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R E P O R T

AN ASSESSMENT OF

MICROBIOLOGICAL RESEARCH TO REDUCE FOOD LOSSES BY PROCESSING

February 16 - April 7, 1990

Consultant Report by

Don F. Splittstoesser, Ph.D.

Postharvest Technology of
Fruits and Vegetables Subproject

Agricultural Research Project (386-0470)

Implementation Order No. 47

Contract No. 386-00000-C-00-5039-00

WINROCK INTERNATIONAL
1611 North Kent St.
Arlington, VA 22209

AN ASSESSMENT OF

MICROBIOLOGICAL RESEARCH TO REDUCE FOOD LOSSES BY PROCESSING

Consultancy Report

To

Winrock International

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Professor of Microbiology
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Geneva, NY 14456

FEBRUARY 16, 1990 - APRIL 7, 1990

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* to follow

I. SUMMARY AND RECOMMENDATIONS

The principal charge to the consultant was to review microbiology research as it pertained to post harvest food losses and to make recommendations for strengthening the program (see Appendix A).

To accomplish this, we attended the post harvest technology workshop at Hyderabad, met with the administrators and researchers at the four centers, and visited the managers and technical staff of eight food processing companies (Appendix B-D).

It is our conclusion that the microbiological research at the three centers (IARI, IIHR, CIHNP), is germane to the problem of post harvest food losses and that the scientists have the training and knowledge needed to carry out the work.

All of the laborateries were handicapped to some extent by a lack of basic equipment, some of which is not especially costly.

A. Recommendations

1. Contacts with the fruit and vegetable processing industry should be strengthened.

   The technical staff of food companies should be made more aware of the research and competency of staff at the different centers.

   Trust should be established so that food company personnel would feel free to come to the centers with their problems.

   Center microbiologists should become completely familiar with commercial processing practices and should know their effect on the microflora of the different foods.

2. More should be learned about the horticultural products for export or that have the potential for export. For example: the microflora of mango leather, the Howard

Mold Count of different fruit purees, the incidence of fecal indicator micro-organisms, especially Escherichia coli.

3. NRCC should have a microbiologist on its scientific staff.

   There are numerous microbiological problems associated with the processing of citrus and, therefore, most citrus laboratories in the U.S. (companies, universities, government) have microbiology programs.

   The research at NRCC on processing should be in collaboration with a microbiologist.

4. Cooperation of the microbiologists with the processing scientists as well as those studying new or novel harvesting, transporting and marketing procedures should be continued.

5. Orchards and vineyards in the regions of the four centers should be surveyed for the incidence of heat - resistant mold spores. This recommendation is made because the thermal process given to most fruit products is not adequate to destroy these micro-organisms. It is likely, therefore, that spoilage problems are currently being overlooked.

6. Studies on the fermentation of horticultural processing wastes to convert them to value-added products should be continued. The researchers should keep in mind that there are economic restraints and thus the goal should be to develop processes that are technologically simple and that incur minimal costs for capital equipment and operation.

   After yield data and fermentation parameters have been defined, collaboration with engineers and economists will be necessary to determine feasibility and scale-up requirements.

II. 8th Workshop - All India Coordinated Project on Post Harvest Technology of Horticultural Crops

and

4th Workshop - Indo USAID Project on Post Harvest Technology of Fruits and Vegetables

Hyderabad FEBRUARY 20-22, 1990

The conference included scientists from the four centers (IARI, IIHR, CIHNP, NRCC), numerous agricultural universities, other government agencies, and members of the food industry. It provided this consultant a means to become familiar with the different research programs and to become acquainted with the leading scientists who work in post harvest technology

Technical Sessions IV (processing of fruits amd vegetables) and V (utilization of processing wastes) were of greatest interest because many of the reports dealt with microbiological problems.

In general the processing studies reported on fermentations (alcohol and vinegar) and the use of combinations of preservatives for extending the shelf life of mangoes, tomato, citrus fruits, onions and other commodities.

Some of the studies such as the lactic acid fermentation of the mango were assigned as cooperative projects to be carried out by each of the four centers. It is my opinion that the research might be more productive if the assignments were less specific. Thus rather than restricting the research to a lactic acid fermentation, the investigators might be encouraged to study alternative methods of preservation.

The report on the OSMO-canning of apple rings was of interest. We recommend that the investigators collaborate with a microbiologist in this research. We have encountered species of Eurotium that grows well in 70% sugar and will survive a 50 C process.

The processing waste studies that involved microbiology included biogas production and the generation of ethanol from different fruit wastes.

III. PROGRAMS AT THE CENTERS

A. National Research Center for Citrus - NAGPUR

Much of the research at this institution is concerned with the production and protection of citrus, especially mandarin and lime. However, there is a laboratory which contains processing equipment and Dr. M.S. Ladaniya, a plant physiologist, has been involved in processing studies such as the preparation of purees and the cooling of fruit.

Although the center does not have a microbiologist, the laboratory of Dr. S.A.M.H. Naqvi, plant pathologist, houses much of the basic equipment needed by a food microbiologist. Thus available is a compound microscope, an oven for the sterlization of glassware, a laminar flow hood, etc.

Recommendation :

NRCC should have a microbiologist as a member of its scientific staff. This microbiologist should 1) provide support to the citrus processing industry,
2) Collaborate with other staff in studies on processing, 3) conduct research on the micro-organisms that may spoil or affect quality of citrus products.

There are numerous micro-organisms that can present problems to the citrus processor: Yeasts may cause undesirable fermentations, lactic acid bacteria can produce diacetyl and other compounds responsible for off-flavors, heat-resistant molds hydrolyze pectins and generate toxic substances. Most of the citrus laboratories in the U.S.A. have microbiological research and quality control programs.

Equipment Needed:

- Bunsen Burners with bottled gas.
- Blender (waring or comparable) with heat-sterlizable jars.
- Quebec colony counter
- Waterbath - for tempering agar.
- Centrifuge bench-top
- Incubator, BOD

Equipment Desirable

- Microscope with photographic accessories
- Microwave oven - for melting agar media
- Spectrophotometer which includes UV
- HPLC for fermentation studies
- Micropipetter with disposable tips.

B. Central Institute of Horticulture for Northern Plains Lucknow.

This institution strives to be a center of excellence for the production, protection and processing of the mango, although research is also conducted on other fruits and vegetables.

The Post Harvest Technology program is headed by Dr. S.K. Kalra, Food Technologist/Chemist. Others involved in PHT are M.D. Singh, Engineer; Drs. B.P. Singh and S.A. Khader, Plant Physiologists; Dr. A. Verma, Economist; Dr. D.K. Tandon. Food Technologist/ Chemist; Dr N. Garg, Microbiologist.

A review of the different PHT programs revealed numerous opportunities for collaborative research. For example, the microflora of the hand harvested mango should be compared with that harvested by the picking devices being designed by M.D. Singh. The fate of micro-organisms exposed to the solar drying treatment is another area that should be investigated. B.P. Singh has observed that an exudate is produced when the

stalk of the mango is removed. The exudate discolors the skin of the mango, a problem that may be of microbial origin.

Earlier research on mango wine by Dr. Onkarayya indicated that certain mango cultivars had the potential for the production of a successful value-added product. Certain problems, however, such as excessive oxidation (browning) needed a solution.

Closely related to wine research is the production of vinegar. It is possible that some mango vinegars might have unique and desirable flavors that would make them a product for the export market.

Cooperative research between Dr. Garg and Dr. Tandon has been concerned with the conversion of horticultural processing wastes to products of greater value. Studies have been conducted on the ethanol fermentation of the "molasses" generated when pectin is extracted from mango peel. Research that is contemplated is to use processing wastes for the production of single all protein which might then enhance the nutritive value of the waste as an animal feed.

Recommendations

1. Mango Wine

   a) Mango Wine research should be reactivated. Major emphasis should be given to the cultivars found by Dr. Onkarayya to be most suitable.

   b) The effect of reducing the pH of the mango must to about 3.3 should be investigated. This would permit a reduction in the initial amount of sulfur dioxide that would be required.

   c) The initial Brix should be adjusted to 21-22

   d) Various strains of *Saccharomyces cerevisiae* should be investigated for their suitability in carrying out the mango fermentation.

e) The use of various fining treatments to reduce browning should be studied. The fining agents might include casein, egg white, bentonite and PVPP.

f) Taste tests should be conducted on the finished mango wines. It should be determined whether a certain level of sugar is needed.

g) If a sweetened mango wine is preferred, studies must determine the best methods for preventing refermentation and spoilage. Options that could be investiagted include pasteurization and the use of chemicals to inhibit the growth of yeast and lactic acid bacteria.

2. Fruit Vinegar

It is recommended that the Orleans process be used to generate vinegar from mango and other fruit wines.

After an initial screening by laboratory personnel, samples of desirable vinegars should be made available to the exporters of Indian fruit products.

3. The microbiologist should continue to collaborate with engineers and post-harvest physiologists so that new harvesting and processing methods can be evaluated with respect to their effect on the microflora.

4. The microbiology of various commercial fruit products should be studied, especially those destined for export to other countries. What types of viable micro-organisms are present in products such as mango leather and raw mango powder? Does the microflora differ significantly depending upon the processor? What are the Howard Mold Counts figures in different canned mango purees? Would the purees meet the Defect Action levels prescribed by the U.S. Food and Drug administration?

5. Because commercial thermal processes for fruit products will not destroy the spores of heat resistant molds, their incidence on fruit and in orchards in the Lucknow area should be determined.

6. The fermentation studies on processing wastes conducted by Doctors Garg and Tandon should be continued. In addition to ethanol and citric acid fermentations, substrates such as mango peel should be studied as a medium for the production of enzymes of economic importance.

   Another research area that might be fruitful is to use nitrogen-fortified wastes as a substrate for the production of single cell protein and thus enhance the nutritive value of wastes as an animal feed.

Equipment Needed :

- pH meter.
- BOD incubator.
- Ebulliometer - (measures ethanol).
- Blender (waring-type) with autoclavable jars.
- Digital reading balance 0.001 - 100 kg.
- Digital reading balance to 3 kg.
- Membrance fitter assemblies with filters.
- Hand refractometer.

Equipment Desired:

- Phase contrast microsope with camera.
- Centrifuge, Hi-Speed, refrigerated.
- Laboratory Fermentor with pH control.
- Auto-pipettors.
- Spectrophotometer with range into UV.
- Sugar analyzer - YSI Model 27.

C. Indian Institute of Horticulture Research Bangalore

Scientists involved in the Post Harvest Technology program include S. Ethiraj and E.R. Suresh, Microbiologists, B.A. Ullasa, Plant pathologist, S.C. Mandhar, Agric. Engineer, G.K. Rao and Shantha Krishnamurthy, Plant Physiologists, K.H. Ramanjaneya, processing specialist, M.S. Madan, Agricultural economist

IIHR probably has the strongest food microbiology program of the four centers due to the fact that it has two microbiologists on its staff.

Research on grape wines has been a major activity for a number of years. Much of the work has been incooperation with the Viticulturists. Thus new grape cultivars as well as vicultural practices have been evaluated as to their effects in wine quality. Various enological practices such as the influence of different yeasts on wine quality have also been studied. The work has been handicapped by a lack of temperature controlled rooms for the fermentation and also storage of wines. This will not be a problem in the future with the installation of the new temperature controlled room facility.

The wine research program has received some criticism due to the fact that India's Wine industry is very small.

Other research has involved the production of vinegar and improved methods for the preservation of mango slices and other fruit products.

The microbiologists have worked closely with the food processing group. This is fortunate since new or modified processes must be microbiologically sound.

Recommendations:

1. The wine research should be continued. IIHR appears to be the only center that is studying grape wines and this research is needed to complement the viticulture programs.

   As tourism and business travel in India increase, we expect that the demand for Indian table wines will also increase.

   The types of wine that will be most attractive to westerners will be red and white table wines made from vinfera grapes. It is recommended, therefore, that research on labruscana - like grapes such as Bangalore Blue be dropped. Studies on promising new crosses such as Arkashyam and Arkakanchan should receive priority.

   The researchers should become familiar with the wines of other countries. Standard table wines from Australia, Europe, the U.S. and elsewhere should be tasted in order to establish the wine styles that should be the Indian goals.

   In the past, oxidation of wines has been a major problem. The use of better temperature control during fermentation and storage may eliminate the difficulty. Other possible solutions are the fermentation of larger volumes (minimum 4 gallons) and the use of better closures after bottling.

2. The research on new or improved methods for preserving mango slices and other fruit products shows promise. The goal should be the development of simple and economical procedures. The research on the synergistic effect of multiple inhibitors, coupled with pH adjustment and mild heat may prove fruitful.

   Another approach might be to use reduced water activity as a preservation method. The addition of sugar, for example, might have application for mango pulp that will later be reprocessed as a juice beverage ingredient.

Reducing pH often enhances the activity of different preservatives. The use of food grade mineral acids should be investigated since they may import less of a sour taste at a given pH.

3. The incidence of heat resistant mold spores in Bangalore orchards should be determined.

Equipment Needed

- BOD incubators (2)
- Blendor (waring type) with heat sterlizable jars (12)
- Eboulliometer - for measuring ethanol
- Bench top centrifuge
- HPLC - for measuring fermentation products.
- Membrane filter assemblies

Equipment Desired

- Grape Stemmer-Crusher - to better simulate commercial conditions
- Hygrometer - to measure the water activity of juice concentrates and other foods.
- Incubator-shaker - for the propagation of aerobic organisms.

D. **Indian Agricultural Research Institute New Delhi.**

The Post Harvest Technology program is under the leadership of Dr. S.K. Roy. The research team includes Dr. S.B. Maini, Biochemist; Dr. Vijay Sethi, Microbiologist; Dr. R.K. Pal, Post Harvest Physiologist; V. Ram and Dr. D.S. Khurdiya, Processing Specialists.

Much of Dr. Sethi's work has been concerned with the preservation of mango, citrus, tomato and other products using various combinations of preservatives. She also has been investigating the use of the lactic acid fermentation to preserve combinations of vegetables such as tomato mixed with shredded cabbage. In addition to determining the efficacy of different preservation treatments, she has also measured their effect on the quality of the fruit or vegetable.

Dr. Sethi has found that certain traditional Indian spices, such as mustard, inhibit the growth of spoilage micro-organisms. This is exciting since it suggests that certain formulated foods may be preserved by using a combination of spices along with other permitted preservatives.

Recommendations

1. The research on the interaction of spices coupled with other preservatives should be expanded to include studies on their effect on heat resistance of spoilage organisms.

2. We recommended that the stirred 3-neck flask procedure be used for measuring the heat resistance of pure cultures in the different preservatitve solutions.

3. We suggest that before extensive research is conducted on the parabens, preliminary studies should determine whether they, in fact, are more effective than benzoic acid.

4. The zero-energy storage facility developed by Dr. Roy should be used for conducting lactic acid fermentations during the hot summer months. In this way the suitability of the chamber for fermented vegetables can be evaluated.

5. The microbiologist should give support to the processing and product development projects. For example: what is the microbiology of dried onion and potato powder? What is the effect of carbonation on the growth of potential spoilage micro-organisms.

6. The incidence of heat-resistant molds in the orchards and vineyards of IARI should be determined.

Equipment Needed

- Blender (waring type) with jars (12) that can be autocloved
- Anaerobic jars (4) with packets for removing oxygen
- Stirrer, electric
- Water bath, for tempering agar
- Centrifuge, bench top, micro
- Balance, digital, 1-1000g
- Membrane fitters with autoclavable holders
- Slide, Howard Mold Count
- Hot plate with magnetic stirrer

Equipment Desired

- pH meter
- Stereoscopic microscope

IV. APPENDICES

A. Charge to Consultant

1. Evaluate ongoing microbiology research programmes & suggest modifications to fill up the gaps keeping in view the future thrusts.

2. To guide in adopting the latest techniques used for the identification of spoilage organisms associated with processed fruit & veg. products and in conducting studies on preservation & heat resistance of spoilage micro organisms.

3. Assess microbial problems of fruit and vegetable processing industry using mango, banana, citrus, guava, tomato, potato and onion as raw material.

4. Identify essential equipment if any required for upgrading research work in this area.

5. Arrange to supply bibliography on spoilage in processed fruits & vegetable products with special reference to tropical and subtropical crops listed above.

6. Deliver lecture on recent advances in identification methodology & control measures for spoilage organisms in processed fruit & vegetable products.

7. Participate in group-meeting/seminar to be organised for the subproject workers.

8. Prepare the consultancy report and submit it at the end of visit for follow up action.

B. ITINERARY FOR DR D.F. SPLITTSTOESSER
Short-term Consultant on 'Microbiology' for PHTFV Sub-Project FEBRUARY 16 - APRIL 7, 1990

FEBRUARY 16 (FRI)	Arrive DELHI 01:20 Hrs LH 760 (Stay: Hyatt Regency Hotel)
11 AM:	Winrock - Delhi office
12 Noon:	USAID (to be confirmed)
5 PM:	ICAR (Dr. G.L. Chadha, Dr. G.L. Kaul, Dr. Amba Dan)
17 (SAT):	Visit to IARI (Microbiology Research on PHT-FV)
19 (MON) AM:	IARI.
" "	Delhi/Hyderbad 16:50/18:50 IC 568.
20-22	Attended PHT-FV Workshop at Hyderabad.
23 (FRI)	Hyderabad/Nagpur 15:40/16:40 IC 270.
23-28	Visit : NRCC, Nagpur.
28 (WED)	Nagpur/Delhi 07:25/08:50 IC 470
" "	Delhi/Lucknow 10:40/11:30 IC 809
FEB 28 to MARCH 12	Visit: CIHNP - Lucknow
MAR 12 (MON)	Lucknow/Delhi 17:10/18:00 IC 836
13 (TUE)	Delhi/Bangalore 09:00/11:30 IC 403
13-24	Visit: IIHR-Bangalore
25 (SUN)	Bangalore/Delhi 19:00/21:30 IC 804
MARCH 26 - APRIL 4	Visit: IARI - PHT-FV (Microbiology)
APRIL 5 & 6	Delhi - Debriefing at ICAR/USAID/ WINROCK and Report finalization.
APRIL 7 (SAT)	Departure from Delhi.

C. Post Harvest Technology Workshop - Hyderabad

Contents

1. Workshop programme.

2. Action taken on 7th workshop's recommendations.

3. Technical reports

(i) Chapter I : (Technical Session I) Preharvest ..... vegetables

(ii) Chapter II : (Technical Session II) Handling ..... vegetables

(iii) Chapter III: (Technical Session III) Storage of fresh fruits and vegetables.

(iv) Chapter IV : (Technical Session IV) Processing of fruits and vegetables.

(v) Chapter V : (Technical Session V) Utilization ..... wastes

EIGHTH WORKSHOP OF AICRP ON POST HARVEST TECHNOLOGY OF HORTICULTURAL CROPS AND FOURTH WORKSHOP OF INDO-USAID SUB-PROJECT ON PHT OF FRUITS AND VEGETABLES.

VENUE: ANDHRA PRADESH AGRICULTURAL UNIVERSITY, HYDERBAD
(Auditorium: Directorate of Rice Research)

Dates: FEBRUARY 20 TO 22, 1990

AGENDA
FEBRUARY, 20, 1990

09.00 hrs INAUGURAL SESSION-Details to be finalised

10.00 hrs Tea

11.00 hrs Session on action taken on 7th Workshop's recommendations and constraints.

Chairman Dr. D.L. Kaul

Rapporteuer Dr. Susanta K. Roy

Speakers All Centres

12.00 hrs TECHNICAL SESSION - I

Preharvest factors and harvesting techniques of fruits and vegetables.

Chairman Dr. S.N. Rao

Rapporteurs i) Dr. A.K. Chakrabarti, IARI
ii) Dr. O.P. Pandey, CIHNP
iii) Dr. N. Govind Rao, APAU

13.00 hrs LUNCH

14.00 hrs TECHNICAL SESSION-I..CONTINUED

Review by the Project Coordinator. Discussions and finalization of the technical programme of the session.

15.00 hrs TEA

15.45 hrs TECHNICAL SESSION - II

Handling, marketing, packaging and transportation of fruits and vegetables.

Chairman Dr. V.H. Potty

Rapporteurs i) Dr. G.D. Joshi, KKV
ii) Dr. B.B. Lal, YSPUHF
iii) Dr. Shiva Raj. APAU

FEBRUARY 21, 1990

09.00 hrs TECHINCAL SESSION-III

Storage of fresh fruits and vegetables.

Chairman Dr. Paul Thomas

Rapporteurs i) Dr. Trilochan Singh, BAC
ii) Dr.(Mrs.) S.Krishnamurthy, IIHR
iii) Dr. Y.N. Reddy, APAU

10.30 hrs TEA

10.45 hrs TECHNICAL SESSION-III CONTD.

Review by the Project Coordinator. Discussion and finalisation of the Technical Programme.

10.45 hrs TECHNICAL SESSION - IV

Processing of fruits and vegetables.

Chairman Dr. Surya Prakash Rao/
Dr. Nanjundu Swamy

Rapporteurs i) Dr. D.S. Khurdiya, IARI
ii) Dr. S.K. Kalra, CIHNP
iii) Dr. A. Rameswar, APAU

13.00 hrs LUNCH BREAK

14.00 hrs TECHNICAL SESSION- IV. CONTD.

Review by the Project Coordinator. Discussion and finalization of technical programme of the session.

15.45 hrs TEA

16.00 hrs TECHNICAL SESSION - V

Utilization of the commercially unacceptable fruits, vegetables, and processing wastes.

Chairman Dr. J.C. Anand

Rapporteurs i) Dr. D.K. Tandon, CIHNP
ii) Dr. G.H. Shah, JKHPMC
iii) Dr. Mohan Kumar, APAU

Review by the Project Coordinator. Discussion and finalization of Technical programme of the session.

FEBRUARY 22ND, 1990

09.00 hrs Review and finalization of INDO-USAID Sub-Project on PHT of fruits and vegetables.

Participating centres

IARI (New Delhi)
IIHR (Bangalore)
CIHNP (Lucknow)
NRCC (Nagpur)

(Participants from AICRP-Centres will visit the processing factories.)

13.00 LUNCH

14.00 PLENARY SESSION

Chairman Dr. K.L. Chadha

Co-Chairman Dr. G.L. Kaul

Rapporteur Dr. Susanta K. Roy

CHAPTER - IV

PROCESSING OF FRUITS AND VEGETABLES.

Chairman		Dr. Surya Prakash Rao/ Dr. Nanjundu Swamy
Rapporteurs	i)	Dr. D.S. Khurdiya, IARI
	ii)	Dr. S.K. Kalra, CIHNP
	iii)	Dr. A. Rameswar, APAU

Presentation of reports by:

IARI - New Delhi

IIHR - Bangalore

CIHNP - Lucknow

KKV - Dapoli

YSPUHF - Solan

TNAU - Periyakulam

HAU - Hissar

APAU - Hyderabad

NDUAT - Faizabad

AADF - Nasik

BAC - Sabour

CHAPTER - V

UTILIZATION OF COMMERCIALLY UNACCEPTABLE FRUITS VEGETABLES AND PROCESSING WASTES.

Chairman Dr. J.C. Anand

Rapporteurs
i) Dr. D.k. Tandon, CIHNP
ii) Dr. G.H. Shah, JKHPMC
iii) Dr. Mohan Kumar, APAU

Presentations of reports by:

IARI - New Delhi

IIHR - Bangalore

CIHNP - Lucknow

YSPUHF - Solan

TNAU - Periyakulam

BCKV - Nadia, West Bengal

AADF - Nasik

JKHPMC - Sopore (J & K.)

D. Fruit and Vegetable Processing Companies.

1. NOGA - Nagpur

Date Visited : 26th Feb, 1990

Key Personnel: C.N. Gopalakrishnan, Plant Mgr.
C.R. Patel, Sr. Food Technologist.

Comments : NOGA (Nagpur Orange Growers Assoc.) is operated by the government of Maharashtra. It thermally process a large variety of fruits (orange, mango, pineapple, berries etc.) into squashes, syrups, nectars and juices, jams and jellies. Vegetable products include tomato ketchup and puree, canned peas, baked beans in tomato sauce.

The company employs three food technologists who manage the quality control laboratory and are involved in some product development. No microbiology is conducted.

Spoilage as manifested by swollen cans occurs but the problem does not seem to be acute. The reason for spoilage and the identity of the causal microrganism(s) is unknown. Other types of spoilage such as caused by flat sour bacilli and heat-resistent molds undoubtedly occurs but escapes detection.

2. SNEHANKI PROCESSORS - NAGPUR

Date Visited : 24th February 1990.

Key Personnel : R.G. WAKHARE, Partner

Comments : The company is a manufacturer and exporter of various products made from orange, pinapple, mango and tomato. It has a juice concentrator.

The technical staff appears to be restricted to one or more persons capable of conducting routine quality control tests.

It was estimated that the incidence of swells was 0.1% or less. The causes of this type of spoilage were unknown. The incidence of other types of spoilage was not known.

3. Yawalker Food Products - Nagpur

Date visited : 24 February 1990

Key Personnel: R. Chaudhari, Accounts

Comments : The company processes fruit products for the domestic market. Some is used for reprocessing in other foods. Orange juice, for example, is shipped in 5 gallon carboys.

The company has a small quality Control laboratory but no facilities for the investigation of problems nor the development of new or improved products.

4. Brindavan Bottlers Ltd - Lucknow

Date Visited : 6 March 1990

Key Personnel : M.P. Bhatt, Plant Manager

Comments : This company is a soft drink bottler. One of their products is maaza, a beverage that contains 16% mango pulp. The pulp is shipped in No. 10 cans (approximately) which is prepared elsewhere. A hot fill (about 95 C) treatment is used to preserve maaza. The company has sophisticated water treatment equipment and a quality control laboratory appeared to be well equipped. It was stated that some microbiological testing was performed.

5. Kissan Products Ltd. - Bangalore

Date vsited : 16 Mar 1990

Key Personnel: Dr. A.G. Mathew, Gen. Mgr. Tech.
S.A. Majeed,
Gen. Mgr. Horticulture

Comments : Kissan is one of the largest fruit and vegetable processors in India. Its product include preserves, squashes and syrups, canned fruits and juices (mango, orange, lime, pear, apple), vegetables (peas, asparagus, sweet corn), Catsup and other tomato products, baked beans.

Dr. Mathew had previously worked 17 years at CFTRI, Mysore and thus is a knowledgeable, experienced food scientist. His speciality is product development with emphasis on flavor. Although his technical staff appeared to be very competent, none appeared to be microbioligitst.

Kissan recently had a spoilage problem of mango pulp aseptically packed in 200L sterile bags. The

casual microorganism was identified as a Lactobacillus by microbiologists at CFTRI. The IIHR microbiologists had not been informed of the problem.

Neither Dr. Mathew nor Mr. Majeeed has visited the IIHR facility.

6. Jagdale Exports

Date visited : 16 March 1990

Key Personnel : A.K. Rastogi, Production Mgr.

Comments : Two factories were visited. One was processing pineapple; the other a mango based soft drink that was preserved by a hot-fill process of about 90C. Other products are mango pulp and tomato juice. The company has installed a system for the aspetic packaging of fruit products. However, it has not been operated to date.

It appeared that the company had minimal technical support.

7. Mysore fruit Products Ltd. - Bangalore

Date visited : 16 March 1990

Key Personnel : D.K. Audikesavulu, Managing Director

Comments : The company prepares mango pulp for export. It also partially processes tomato products for Kissan.

Three or four food Technologists were employed and the company had a small laboratory for microbiology.

8. NAFED Processed Foods

Date Visited : 31 March, 1990

Key Personnel : H.C. Lal, Gen. Mgr.
D.V. Narula, Production Mgr.
P. Nalawade, Mgr. Cold Storage

Comments : This is a large company with a number of processing plants. Forty six products are canned. This includes various mango, pineapple, tomato, jams, pickles, temperate fruits, apple peas and mushroom items. At least two products, baked beans in tomato and sarsonkasaag, are formulated foods. The company has a freezing facility for the processing of green peas. It also has a cold storage warehouse for the storage of apples, potatoes, eggs, bakers yeast and other items.

The company has quality control laboratories but relies on private laboratories for bacteriological testing.

The personnel at IARI and CFTRI are also utilized when technical problems arise.

E. SEMINARS PRESENTED

Date	Title	Location
21 Feb	Heat Resistant Molds that spoil Processed Fruits	PHT Workshop Hyderabad
26 Feb	Current Microbiological concerns in the preservation of Fruit Products.	NRCC, Nagpur
Mar 9	Fermented Foods and Microbiological Criteria	CIHNP Lucknow
Mar 17	Fruit and Vegetable Research at Cornell Univ.	GKVK Hebbal
Mar 20	*Byssochlamys* and other Heat-Resistant Molds	CFTRI Mysore
Mar 23	Microbiology of Fruit and Vegetable Products	IIHR Bangalore
Mar 30	Fermentation and Preservation Microbiology	IARI New Delhi

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