Ont., Canada (Phone: 416-761-4046).

- Emmber Brands, P.O. Box 2006, Milwaukee, WI, 53201, U.S.A. (Phone: 800-558-4242).

References

- Mandigo, R.W., 1986. Restructuring of muscle foods. Food Technol., 38(3): 85-89.

MICROENCAPSULATION TECHNOLOGY

Rationale

Microencapsulation of minute food particles is a more recent development. Good techniques have been developed and tested on the industrial scale. The potential to produce unique foods is great. Latin American countries are designated for this technology because of their resources of food ingredients, such as spices, vitamins, oils, as well as raisins, nuts, etc.

Process/Technology

- Microencapsulation is a packaging technology at the miniature scale.
- The technology consists in covering minute food particules (micron to millimetre range) with a thin coating of protective material.
- Several techniques are now available to manufacture encapsulated food ingredients or components.
- Spray drying is the most common method used in the food industry. It consists in spray drying a suspension of material in a solution of coating material.
- Fluidized bed processing with spray coating.
- Cold extrusion of suspension into dehydrating liquid.
- Spray cooling and spray chilling when the coating is fatty material.
- Centrifugal extrusion which creates very fine particles of core and coating materials.
- Rotational suspension separation in which the excess coating liquid is spread into a thin film.
- Coacervation consists of phase separation of a suspension of core materials in a liquid solution.
- Inclusion complexation uses cyclodextrin which forms complexes with many flavours, colours and vitamins.

Raw Materials

- Materials to benefit from microencapsulation are food ingredients for reasons of stability, incompatibility, time-release, ease of handling, solid form, nutrition protection, dust reduction.

- Flavouring material, bacterial or yeast cultures, enzymes, spices, vitamins, special salts, acidulants, oils, colouring material, conditioners, sweeteners, minerals are all candidates for encapsulation.

- Food products such as raisins, nuts, snacks, liqueurs, wines, candies and others can be advantageously coated for eating quality improvement.

- Coating materials most commonly used are gum acacia, gelatin, modified starch, dextrins, non-gelling protein, gum arabic, cellulose derivatives, emulsifiers (lecithin, mono- or di-glycerides), lipids, carbohydrates (destrose, glucose ...), glycerin, stearine, sodium alginate, etc.

Products

- Microencapsulated products are presented in solid form although the core material can be solid, liquid or gas.

- Food ingredients used in small quantities in food manufacturing flavourings, colourants, vitamins, cultures, etc.

- Long-life snack foods.

- High value specialty products.

Legislation

- Core materials and coating materials are usually food-approved.

- It is however advised to verify with U.S. Food and Drug Administration and Health and Welfare Canada to ensure authorization.

- Cyclodextrins is an example of a coating not approved in the U.S.

Contacts

- Coating Place Inc., Box 248, Verona, WI, 53593, U.S.A. (Phone: 608-845-9521).

- Hoffmann-LaRoche Inc., 340 Kingsland St., Nutley, NJ, 07945, U.S.A. (Phone: 201-235-5000).

References

- Dziezak, J.D., 1988. Microencapsulation and encapsulated ingredients. Food Technol., 42(4): 136-148.
- Anandaraman, S. and Reineccius, G.A., 1986. Stability of encapsulated orange peel oil. Food Technol., 40(11): 88-93.

FREEZE-DRYING TECHNOLOGY

Rationale

The dry form is recognized as the best method to protect foods over long periods and it offers many advantages for storage, transport and utilization. Freeze-drying is among the rare processes which do not use heat for drying and consequently offers a better protection to nutritional and eating qualities of foods. The technology has now become feasible for large-scale operations and could find applications in Latin American countries to export high quality exotic products such as fruits, vegetables and particularly a wide variety of shellfish.

Process/Technology

- Freeze-drying is considered the best drying technology available to preserve the nutritional value and the natural aroma, flavour and colour of food. If desired, the shape of the food is also retained.
- Because the process appears to be time consuming, it has been applied in the past to high value products for which the quality is of paramount importance.
- To retain their exceptional flavour characteristics, instant coffee and instant tea are usually processed by freeze-drying.
- Mushrooms are frequently freeze-dried to protect their flavour and their shape.
- With the increased importance given to the natural quality of foods, freeze-drying is now finding applications in the area of many staple food products.
- There are industrial systems available now that permit large scale production.
- Freeze-dried products are very light in weight which corresponds to economic advantage in transport and overseas shipments.
- Freeze-dried products will retain most of their food characteristics for years without refrigeration.
- Consequently freeze-drying can be considered a recent technology developed during the past thirty years but still at the start of wide applications.

- In Japan, freeze-dried foods are manufactured in 25 independent plants and new products are regularly being developed.

Raw Materials

- Freeze-drying is commonly used for valuable flavour products such as instant coffee, instant tea, instant chocolate.
- Mushrooms have been available in the freeze-dry form for many years.
- Recent applications of the technology are for high value shellfishes: shrimp, scallop, scampi, lobster, crab, etc.
- Fruits and vegetables are lending themselves more and more to freeze-drying.
- Materials containing living organisms are best preserved in the freeze-dried state.
- Flavourings, colourings and the like are preferably freeze-dried for storage and utilization purposes.

Products

- Freeze-dried products are easier and cheaper to export.
- Properly packaged freeze-dried products have a very long shelf life quality.
- Rehydration is rapid in hot or cold water.
- Instant foods are the most common freeze-dried items.
- Ingredients in freeze-dried form are convenient for storage and utilization.
- Beverages, soups, sauces, dips, sour cream, yoghurts, etc. are more and more freeze-dried.
- Many products in flake form (bananas, peaches, apples, and others) are often produced by freeze-drying.
- New trend is the manufacture of freeze-dried meals as is required for the army or for space travels but also for camping.

Legislation

- Exports to the U.S. and Canada of freeze-dried exotic fruits, vegetables, herbs or shellfish is no more stringent than for the genuine products, fresh or frozen. Compliance to freedom from insects, disease and pathogenic organisms must be met.

Contacts

- Lyosan Inc., 500 Blvd. de l'Aéroport, C.P. 598, Lachute, Quebec, Canada, J8H 4G4. (Phone: 514-562-8525).

  N.B.: Lyosan is the sole firm in North America manufacturing freeze-drying systems and at the same time producing a variety of freeze-dried foods. Lyosan is in the process of installing a freeze-drying plant in Peru, the building infrastructure being done by the country of destination.

- Innovation Foods Inc., 179 Starlite St., South San Francisco, CA 94080, U.S.A. (Phone: 415-871-8912).

- Oregon Freeze Dry Foods Inc., Albany, Oregon, U.S.A. (Phone: 503-926-6001).

References

- Lingle, R., 1986. Drying: Ancient Methods have new twists. Prepared Foods, March: 92-96.

- Mellor, J.D., 1978. Fundamentals of Freeze-Drying. Academic Press.

- Fortin, Corinne, 1986. Influence de la lyophilisation sur la valeur nutritionnelle des aliments. Ind. Alim. et Agr., 103(10) : 1017-1019.

- King, C.J., 1971. Freeze-Drying of Foods. CRC Press.

ESSENTIAL OILS TECHNOLOGY

Rationale

Food flavourings are among the most essential ingredients used in the fabrication of foods at the industry, institutional and home levels. The food flavour and fragrance industry is an ever prospering industry. Natural flavourings have currently greater consumer appeal than artificial flavourings. Since Latin American countries are a good source of aromatic materials, such as citrus, tropical fruits, spicy herbs and vegetables and even food processing wastes including citrus peels, etc., essential oil production could become a flourishing industry.

Process/Technology

- Essential oils are flavouring compounds corresponding to the volatile fraction produced upon distillation of aromatic materials.
- Chemically, they are usually composed of terpene hydrocarbons accompanied by small proportions of aldehydes, alcohols and esters.
- In some instances, the minor components are contributing more to the flavour than the major terpenes themselves.
- Since terpenes are susceptible to oxidation, technologies have been developed to reduce their content and thus produce concentrated flavour oils.
- When essential oils and extracted nonvolatile constituents are standardized together, potent flavourings called oleoresins are obtained.
- Classical oil extractors make use of pressure (cold) or of piercing to release the oil from cells. An oil in water emulsion is created which is then separated in a two-stage centrifugation.
- Steam distillation or supercritical fluid extraction processes can also be used.

Raw Materials

- The current trend is toward natural flavours extracted from plant materials as compared to artificial flavours.

- Essential oils are present in a wide variety of biological materials.
- Citrus, other tropical fruits, spicy crops, other aromatic herbs and vegetables contain high concentrations of essential oils.
- Much of the raw materials could also come from second class fruits or processing wastes such as peel wastes, etc., wild plants (sage, berries) as well as from cultivatec crops.

Products

- Natural flavourings can be produced in different forms such as liquids, pastes, solids, encapsulated, blended with other ingredients, etc.
- Essential oils or oleoresins can be offered at different levels of flavouring potency, going from diluted solutions to several-fold concentrations.
- Trends are to incorporate flavourings with food ingredients as with prepared foods.
- Flavour enhancers are often desirable to accentuate a particular flavouring in a food.
- A demand exists for custom-made flavourings obtained by blending of single flavouring compounds.
- New technologies revolve around the combination of specific functional properties along with flavouring ingredients. Innovative products are obtained upon incorporation into the flavouring of preservative properties, antioxidant properties, water retention function, and others.
- It has become more and more imperative today to develop flavouring ingredients tailored to meet a user's specific requirements.

Legislation

- The Food and Drug Administration in the U.S. and Health and Welfare in Canada have jurisdiction over the composition and use of flavours in foods.
- In both countries permitted food additives are listed in Food and Drug regulations.
- As a general rule, safety and efficacy of food additives must be evaluated and cleared before they can be sold.

- Substances considered to be Generally Recognized As Safe (GRAS) among qualified experts are exempted from above definition.

- It is advised to work through the Flavor and Extract Manufacturers' Association.

Contacts

- Les Huiles Essentielles Cedarome Inc., 200 St-François Xavier, Delson, Quebec, Canada, J0L 1G0. (Phone: 514-638-3337)

- Flavour Manufacturers' Association of Canada, Suite 10, 3625 Weston Road, Weston, Ont., Canada, M9L 1V9. (Phone: 416-233-0007)

References

- Heath, Henry, and Runeccus, Gary. 1986. Flavor Chemistry and Technology. AVI Publishing Co.

- Lindsay, R.C. 1984. Food Ingredient Technology. Food Technol. 38(1): 76-81.

- Williams, Sally K. and Brown, W.L. 1987. Future Trends for Flavorings and Spices. Food Technol. 41(6): 76-79.

VEGETABLE PROTEIN TECHNOLOGY

Rationale

World protein requirements could be met easily if consumers would learn to use more of the plant proteins in their diet. Since Latin American countries have access to several proteinaceous crops such as cereals, oilseeds, legumes, etc., the development of a vegetable protein industry would be appropriate primarily for domestic consumption but also for exports.

Process/Technology

- Protein deficiency is a serious problem in many parts of the world including LAC countries.
- Animal protein products are either in short supply or too costly to satisfy protein requirements in everyone's diet.
- Vegetable proteins are in abundant quantity in the plant kingdom.
- Good technologies have been developed to extract plant proteins for food or for feed use.
- There are also many avenues to incorporate vegetable proteins into staple or special food products.

Raw Materials

- Vegetable proteins are found in relatively large quantity in four groups of plants.
- Cereals (oats, wheat, rice, corn, soya, etc.)
- Oilseeds (soya, canola, sunflower, cotton, ground-nuts, etc.).
- Pod-type leguminous plants (kidney beans, peas, lentils, broad beans).
- Leafy leguminous plants (alfalfa, clover).
- Others: tobacco, mushrooms, algae, yeasts.

Products

- Extracted vegetable protein is usually white material, bland in flavour.
- Cereal proteins are widely used in bread, pasta, breakfast cereals and biscuits as ingredient for their nutritional and functional properties.
- Processed meat products can be compounded with small proportions of vegetable proteins.
- Vegetable proteins lend themselves to extrusion processes for the manufacturing of snack foods or imitation meat products.
- Protein concentrates and protein isolates refer to degrees of purification.
- Proteins can be modified in several ways to confer a variety of functional properties.
- Hydrolyzed proteins.
- Milk replacers.
- Animal feed.

Legislation

- Their use as food in North America is subject to strict regulations with regards to their addition to staple foods and to imitation foods.
- Federal food agencies must be consulted before marketing to ensure compliance to regulations.

Contacts

- Griffith Laboratories, 757 Pharmacy St., Scarborough, Ont., Canada (Phone: 416-288-3050).
- Protein Technologies International, Checkerboard Square, St. Louis, MO 63164, U.S.A. (Phone: 800-325-7137).
- Deltown Chemurgic Corporation, 191 Mason St., Greenwich, CT 06830, U.S.A. (Phone: 203-629-8754).

References

- Giroud, P., 1978. Dehydration de luzerne avec extraction de proteines et économie d'energie. Ind. Alim. Agr., 95 (Sept-Oct): 1125-1139.

. Feed Protein Conference, 1973. Canadian Livestock Feed Board.

. Woerfel, J.B., 1981. Processing and utilization of by-products from soy oil processing. J. Amer. Oil Chem. Soc., 58(3): 188-191.

NATURAL FOOD COLOUR TECHNOLOGY

Rationale

There is a growing interest in North America as well as in the world for the utilization of natural colourant in food processing. This has come about since the banning of several synthetic colourants for safety reasons. The list of synthetic or certified food colours is getting shorter with time and their production is subject to strict control by federal agencies. As a result of this,natural colour technology is developing at a rapid rate and this could well be the time for Latin American countries to exploit the industry of colourants from exotic crops, fruits, flowers, leaves and many other products as well as even insects.

Process/Technology

- In the past several synthetic colourants have been declared unsafe and were banned for food use.
- The list of "certified food colours" in the U.S. has been brought down to 16. The introduction of any new synthetic colourant requires long and costly toxicological studies.
- The U.S. Food and Drug has a list of 24 natural extracts.
- At the consumer and industry level the preference is for natural colourants.
- New technologies are opening the way to the production of colour extracts having greater strength, more uniformity and stability.

Raw Materials

- Raw materials for colour extraction are abundant in nature.
- Bixa orellana seeds (annatto), crocuses (saffron), gardenia (carotenoids, iridoids, flavonoids).
- Coccid insects (cochineal, carmines).

- Kermes ilicis insects (Kermes).
- Strawberry, blackcurrent, beets, carrots, grapes, etc.
- Alkanna roots (alkannet).
- Monascus.
- Apricots, corn, egg yolks, flamingos, salmon, shrimp (carotenoids).
- Green leaves (carotene, chlorophylls, xantophylls).

Products

- Colour extracts can be as aqueous solution, alcohol solution, oil base, crystalline, powder, paste.
- Anthocyanins (water soluble) orange, red, blue pigments from grapes, strawberries, raspberries, blueberries, cranberries, apples, roses, corn.
- Betanins are red and yellow pigments from beets, cactus fruit, red chard, bougainvillea flowers.
- Carotenoids are yellow, red and orange pigments from carrots, tomatoes, paprika, red salmon, butter, palm oil, corn kernels, marigold petals, algae, green leaves.
- Chlorophylls are green pigments from green leaves.
- Annatto, yellow pigment from Bixa orellana

Legislation

- It is advised to verify the list of permitted colour additives of U.S. Food and Drug and of Health and Welfare Canada.
- Natural colourants usually do not require costly toxicological studies. However there are exceptions such as chlorophylls which are permitted in Canada and prohibited in the U.S.
- There are natural compounds which are carriers of pigment and which are permitted in foods for reasons other than colouring. Riboflavin is a vitamin additive of yellow colour.

Contacts

- Chemical Dye Co., Kingston, Ont., Canada.
- Chr. Hansen's Laboratories, 9015 W. Maple, Milwaukee, WI 53214, U.S.A. (Phone: 414-476-3630).

References

- Newsome, R.L., 1986. Food colours. Food Technol., 40(7): 49-56.
- Dziezak, J.D., 1987. Applications of food colorants. Food Technol., 41(4): 78-88.

CITRUS AND APPLE POMACE TECHNOLOGY

Rationale

Citrus peel and apple pomace usually are embarrassing wastes from the juice industry. They are costly to dispose of and often are a source of pollution. The trend is toward technologies to salvage and add-value to those residues. Latin American countries could benefit from technologies aimed at waste reclamation.

Process/Technology

- Citrus peels are an excellent source of essential oil which has been described separately. They are also a rich source of pectin and fibre.
- Apple pomace contains on a dry basis about 18% protein and 20% fibre. In addition, it contains carbohydrates, proteins, fat and minerals.
- The market for pectin is large in the world. Apple pectin comes from pomace and citrus pectin from peels.
- Developed technologies have shown that those residues are also easily fermentable to produce food or fuel compounds.

Raw Materials

- Apple pomace and reject apples.
- Citrus peels and rejects.

Products

- The technology to produce pectin from citrus peel and apple pomace is not new.
- Ethanol production for fuel use.
- Citric acid for food additives.
- Methane production as source of energy.
- Edible fibres.

Legislation

- There is no foreseen objections to the conversion of those residues into food articles provided esthetic and sanitary considerations are respected.

Contacts

- Bulmer Pectin Ltd., Plough Lane, Hereford, HR4 0LE. (Phone: 0432-352000).
- Tree Top Inc., P.O. Box 248, Selah, Wash., U.S.A., 98942. (Phone: 509-697-7251).

References

- Hang, Y.D., 1987. Production of fuels and chemicals from apple pomace. Food Technol., 41(3): 115-117.
- Prescott and Dunn, 1982. Industrial Microbiology, AVI Publishing.

SUPERCRITICAL FLUID TECHNOLOGY

Rationale

The supercritical technology has a great future in the food industry where the trend is to go after high value components in plant and animal materials. It is likely to replace the conventional methods of separation utilizing organic solvents or heat. Since the basic materials of interest (coffee, tea, exotic fruits, herbs and vegetables) are found in large supply in Latin American countries, it is appropriate to consider the application of this technology for those countries.

Process/Technology

- Supercritical fluid processing is an emerging technology which can be used to extract, separate or fractionate components from a mixture.
- The extraction is based upon the accrued solvency propertie[s] of gases when under supercritical conditions, that is, at a combination of pressure and temperature in excess of the critical phase point of a particular gas.
- Although different gases can be used, CO_2 is preferred because it is nontoxic, noncarcinogenic and relatively cheap.
- Everything else being equal, a change in the fluid pressure will change the solvent properties.
- So far the technology is applied to decaffeinate coffee and tea at the HAG A.G. plant (West Germany) currently owned by General Foods.
- Hop extracts are also commercially produced by supercritica[l] processing in Germany.
- Coupling of supercritical with other technologies is a potential possibility to improve productivity.

Raw Materials

- Materials currently being processed by supercritical fluid are coffee, tea and hops.
- Pilot scale demonstrations in industry, government and universities have shown that the process has a wide range of additional applications.

- Extraction of oleoresins, essential oils or fragrances from aromatic plants, spices, fruits and vegetables.
- Removal of undesirable carcinogens, pesticides, caffeine, nicotine, odors, cholesterol, biogenic amines, fatty acids, etc. from food materials.
- Fractionation of components from a multicomponent system such as fats and oils.
- Oil extraction from oilseeds, nuts, olives, corn, cocoa, and others.

Products

- Products processed by supercritical fluid extraction will be completely free from residual solvent.
- Dietetic products can be obtained upon reducing level of fat.
- Recovery of extracted components is greatly superior to traditional means.
- Ingredients separated by supercritical technology are of superior quality (flavors, colours, etc.).
- Minor components can be extracted by supercritical processing: caffeine, cholesterol, avidin, flavors, aromas, colours, oil fractions, etc.

Legislation

- No legislation could possibly object to the use of supercritical fluid technology in the food industry. The process is a clean one as no trace of objectionable solvent is left in the material being extracted or in the extract itself.

Contacts

- Norac Technologies Inc., 4222-97 Street, Edmonton, Alberta, Canada, T6E 5Z9. Phone: (403) 461-7163.
- General Foods Inc., Tarrytown, N.Y., U.S.A.

References

- Rizvi, S.S.H., Daniels, J.A., Benado, A.L. and Zollweg, J.A., 1986. Supercritical fluid extraction: Operating principles and food applications. Food Technol. 40(7): 57-64.

- Rizvi, S.S.H., Benado, A.L., Zollweg, J.A. and Daniels, J.A., 1986. Supercritical fluid extraction: Fundamental principles and modeling methods. Food Technol. 40(6): 55-65.

- Dziezak, J.D., 1986. Innovative separation process: finding its way into the food industry. Food Technol. 40(6): 66-69.

- Temelli, F., Chen, C.S. and Braddock, R.J., 1988. Supercritical fluid extraction in citrus oil processing. Food Technol. 42(6): 145-150.

CRYSTALLINE FRUCTOSE TECHNOLOGY

Rationale

Fructose, also called the corn sweetener, has several industrial advantages over the common sucrose or dextrose made from cane sugar. Crystalline fructose is 80% sweeter than sucrose and has 20% fewer calories. It has been produced for many years as a solution in water. The liquid fructose is convenient where transportation by tank is practical. For long distance transport, however, the dry form is more desirable. The crystalline fructose technology is welcome in countries where corn is an easy and plentiful crop.

Process/Technology

- The industrial production of fructose in crystalline form is a recent technology.
- The crystal is 54% sweeter than the 10% fructose solution and 80% sweeter than sucrose. In addition it has a sweetness synergism in blends with other sugars.
- Other functional properties are as a flavour enhancer, gelatine base, or water-binding agent.
- On a sweetness equivalent, it has a calorie content 20% lower than sucrose alone.

Raw Materials

- Corn
- Jerusalem artichoke

Products

- Crystalline fructose has wide applications in the food industry particularly for the preparation of dry mixes.

Legislation

- There are no regulatory constraints in the marketing of crystalline fructose.

Contacts

- A.E. Staley Mfg. Co., 2200 E. Eldorado St., Decatur, Ill., 62525, U.S.A.
- Labatt Co., London, Ont., Canada.

References

- Dziezak, J.D. 1987. Crystalline Fructose: A breakthrough in corn sweetener process technology. Food Technol., 41(1): 66, 67, 72.

FLAVOURS AND AROMAS BY FERMENTATION

Rationale

The flavour and aroma of many food products are developed by microorganisms and enzymes present in or added to them. They should be used in biological models for the production of flavours and aromas. The field is wide open for any country to select appropriate systems utilizing their respective food processing residues such as molasses, bagasse, cheese whey, etc.

Process/Technology

- Developed flavours and aromas in food are largely due to microorganisms and enzymes which are inherent in the food or which have been added to it.
- Examples of fermented foods are fermented dairy products (cheeses, butter, yoghurt, acidophilus milk), meat products (sausages), vegetable products (sauerkraut, beer, bread, dills, soybean foods), fruit products (fermented juices, wine), etc.
- Immobilized enzyme or cell technology is a recent development which applies to this technology.
- New and better support materials and techniques are being discovered to increase efficiency of fermentation.
- Flavours produced by microbial fermentation are considered natural flavours and often are multicomponent systems.

Raw Materials and Products

- The common raw materials that are used in these fermentations are by-products from sugar processing (bagasses, molasses), from milk processing (whey, lactose residue) or other source of carbohydrates.
- Milk constituents to produce cheese flavours.
- *Penicillium roqueforti* on milk fat to produce methyl ketones responsible for blue cheese flavour.
- Lipolysis of milk fat with lipases produces lipolyzed milk fat used in chocolate making.
- Lactose fermented by *Propionibacteria* to produce propionic acid typical of Swiss cheese.

- Streptococcus diacetilactis on milk to produce diacetyl and acetylmethylcarbinol typical of sour cream flavour.
- Ethanol to acetaldehyde by alcohol dehydrogenase.
- Ricinoleic acid to decalactone typical of peach flavour by Candida strains.
- Ethyl acetate (fruity aroma) produced by Ceratocystic moniliformis or by Candida utilis from ethanol.
- Terpene esters by aspergillus niger or by esterase-lipase system from Mucor miehei.
- Mustard oils (horseradish aroma) produced by myrosinase on glucosinolates.
- Many other possibilities.

Legislation

- It may be necessary to obtain patent licences or rights to utilize some of the fermentation processes.
- For food utilization, clearance has to be obtained from federal agencies.

Contacts

- Flavors of North America, Inc., 303 Northfield Rd., Northfield Il. 60093, U.S.A. (phone: 312-441-9740).
- Givaudau Corporation, Box 5034, Clifton, NJ 07015, U.S.A. (Phone: 201-365-8104).
- Fearn International Inc., Franklin Park, IL 60131, U.S.A.

References

- Gatfield, I.L. 1988. Production of flavour and aroma compounds by biotechnology. Food Technol., 42(10): 110-122.

ENZYME PRODUCTION TECHNOLOGY

Rationale

The use of enzymes in the food industry is developing at a fast rate. There are some 20 enzymes which are currently used in food. The need is for thermostable enzymes and also for a greater variety. There are some 70 manufacturers of enzymes in the world. The success belongs to those who can produce them at the lowest cost. Latin American countries have an abundance of raw materials such as papayas, pineapples, figs, and animal materials appropriate for enzyme production.

Process/Technology

- Enzymes are food constituents mainly proteinaceous which can catalyze biochemical reactions.
- They are thus able to produce new ingredients and to modify functional properties in food.
- They are found in certain plant and animal tissues or are produced by fermentation with microorganisms.
- With recombinant DNA technology it is now possible to introduce a particular enzyme gene into a micro-organism host that will produce the enzyme in greater quantity and also can improve thermostability.
- Several other technologies developed in parallel are now available to effect modification of enzyme properties: mutation, DNA transfer, chemicals, etc.

Raw Materials

- Natural plant materials: papaya, figs, pineapple, barley malt.
- Natural animal materials: stomach of calves, lambs, kids, swine, ruminants, bovine liver, pancreas.
- Micro-organisms: the most common ones are aspergillus niger, bacillus subtilis, aspergillus oryzae, candida and kluveromyces, streptomyces, saccharomyces species, bacillus cereus, mucor miehei, etc.

Products

- Rennet, a milk coagulating enzyme, is in great shortage in the world.
- Amylases are major enzymes used for starch hydrolysis and in baking and brewing industries.
- Glucose isomerase is also a major enzyme in great demand.
- Papain extracted from papaya is used as meat tenderizer. Attempts are being made to produce it by tissue culture.
- Other carbohydrate enzymes: invertase, cellulase, glucose, oxidase, lactase.
- Proteolytic enzymes: trypsin, chymotrypsin, bromelain, pepsin, ficin, cathepsin, collagenase, peptidases, elastase, chymosin, etc.
- Lipolytic enzymes: specific lipases or esterases.
- Other specific such as: catalase, pectinase, etc.

Legislation

- Federal agencies control the utilization of enzymes in foods or in materials with potential to affect human health.
- Normally natural enzymes extracted from plant or animal materials do not require toxicological studies.
- Since a large number of enzymes are products of fermentation with micro-organisms, the latter ones must be on the list of approved species.
- Consequently, it is advised to verify with Food and Drug Administration (U.S.A.) and Health and Welfare Canada to ensure acceptance.
- The production of enzymes with non recognized organisms or genetically modified ones can require toxicological studies before consideration.

Contacts

- Enzyme Bio-systems Ltd., International Plaza, Englewood Cliffs, NJ, 07632, U.S.A. (Phone: 201-894-2320).
- Enzyme Development, 2 Penn Plaza, New York, NY 21, U.S.A. (Phone: 212-736-1580).
- Novo Laboratories Inc., 33 Turner Rd., Danbury, CT, 06810, U.S.A. (Phone: 203-790-2600).

References

- Wasserman, B.P., 1984. Thermostable enzyme production, Food Technol., 38(2): 78-98.
- Pitcher, W.H., 1986. Genetic modification of enzymes used in food processing. Food Technol., 40(10): 62-69.

YEAST PRODUCTION TECHNOLOGY

Rationale

The use of yeast in food is as old as breadmaking. Yeast is almost synonymous to fermentation for the production of alcohol (winemaking, brewing, distilling) or carbon dioxide (breadmaking). Today, yeast production technology is becoming attractive for additional purposes, as a source of protein and vitamins, as contributor and enhancer of flavours, and for its functional textural properties. Since Latin American countries have abundant supplies of yeast substrates, the development of the yeast industry in those countries represents a sound potential.

Process/Technology

- Yeasts are unicellular microorganisms with great fermentative capabilities.
- They grow best on carbohydrate substrate or alcohol substrate at an optimum pH and temperature in presence of vitamins, minerals and growth hormones.
- Under anaerobic conditions they produce alcohol and CO_2 (wine, beer).
- Under aerobic conditions they thrive much more and liberat carbon dioxide and water. It is the system used in yeast production.
- Yeasts contain more than 50% protein (dry basis) and also vitamins, enzymes and amino acids.
- Only three genera of yeasts are currently used in the industry: Saccharomyces (Bakers' yeast, wine's yeasts, beer's yeasts), Candida (or Torula) which grows well on ethanol sulfite liquor, molasses, Kluyveromyces are designated to grow on lactose.
- An improved technology has been developed for producing food yeasts on a continuous high-cell density and direct-dry system.

Raw Materials

- Carbohydrate materials which are in abundant supply in Latin American countries.

- Molasses, bagasses, and other sugar refinery residues.
- Oxygenated compounds such as methanol, ethanol, simple sugars.
- Whey permeate and lactate from dairy operations.
- Sulfite liquor from papermill operations.

Products

- Active yeasts are produced for bakeries, wineries, breweries, and distilleries. They can be made available in compressed form, active dry form, and instant active dry form.
- Inactive yeasts are manufactured primarily for their food value as source of protein, vitamins, flavours, or for their functional properties as food ingredients, or as a source of enzymes.
- In addition to primary-grown yeasts, there are spent yeasts from breweries, wineries or distilleries which have good food or feed value.

Legislation

- Yeast production plants must submit to inspection and control as for any food processing plant.
- There are restrictions for human use. The U.S. Food and Drug Administration permits the usage of dried yeast from S. cerevisiae, K. fragilis and C. utilis in human food provided the folic acid content of the yeast does not exceed 0.4 mg/g.
- Clearance with the appropriate federal agencies is recommended.

Contacts

- Lallemand Inc., 1620 Prefontaine, Montreal, Que., Canada, H1W 2N8 (Phone: 514-522-2133).
- Phillips Petroleum Co., 94-H Phillips Research Center, Bartlesville, OK, 74004, U.S.A.
- Universal Foods Corporation, 433 East Michigan Sts., Milwaukee, WI, 53201, U.S.A. (Phone: 414-271-6755).

References

- Dziezak, J.D., 1987. Yeasts and yeast derivatives: Definitions, characteristics, and processing. Food Technol., 41(2): 104-121.

- Shay, L.K. and Wegner, G.H., 1985. Improved fermentation process for producing Torula yeast. Food Technol., 39(10): 61-66.

LACTOSE HYDROLYSIS TECHNOLOGY

Rationale

A new technology of immobilized lactose to produce hydrolyzed lactose has been developed in recent years. The technology is of interest for those countries where there is a high incidence of lactose intolerance or where the volume of whey available could make the process attractive.

Process/Technology

- A large proportion of the world population is lactose intolerant and thus cannot benefit from the nutritive value of milk.
- Whey is often considered a waste product resulting from cheesemaking although it contains 5% lactose, 0.8% proteins, 0.3% fat and minerals and vitamins.
- Hydrolysis of lactose into glucose and galactose eliminates intolerance and increases sweetening power.
- Hydrolysis with liquid lactase is not cost effective because the costly enzyme is lost and also because the process is slow.
- Early immobilized lactase systems which were developed were using costly support materials.
- Bone charcoal was recently found an ideal support in terms of loading capacity and low cost.

Raw Materials

- The technology applies to the treatment of milk for the removal of lactose.
- It applies also to cheese whey or to permeate after protein removal.

Products

- Reduced-lactose milk for lactose intolerant candidates.
- Reduced-lactose milk products.
- Hydrolyzed whey as a source of sweetener.
- Hydrolyzed demineralized whey as ingredient in food manufacture.

Legislation

- It is recommended to verify approbation from federal agencies before investing in the technology although no problem should be anticipated.

- The safety of lactase is associated with its source.

Contacts

- British Charcoals & Macdonalds, 21 Dellingburn St., Greenock, PA 15 4TP, Scotland.

- Agropur, 10 rue Principale, Granby, Que., Canada, J2G 7G2 (Phone: 514-375-1991).

References

- Daniels, M.J., 1985. Low-cost process for lactose hydrolysis with immobilized lactase. Food Technol., 39(10): 68-70.

- Thibault, P., 1984. Les enzymes immobilisées. Ind. Alim. et Agr., 101 (10): 885-889.

MONOSODIUM GLUTAMATE TECHNOLOGY

Rationale

There are two types of substances which are produced on a large scale to enhance the flavour of foods, the nucleotides (inosine 5'-monophosphate, guanosine 5'-monophosphate) and salts of glutamic acid. The monosodium glutamate is by far the most in demand. Since substrates (e.g. molasses, bagasse, sulfite liquor, etc.) used for its production are abundantly available in Latin American countries, it would be appropriate that the manufacturing be close to the source of raw materials.

Process/Technology

- Glutamic acid is a natural amino acid widely present in food proteins as well as in the human body.
- Except for a few allergic people, the sodium salt of glutamic acid is a safe flavour enhancer for most people.
- Although it could be extracted from natural foods, beets, corn, wheat, milk and milk products, meats, mushrooms, tomatoes and peas, it has been found easier to produce it by fermentation.
- Microbial fermentation with *Corynebacterium glutamicum* has the advantage of producing the L-form which has the flavour-enhancing properties.
- Several hundreds of thousands tons are used annually in the world in industry, institutions, restaurants and homes, and the demand is increasing.

Raw Materials

- Carbohydrate substrates such as molasses, bagasses, whey, lactose permeate, sulfite liquor, etc.
- A source of *Corynebacterium glutamicum*.

Products

- Glutamic acid.
- Monosodium glutamate
- Non sodium salts of glutamic acid such as calcium, potassium or ammonium.

Legislation

- Its added level in food is self-limiting since the peak of flavour enhancement is at 0.2-0.8%.
- U.S. Food and Drug Administration considers it as Generally Recognized as Safe (GRAS).
- In Canada, it may be used at levels consistent with Good Manufacturing Practices.
- Its presence must be disclosed on the label.

Contacts

- Ajinomoto U.S.A. Inc., 500 Frank W. Burr Blvd., Teaneck, NJ 07666, U.S.A. (Phone: 201-488-1212).

References

- IFT Expert Panel, 1987. Monosodium glutamate. Food Technol., 41(5): 143-154.

FERMENTED SOYBEAN FOODS

Rationale

In addition to the numerous food ingredients which are derived from soybeans, several oriental foods have been produced from soya by fermentation. Although these foods have been prepared in the Orient for centuries, their unique properties are becoming more and more attractive to Westerners. Consequently, the market is developing for several soya products.

Process/Technology

- Traditional fermented soya products have been a secret domestic art for several thousand years in the Far East.
- A given number of fermented soybean foods such as Shoyu, Miso, Tempeh, Natto and Sufu are now produced on a commercial scale in the Orient and also in many Western countries.
- Tofu is an exception as it is not a fermented product. However, it is the curd obtained from the coagulation of soybean protein extract. It is a popular base to prepare some fermented foods and also to be used as an ingredient in many other foods.
- These products can also be derived from vegetable materials other than soybean or in mixtures with soybeans.

Raw Materials

- Soybean or derived fractions.
- Other vegetable proteinaceous crops such as rice, wheat, peas, beans, fababean, coconut cake, etc.

Products

- Tofu
- Miso, Shoyu (sauce), Tempeh, Natto, Sufu, Tamari, Koikuchi, Meetauza, Maho.
- Ingredients in traditional products such as sausages, yoghurt, beverages, etc.

Legislation

- Safety and sanitary practices must satisfy regulatory authorities.
- Process and products should receive approval in the country of destination.

Contacts

- Miyako Oriental Foods Inc., 4287 Puente Ave., Baldwin, Park, CA, 91706, U.S.A.
- Soyfood Center, P.O. Box 234, Lafayette, CA, U.S.A.

References

- Shurtleff, W. and Aoyagi, A. 1984. The book of tofu. Vol. 1. Ten Speed Press, P.O. Box 7123, Berkeley, CA, 94707, U.S.A.
- Shurtleff, W. and Aoyagi, A. 1984. The book of tempeh. The Soyfood Center, P.O. Box 234, Lafayette, CA, U.S.A.
- Beuchat, L.R. 1984. Fermented soybean foods. Food Technol. 38(6): 64-70.
- Morales, J., Bourges, H., and Camacho, J.L. 1981. Utilization of soya protein in highly nutritious low-cost products in Mexico. J. Amer. Oil Chemists Soc., 58(3): 374-376.
- Fukushima, D. 1979. Fermented vegetable (soybean) protein and related foods of Japan and China. J. Amer. Oil Chemist Soc., 56(3): 357-362.

LACTULOSE TECHNOLOGY

Rationale

Lactulose is a sugar derived from the major milk sugar, lactose. Small amounts can be found in cow's milk and in human milk. Applications of this sugar in infant nutrition, pharmaceutical uses and selected food products should be appealing to most countries.

Although processing technologies derived from dairy products were eliminated in the development of the short list, lactulose technology was retained at the suggestion of the Canadian coordinator due to its pharmaceutical and infant nutrition applications of benefit to both domestic and export markets.

Process/Technology

- Lactulose is a di-saccharide made up of galactose and fructose.
- It is produced from lactose by isomerization of the di-saccharide galactosido-glucose.
- The conversion can be done by chemical means using calcium hydroxide or by enzymatic means using invertase.
- The enzyme can be immobilized on a support material situated in a column.

Raw Materials

- Lactose is made from skim milk or cheese whey which are relatively abundant and low cost materials. It can also be produced from skim milk powder but the economics are dependent on the international trade price.
- The production of lactulose from these raw materials contributes a considerable value-added to cheap ingedients.

Products

- The final product is usually a 65% sugar solution in water.
- Lactulose is not broken down by suitable enzymes in the small intestine and is thus not absorbed there.
- It is however used by Bifido and other acidophilus bacteria in the colon, thus creating an acid environment and preventing the proliferation of alcaline bacteria.

- Applications are in infant formula and in yoghurt to stimulate the development of Bifido bacteria.

- It is used in medicine for the treatment of chronic constipation and for the treatment of systemic encephalopathy (or brain affection).

Legislation

- Since lactulose is a normal constituent of food and even highly desirable, there are no known regulations controlling its use.

Contacts

- Technilab Inc., Montreal, Canada, H4R 1R7.

- Dr. Denis Roy, St-Hyacinthe Food Research Centre, St-Hyacinthe, 3600 Casavant Blvd., St-Hyacinthe, Quebec, Canada, J2S 8E3.

N.B.: The involvement of a pharmaceutical manufacturing company would be desirable.

References

- Thelwall, L.A.W. 1987. Derivatives of lactose and their applications in food products. Int. Dairy Congress Proceedings. The Hague NLD Dordrecht: D. Reidel Publishing Co.

- Pritzwald-Stegmann, B.F. 1986. Lactose and some of its derivatives. J. Soc. Dairy Technol. 39(3): 91-97.

- Harju, M. 1986. Lactulose as a substrate for B-galactosidases. 1. Materials and Methods. Milchwissenschaft, 41(5): 281-282.

- Valente, M. 1985. Lactulose as a substrate for B-galactosidases. 2. Results and Discussion. Ind. Alim. Agric. 102(11): 1179-1183.

APPENDIX H

ADDITIONAL TECHNOLOGIES

MEAT FERMENTATION TECHNOLOGY

Rationale

Although the application of fermentation technology in the meat industry is relatively recent, it has been extensively used in the manufacture of dairy products (cheese, yogurt, sour cream) and of plant products (bread, soy sauce, wine, beer, sauerkraut).

Meats are normally low acid products which are more conducive to food poisoning by staphylococcus organisms than dairy and plant products. In addition to other benefits, acidic fermentation does offer a means of preservation, particularly in countries where refrigeration is not universal.

Process/Technology

- Fermentation can take place in processed meats by natural aging or by controlled lactic bacteria.
- Aging refers to holding the processed product for varying periods under controlled temperature and humidity conditions. Fermentation is left to chance. Certain products such as salamis are aged without added cultures.
- For ensuring uniform quality, starter lactic culture bacterias (Latobacillus Plantarum, Pediococcus acidilactici, micrococcus aurantiacus) are added to attain a pH below 5.3.
- Temperatures used range between 21°C and 46°C depending on the rate of acid development desired.
- Fermentations can be achieved in 6-8 hours whereas traditional aging processes require 3-5 days.
- Development of undesirable microorganisms is prevented or retarded by the competition of lactic bacteria occupying the territory, by a low pH, by generating antibodies and bacteriocins.
- Low pH can also be attained by adding chemical acidulants.

Raw Materials

- Sausages, salami, hams, bacon, pepperoni, lunch meats, dry beef, etc.
- Fresh meats, poultry and seafoods for processing and preservation.

Products

- Dry and semi-dry products.
- Products with water activity in the range 0.6-0.8.
- Low nitrite bacon (50 ppm).
- Other effects of fermentation:
  - better flavour development
  - accelerated curing reactions
  - extended shelf life stability
  - controlled food pathogens
  - reduced nitrosamine, histamine, tyramine.

Legislation

- Fermentation of meats has been a commercial practice for a long time in Europe as well as in North America. Since meat processing is under rigid supervision by regulatory agencies, fermentation technology is controlled under the same regulations.

Contacts

- Canada Packers Ltd., 2211 St. Clair Ave. W., Toronto, M6N1K4 Ont., Canada (Phone: 416-761-4046).
- Schneider, J.M. Ltd., 321 Courtland Ave. E., Kitchener, Ont., Canada, N2G 3X8. (Phone: 416-231-2286).

References

- Bacus, J. 1984. Update: Meat fermentation 1984. Food Technol. 38(6): 59-63.
- Smith, J.L. and Palumbo, S.A. 1981. Use of starter cultures in meats. J. Food Protection, 46: 997-1000.

MODIFIED DAIRY INGREDIENTS

Rationale

The use of dairy ingredients in food products conveys an image of high quality as compared to imitation dairy products. Ingredients are often improved by appropriate modification to impart desired functional properties. Access to the latest technologies in this regard is enabling food manufacturers to produce superior quality products.

Process/Technology

- Dairy ingredients can be derived from milk by fractionating the major constituents of milk. This can lead to numerous ingredients.
- Superior ingredients are obtained by designing functional properties through modification.
- Modification is effected by several means: heat treatment, fermentation, chemical reactions, additives, blending, others.
- Manufacturers of dairy ingredients are usually secretive as to processes being used.
- Joint ventures or licensing are often the only expedient way to access these latest technologies.

Raw Materials

- Milk, skim milk, lactose, milk proteins, milk fat, butter, whey.
- Fresh, concentrated or powder.

Products

- Designed products with specific functional properties.
- For instance, Nollibel P25*, a powdered non-fat product, results in cost reduction, higher quality and interactions in frozen products; dairy desserts, soups, sauces, fillings, etc.
- Belcover P25*, another powdered non-fat product, improves crushing, viscosity, flavour, and reduces costs in all chocolate products.

* Sample products

- Bianbel*, a mixture of sucrose and milk constituents, is a dairy emulsifying agent to replace egg white, superior to caseinates and milk proteins for foaming, texturizing, binding, keeping quality, and reduces costs of pastry, rolls, croissants, sauces, dressings, etc.

Legislation

- A special permit may be required to import dairy ingredients.

Contacts

- Pascobel Inc., 133 Montée de Liesse, St-Laurent, Québec, Canada, H4T 1T9. (Phone: 514-738-1303)

  N.B. Pascobel is associated with the leading Bel Industries Co. and is in a situation to transfer the most advanced technologies in designed dairy ingredients.

References

- Hugunin, A.G. and Ewing, N.L. 1976. Dairy Based Ingredients for Food Products. Dairy Research Inc., 6300 North River Road, Rosemont, Illinois, 60018, U.S.A.

- Kirkpatrick, K.J. and Fenwick, R.M. 1987. Manufacture and general properties of dairy ingredients. Food Technol. 39(10): 58-65, 85.

* Sample products

MILK PROTEIN HYDROLYZATION (HYDROLYSIS)

Rationale

Milk protein hydrolyzates are known for their special nutritional, functional and physiological properties. This technology, which is still in the development stage, offers good potential as many applications of the hydrolyzates are foreseen in the food, pharmaceutical and cosmetic areas. Manufacturers already engaged in fermentation processes could advantageously consider this technology.

Process/Technology

- Protein hydrolysis can be achieved by chemical means, by bacterial cells or by enzymes.
- The enzymatic approach is preferred because the rate and degree of hydrolysis are easier to control and hydrolytic products suffer less contamination generated by side reactions and unwanted whole cells.
- The choice of the proteolytic enzyme is important. Chymotrypsin and trypsin are commonly used.
- Because of the high cost of purified enzymes, batch processes are being replaced by continuous immobilized enzyme or cell processes.
- Enzyme immobilization has made good progress. Several techniques and materials are available. Inert support can be organic or inorganic. Examples of common supports are agarose gels, dextran, cellulose, nylon, different polymers, porous glass, diatomacious earth, silica aluminate screening, stainless steel balls, sand, etc.
- Fixation techniques can be absorption, entrapment in a gel matrix, microencapsulation, covalent attachment, intermolecular crosslinking, incorporation into polymers.
- The immobilized enzyme is placed in a substrate at optimum pH (7.0 for chymotrypsin) and at optimum temperature (22°C to 37°C).
- The protein solution (2-3% in buffer) is added with agitation for batch or in continuous flow for column processes.

Raw Materials

- Casein.
- Whey protein.
- All milk proteins.

Products

- Mixture of peptides of varying molecular weight. The composition will vary with the enzyme used and the extent of hydrolysis.
- Extensive hydrolysis will lead to the formation of bitter peptides.
- Applications to improve the nutritional quality of foods, increase digestibility in dietary and infant foods, reduce allerginicity, provide soluble protein for soft drinks and juices, induce gastric secretion, control sleepiness, appetite and insulin secretion.
- Application in the composition of hypoallergenic milks.
- Used in the manufacture of cosmetic creams.
- Hydrolyzates are contributing flavouring to foods.
- Improved absorption of calcium is claimed.

Legislation

- The use of protein hydrolyzates in certain foods is regulated and must be approved by regulatory agencies. Otherwise, the breakdown of protein into peptides units is part of the digestion process and is a normal occurrence in many foods.

Contacts

- J. Amiot, Departement de sciences et technologie des aliments, Université Laval, Québec, Canada. G1K 7P4. (Phone: 417-656-7208)

References

- Vuillemard, J.C. and Amiot, J. 1985. Hydrolyse des proteines alimentaires par voie bactérienne. Microbiologie-Aliments-Nutrition. 3:333-343.
- Vuillemard, J.C., Goulet, J., Amiot, J., Vijayalakshmi, M.A., and Terré, S. 1988. Continuous production of small peptides from milk proteins by extracellular proteases of free and immobilized *Serratis marcescens* cells. Enzyme Microb. Technol., 10(1): 1-8.

MILK FAT FRACTIONATION

Rationale

Milk fat is a blend of several thousand different triglycerides with differing properties. In recent years, the industry became interested in fractionating milk fat into a few major fractions to explore new uses based on their unique properties. The historically high prices for milk fat have hindered the fractionation technology. Based on the increasing demand for fat fractions, the economics are now favourable particularly in countries having access to internationally low-priced milk.

Process/Technology

- Milk fat can be fractionated by several different processes: Supercritical CO_2 extraction, short-path distillation, and melt crystallization.
- The melt crystallization process is currently more appropriate as it has been developed for industrial applications.
- The fractionation approaches can be gradual melting and separation of liquid fractions (centrifugation or vacuum), or stepwise crystallization of the melted fat with or without solvent.
- The Tirtiaux process is based on crystallization-filtration, whereas in the Alfa-Laval process, a diluted aqueous surfactant with electrolytes is used to ease the crystal separation by centrifugation. Both processes are available at industrial scales.

Raw Materials

- Milk fat, butter or butteroil at the lowest possible price.

Products

- High melting fat fraction (m.p. about 40°C) for baking applications such as croissants and biscuits, for chocolate coatings and for ice cream and similar products and dried products.
- Intermediate melting fat fraction (m.p. 5 to 40°C) for spreadable butter and for other spread foods.

- Low melting fat fraction (m.p. -30 to 5°C) to use as table oil, cooking oil or food ingredient carrier.

Legislation

- Approval by regulatory agencies will be required for classified raw materials such as butter and oil.

Contacts

- Alfa-Laval Limited, Toronto, Ont., Canada (Phone: 416-299-6101).

References

- Fjaervoll, A. 1970. Fractionation offers new applications for milk fat. Dairy Industries, 35: 502-505.

- Arul, J., Boudreau, A., Makhlouf, I., Tardif, R. et Grenier, B. 1988. Distribution of cholesterol in milk fat fractions. J. Dairy Res., 55(3): 361-371.

- Riel, R. and Paquet, R. 1972. Procédé continu de fractionnem des graisses par fusion et filtration. Can. Inst. Food Sci. Technol. J., 5(4): 210-213.

CASEIN MANUFACTURE TECHNOLOGY

Rationale

Casein is an ingredient derived from milk. Because of its unique functional and nutritional properties, casein and caseinates are increasingly used in the manufacture of a large number of processed food products as well as feeds. Canada and the United States are importing most of their requirements because the economics do not justify casein production in North America at current milk prices. However, it could become a profitable venture in countries having access to skim milk powder at relatively low international prices.

Process/Technology

- Casein is usually produced from fresh skim milk by acid or calcium precipitation. It is appropriate where there is abundant milk production.
- For non-dairy countries, the objective could be to produce casein and caseinates using imported skim milk powder at relatively low international prices.
- The Pillet process has been shown to allow for the use of skim milk powder as starting material and to produce a high quality casein.
- In the Pillet process, the reconstituted skim milk is first coagulated with dilute acid and steam. The coagulate is separated by centrifugation and thoroughly washed in exclusive washing towers. The casein is centrifuged before drying on fluidized bed system.

Raw Materials

- The principal product for casein production is milk.
- The major raw material in non-dairy countries is skim milk powder imported at low international prices.
- Casein and caseinates can be produced first to satisfy the local requirements, for export to other LAC countries, and for exports to the huge North American market.

Products

- Pure casein and a variety of caseinates with different functional properties as food additives.

- Food applications: imitation cheese, coffee whitener, bakery products, meat products, desserts, infant foods, etc.

- Medical and pharmaceutical products: special diets, lactose intolerance, protein sensitivity, coatings and binders for pills, etc.

- Feed applications: animal feed, pet foods.

- Industrial uses: adhesives and glues, lubricants, cleaning agents, paint products, rubber products, leather products, etc.

Legislation

- Legislation is not interfering with the production of casein and caseinates. However, there is control on the use of caseinates in food products.

Contacts

- Planprocess Inc., 133 Montée de Liesse, Ville Saint-Laurent, Qué., Canada, H4T 1T9.
(Phone: 514-738-8745).
(Mr. Jean-Guy Lauzière is the most familiar with the casein file in North America.)

- Ault Foods Ltd., 490 Gordon Street, Winchester, Ont., K0C 2K0.
(Phone: 613-774-2310).

References

- Reed, P.M. 1974. Caseine and Caseinates. Encyclopedia of Food Technology, Food Series. Vol. 2. Ed. Johnson and Peterson. Westport, Connecticut. AVI.

- Muller, L.U. 1971. Manufacture and uses of casein and co-precipitate. Dairy Sci.: Abstr., 33(9): 659-674.

MICROFILTRATION TECHNOLOGY

Rationale

Membrane technology has already been described under a separate heading (see Appendix C-1). The purpose of isolating microfiltration, which has larger pores than, for instance, ultra filtration, is to emphasize the importance of selecting the appropriate system for each particular product process. In addition, so much has been publicized on ultrafiltration and reverse osmosis that the microfiltration technique is often being wrongly disregarded for many applications.

Process/Technology

- Microfiltration membranes have larger pores than ultra-filtration and reverse osmosis membranes.
- They separate in the range of 0.02 to 2.0 microns as compared to ultrafiltration (o.002 to 0.2 microns).
- In practical terms, microfiltration will retain suspended solid particles and will permeate dissolved materials.
- Bacteria and yeast cells, for instance, will be retained whereas viruses will permeate through the membrane.
- Most membranes today are made of polymers. There are many types and the polysulfone one is probably the most widely used, supplanting the older generation of cellulose acetate polymers. In searching for environment-friendly membranes (pH, pressure, temperature, sterilizing chemicals, etc.), ceramic membranes have been introduced.
- As for other membrane filtration, microfiltration separation is performed in the cold, thus saving energy and heat damage to the product being processed.

Raw Materials

- Microfiltration technology applies to all fluid materials in the food processing industry.
- It will permit the clarification of beverages by removal of suspended particles.
- It is a preferred method to harvest yeast cells.
- It also has wide applications in food waste recovery systems.

Products

- Clarified beverages (wine, beer, juices, etc.).
- Harvested solid materials such as precipitated proteins, yeast cells, fat globules, etc.
- Starch particles, soya isolates, etc.
- Many others.

Legislation

- Membrane processing is an accepted technology in the food industry for which no particular regulation exists.

Contacts

- Osmonics Inc., 5951 Clearwater Drive, Minnetonka, MN, 55343, U.S.A.
- Zenon Corp., Mississauga, Ont., Canada. (Phone: 416-825-1492).

References

- Ballew, H.W. 1969. Basics to Filtration and Separation. Nucleopore Corp., Pleasanton, CA.

LECITHIN FROM OILSEEDS

Rationale

The world market for lecithin exceeds 100,000 tonnes per year. Although egg yolk is a rich source of lecithin, large quantities are obtained from oilseed crops. Oilseed-producing countries may want to salvage this constituent which is showing up as a by-product from oilseed processing.

Process/Technology

- Lecithins are compounds having double affinity for water and for fat. For that reason, they are sought for their emulsifying properties.
- During oil processing, most of the lecithin is removed with the soapstock.
- The gums separated from the centrifugation of crude oil are dried in a thin film type evaporator to a level below 1% moisture.
- The lecithin is cooled in a scraped wall heat exchanger to a temperature below 40°C.
- Ingredients are added to meet grade specifications.
- Bleaching is achieved with hydrogen peroxide.
- Fractionation and modification can be performed to produce specific lecithin types.

Raw Materials

- Soybeans are the most common source.
- Rapeseed, sunflower seed, cottonseed, flax and corn germ can also be used.
- Egg yolk.

Products

- Crude soybean lecithin (or other oilseeds) containing 40% phosphatides.
- Acetone fractionated in powder or granular form having neutral taste.
- Alcohol fractionated for a richer choline lecithin fraction with greater emulsifying properties.

- Hydroxylated lecithin to improve solubility in cold water and emulsifying properties.

- Hydrolyzed lecithin (enzymatic, acid or alkali) to improve emulsifying properties.

- Acetylated lecithin with improved emulsifying properties.

- Lecithin is widely used in prepared foods (baking, ice cream, margarine, instant foods, candy, gum, shortening, etc.

- It has numerous industrial uses (paints, inks, dyes, insecticides, plastics, rubber, textiles, etc.

- It is also used in cosmetics, drugs, animal feeds.

- It is a medical detergent for cholesterol deposits and gallstones. It is claimed to lower blood cholesterol and triglycerides in blood serum and to alleviate memory loss and mental flow problems

Legislation

- Lecithin is a natural constituent of foods. However, nutritional and medical claims must be authorized by regulatory authorities.

Contacts

- American Lecithin Co., Atlanta, Georgia, U.S.A.

- General Mills Co., Minneapolis, Minn., U.S.A.

References

- Van Nieuwenhuyzen, W. 1976. Lecithin production and properties. J. Oil Chemists' Soc., 53(6): 425-427.

- Scocca, P.M. 1976. Utilization of lecithin. J. Oil Chemists' Soc., 53(6): 428-429.

EDIBLE FILMS AND COATINGS TECHNOLOGY

Rationale

Food coating with wax has been used in the past to retard dehydration of fresh fruits. This was inappropriate as wax was inhibiting respiratory functions and leading to anaerobic fermentation. New developments in edible coating materials are now allowing the extension of storage life of foods and the improvement of the efficiency of secondary packaging. This technology is important for countries involved in exporting specific fresh and processed foods to sustain product freshness and microbial stability.

Process/Technology

- Edible films are usually polymers of polysaccharides such as starch, pectin, alginate, carrageenan, cellulose derivatives, dextrins. They are not impervious to moisture unless used in the gelatinous form.
- Protein films such as collagen, gelatin, casein, albumin, gluten, zein and others are used as meat casing, meat coating to provide water and oxygen barriers.
- Lipid films include waxes, surfactants and monoglycerides. Their main function is to prevent moisture movement and to protect the food surface.
- Blended films are developed to provide resistance to moisture, gases or solutes.
- The method of application makes use of the evaporative property of the solvent, called coarcervation. Thermal gelation in which protein is coagulated by heat or sol-gel transformation by cooling are also used.

Raw Materials

- Edible films and coatings technology applies to solid foods such as fruits, vegetables, processed meat, poultry and fish products, bakery products, confectionaries, ingredients, etc.
- Pharmaceutical and non food products.

Products

- The original and most current aim is to control moisture movement, absorption or loss of water, so that crispy and dry foods remain so.

- Other functions of the technology are:

  - Prevention of oxidation of fats, vitamins, flavours and colours.

  - Suppression of aerobic respiration in fresh fruits and vegetables similar to controlled atmosphere.

  - Reduction of cost of secondary packaging.

  - Inhibition of bacterial, yeast and mold growth.

  - Prevention of chemical and enzymatic reactions.

  - Reduction of weight loss.

  - Creation of impermeability to fats and oils.

  - Retardation of solute diffusion from surface to interior such as salt, antioxidant.

  - Incorporation of additives.

  - Reinforcement of the structure of a food item.

  - Higher quality food products.

Legislation

- Approval of coating materials by regulatory agencies must be ensured.

Contacts

- Coating Place Inc., Box 248, Verona, WI, 53593, U.S.A. (Phone: 608-845-9521).

References

- Kester, J.J. and Fennema, O.R. 1986. Edible films and coatings: A review. Food Technol., 40(12): 47-59.

- Gilbert, S. 1986. Technology and application of edible protective films. In "Food Packaging and Preservation. Theory and Practice", ed. M. Mathlouthi, p. 371. Elsevier Applied Science Publishing.

SKIN PACKAGING TECHNOLOGY

Rationale

Skin packaging is a growing technology which is widely used to package food and non food items, small or large, particularly those which are irregular in shape and difficult to package. It is a way to protect products from damage during handling, storage or transportation as well as offering a protection against biological deterioration.

Process/Technology

- Skin packaging consists in placing the product on a rigid base or substrate, and draping it over with a preheated transparent film.
- The film is tightly drawn over the product with the aid of vacuum, and sealed to the substrate base (carton board or foam board).
- Virtually no air space is left between the product and the film, and the product is also protected against damage through movement or vibration.

Raw Materials

Any kind of solid or processed food.

- Any primary-packaged fluid food products.
- Applications to fruits, vegetables, meats, fish, confectionary and bakery products, etc.
- Retort pouches or other fragile packaged foods.

Products

- Individual food portions.
- Large institutional food presentation.
- Primary or secondary packaged food items.
- Bulk-packaged foods.

Legislation

- Films coming in contact with the food must have the approval of regulatory authorities. The current films made of ethylene vinyl acetate or of surlyn are U.S. FDA-approved. In Canada, various films have been preapproved but the supplier/user has to obtain a Letter of Confirmation from the Toxicology Division of Health and Welfare Canada for each of the films to be used.

Contact

- Stone Container Corp., 2021 Swift Dr., Oak Brook, IL, 60521, U.S.A.

Reference

- Friedman, D. 1985. Skin Packaging Retort Pouches. Food Technol., 39(5): 105-108.

ULTRA HIGH TEMPERATURE PROCESSING (UHT)

Rationale

Microorganisms in a product are more affected by the exposure to actual temperatures than by the duration of exposure, whereas the reverse holds true for chemical constituents. That is why the demand for higher quality products has led to heat treatment systems using higher temperatures and shorter exposure times. UHT will produce more sterile products with a minimum of damage to flavour, colour and nutritional quality.

Process/Technology

- Ultra high temperature (UHT) processing with temperatures ranging from 85-125°C refers to heat treatments aimed at producing aseptic products. Temperatures are sensibly superior to the so-called high temperature short time (HTST) process (71.7°C/15 sec).

- UHT applies to the treatment of the product before packaging. This assumes that the product will be aseptically packaged.

- The purpose is to protect the quality of the product better than by conventional retort sterilization processes.

- For solid or semi-solid products, scraped surface heat exchangers are most often used.

- For liquid products, plate or tubular heat exchangers are the most popular.

- To avoid damaging the product, rapid heating and cooling are important. Steam injection heating followed by vacuum cooling are recommended for labile products.

- There exists a process (Daisy) in which the product is sprayed into a chamber of steam and then drawn to a vacuum chamber for sudden cooling.

- For particulate foods, superheated steam (150 °C) is being used to effect sterilization of the product.

- Many other methods have been devised to quickly heat a product. The treatment will vary with the product to be treated: 85°C to 110°C/15 sec would be sufficient for juices whereas other products may require 125°C for a few seconds to one minute.

Raw Materials

- Most processed products intended for long preservation.
- Juices, milk, processed fruits, processed vegetables, processed meats, soups, sauces.

Products

- Aseptically packaged foods for mid or long preservation.
- Liquid, solid or semi-solid foods.
- Packaged in pouches, trays, comiblocks, tetrapak, etc.

Legislation

- When using steam injection, regulatory authorities must approve the process. The United States have been reluctant to the use of direct steam.

Contacts

- Nelson's Dairy Limited, 180 Ormont Avenue, Weston, Ont., Canada, M9L 1N7. (Phone: 416-742-6811).
- Agrinove, 180 boul. Bégin, Ste-Claire, Québec, Canada, G0R 2V0. (Phone: 418-883-3301).
- Ault Foods Ltd., 490 Gordon Street, Winchester, Ont., Canada, K0C 2K0. (Phone: 613-774-2310)
- Alfa-Laval Ltd., Toronto, Ontario, Canada. (Phone: 416-865-9480)

References

- Teixeira, A.A. and Shoemaker, C.F. 1983. Computerized Food Processing Operations. pp. 111-117. AVI Book by Van Nostrand Reinhold, New York.
- von Bockelmann, B.A.H. and von Bockelmann, I.L.I. 1986. Aseptic packaging of liquid food products: A literature review. J. Agric. Food Chem. 34:384-392.

TISSUE CULTURE TECHNOLOGY

Rationale

Tissue culture techniques to grow plant cells have been successfully developed for over two decades. The objectives can either be agronomic (improvement and production of plants) or food-oriented (production of selective constituents such as enzymes, flavourings, colourings, etc.). The food-oriented technologies may provide future opportunities for application by selected LAC food processors. There exist, however, current difficulties to achieve industrial scale capacities; the problems are expected to be satisfactorily resolved in the near future.

Process/Technology

- Tissue culture is essentially the culturing of isolated shoot buds in a nutrient milieu. Callus tissue is obtained on nutrient agar, and cell suspension cultures on agitated liquid media.
- The basic media usually consist of inorganic salts, vitamins, sucrose and growth regulators (cytokinins).
- Undifferentiated callus cultures may require transfer at 4 to 6 weeks, whereas cell suspension needs transfer at 10 to 28 days.
- The current mode of production is batch. The batch capacity can vary from one litre to 200 litres. The production may be increased by feeding the batch with media components.
- A continuous operation can be created by circulating the medium to and from the bioreactor vessel and allowing the produced cells to settle out of the medium.
- Improvements involving immobilized cells and metabolite release are in the development stage.
- The final step is to extract the desired food constituent from the separated cell biomass by an appropriate method (solvent, distillation, supercritical separation, etc.).

Raw Materials

- Cells from plants carrying desirable characteristics of interest to the food industry such as papaya for papain, grape vine for colouring, etc.
- Samples of live plant materials of agronomic or food interest.

Products

- Tissue extracts or cell biomass extracts are rich in selected food constituents. These can be primary products such as enzymes, carbohydrates (potent sweeteners), lipids, amino acids, vitamins, or secondary products such as flavourings, colourings, pharmaceuticals, antibiotics, etc.
- Examples of successful productions are: papain as a meat tenderizer, amylase used in baking, saccharids as food additives, jojoba oil as pharmaceutical aid. Other products include dyes, pharmaceutical shikonin, mint flavouring, insecticides, pesticides, etc.

Legislation

- Tissue culture is an accepted process which does not contravene food regulations.

Contacts

- Plant Biotechnology Institute, National Research Council, Saskatoon, Sask., Canada, S9N 0W0.
- Food Research and Development Centre, 3600 boul. Casavant ouest, St-Hyacinthe, Québec, Canada (Phone: 514-773-1105) J2S 8E3. Attn.: Dr. François Cormier.
- Biotechnology Research Institute, 6100 Royalmount Ave., MOntreal, Quebec, Canada, H4P 2R2. (Phone: 514-283-8279)

References

- Tomes, D.W. and Kasha, K.J. 1981. Tissue Culture. Agrologist 10(3): 17-18.
- Levin, R., Gaba, V., Tal, B., Hirsch, S., and DeNola,D. 1988. Automated plant tissue culture for mass propagation. Biotechnology 6(9): 1035-1040.

. Morrison, R.A. and Evans, D.A. 1988. Haploid plants from tissue culture: new plant varieties in a shortened time frame. Biotechnology, 6(6): 685-689.

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FECHA DE DEVOLUCION

2[illegible]	1993		
[illegible]	[illegible]		

IICA
PM-A1/SC no.90-05

Autor North American food processing technologies

Título

Fecha Devolución	Nombre del solicitante
28 MAY 1993	Luis Lizán[illegible]
[illegible]	[illegible]

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