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UNIVERSITY OF FLORIDA
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

HOMESTEAD, FLORIDA 33031

UNIVERSITY OF FLORIDA

TROPICAL RESEARCH
AND EDUCATION CENTER

18905 S.W. 280th Street
Telephone: 305/246-6340
FAX: 305/246-7003

4 May 1992

Dr.Garry Kinney
Grant Officer
Cooperative Development
Research Program
Agency for International Development
Washington D.C. 20523

Dear Sir:
I have the pleasure of sending you the final report relating to Grant DPE-5544-G SS 7072, Project C7 122.

The delay is due to the fact that most of the research activities were carried out with graduate students who worked on their thesis requirements and the results obtained by them are presented in this report.

This report is being delivered by our Israeli counterpart Dr.Mordecai Lapidot who happened to be in Miami on his way to Washington and has kindly agreed to present it to you personally.

This report consists of the following parts:

1. A synopsis of all the research activities including a financial statement and acknowledgement. (30 pages)

2. Annex 1. Diagnostico de las enfermedades fungosas en frutas de lechosa (Carica papaya L.) y melon (Cucumis melo L.) para exportacion. (70 pages)

3. Annex 2. Effecto de la radiacion gamma y calor sobre el desarrollo de Colletotrichum sp. en lechosa (Carica papaya L. variedad "Solo"). (173 pages)

4. Annex 3. Efecto de los tratamientos de radiacion gamma y calor sobre el desarrollo de Fusarium sp. en lechosa (Carica papaya L.) variedad "Solo".

REC'D IN R&D/R
OCT 28 1992

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C7-122

FINAL REPORT

To:

GRANT OFFICER - A.I.D./W PROJECTS DIVISION
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.C. 20523

GRANT:

DPE-5544-6-SS-7072-00, PROJECT C7-122

TITLE:

"Utilization of Low Dose Irradiation for Senescence Retardation and Desinfestation of Crops Important to Development of Tropical Countries"

FROM:

Instituto de Ciencia y Tecnología de Alimentos
Facultad de Ciencias
Universidad Central de Venezuela
P.O.B. 47097
Caracas 1041-A
Venezuela

CC: CDIE + BOSTID

1. INTRODUCTION

1.1. Objectives of the project:

The overall aim of this project was to generate scientific data and develop techniques for the successful application of irradiation technology for improved preservation of tropical food crops.

1.2. Participants:

Venezuela

Instituto de Ciencia y Tecnologia de Alimentos, Facultad de Ciencias. Universidad Central de Venezuela

-Asher Ludin. Coordinator of the Project
-María S. Tapia de Daza. Co-coordinator
-Rosa Virginia Díaz de Tablante
-Gina Borges de Hermoso
-Nelly de Albarracín
-Raúl Martínez
-Yadira Guevara
-Isabella Papparoni
-Elizabeth Cardillo
-Wilson Ruíz
-Héctor López
-Hilda Rodríguez
-Yajaira Albornett
-Petra Pino

Instituto Venezolano de Investigaciones Científicas (IVIC)
-Fernando Lalaguna
-Milagros Agudo
-Paolo Traversa
-Francisco Pino
-A. Maneiro

ISRAEL

Soreq Nuclear Research Center, Radiation Technologies

-Mordecai Lapidot
-Samuel Saveanu

Institute for Technology and Storage of Agricultural Products
The Volcani Center

-Nachman Paster
-Rivka Barkai-Golan

1.3. FINANCIAL STATEMENT & COMMENTS

This grant was made effective by A.I.D. Washington D.C. as of September 24, 1987. Notification of this approval was received in Caracas, in January 1988. The first allocation of funds was made on July 3rd. 1989, and the last sum was deposited by A.I.D. on Feb. 25th 1991. A total of 97.4% of the allocated sum was thus deposited.

The remaining sum $4,206.00 is being expected upon the presentation of this report.

FINANCIAL STATEMENTS

FUNDS RECEIVED AND SPENT IN VENEZUELA

FUNDS RECEIVED

3 JULY	1989	------	US$	5600
27 JULY	1989	------	US$	9500
31 JULY	1989	------	US$	56300
11 DEC.	1990	------	US$	10220
25 FEB.	1991	------	US$	10354
			TOTAL	91974
			FUNDS PENDING	4026
			TOTAL ALOCATION	96000

FUNDS SPENT IN VENEZUELA

	TO 31 DEC. 1989	TO MAY 1991	TOTAL
SALARIOS	4836.80	6263.20	11000
EQUIPMENT	32069.58	-	28000
OPERATING EXP.	4359.02	26171.40	34500
FOREIGN TRAVEL	5189.74	610.20	5800
OVERHEAD	8463.48	8036.52	16500
TOTAL	54918.62	41081.38	96000

LIST OF EQUIPMENT ACQUIRED WITH THIS PROJECT

-Perking Elmer Spectrophotometer (1)

-Durometer (1)

-Tintometer-Colormeter (1)

-Bacteriological Laminar Flow Chamber (1)

-Bacteriological Incubator (2)

-Electric Autoclave (2)

-Refrigerator (1)

As a final comment we would like to manifest our gratitude to US-AID Cooperative Development Research Program for funding this project and enabling us to carry out a particularly useful scientific activity which is appreciated not only in Venezuela but also in several neighbouring countries. Thus making food irradiation better understood and paving the way for the introduction of modern agricultural technologies for food preservation.

2. RESEARCH ACTIVITIES

2.1. VENEZUELA

2.1.1. EFFECT OF IONIZING RADIATION ON MICROFLORA OF TROPICAL FRUITS AND VEGETABLES

The following aspects were included in the original proposal in order to study the effect of ionizing radiation on native microflora of fruits and vegetables:

A. Studies on microbial resistence to irradiation and complementary pre-treatments:

-Identification and enumeration of natural microflora

-Isolation of specific organisms, including some biological indicators and some typical fruit spoilage bacteria & fungi

-Determination of D-values of spores and vegetative cells of specific isolates and of spores of biological indicators.

-Study of the effect of sinergic treatments on the surviving population

The objective was to get as much as information as possible on microbial resistance to ionizing radiation, expressed in terms of D-values and enumeration of surviving population with respect to:

-radiation dose
-sinergic treatments
-type of fruit

B. Microbial analysis of the product before and after irradiation as a complementary evaluation of their quality

-Enumeration of total microcount before and after irradiation taking into account:

-radiation dose
-synergic pre-treatment
-duration after irradiation
-storage conditions
-relationship with other aspects of quality

The research developed in the project in order to fulfill the aspects outlined in the above mentioned plan are the following:

2.1.1.1. PAPAYA

2.1.1.1.1. DIAGNOSIS OF DISEASE OF FUNGAL ORIGEN IN PAPAYA (*Carica papaya* L.) CULTIVATED IN VENEZUELA FOR THE EXPORT MARKET.

OBJECTIVES

The general objective of this work was to diagnose some of the most important post-harvest diseases of fungal origin, affecting papaya fruit grown in Venezuela for export purposes.

More specific objectives were:

- Detection of post-harvest diseases affecting venezuelan papaya that could be controlled by ionizing radiation
- Isolate fungi from papaya that exhibited potential of post-harvest diseases
- Perform pathogenecity tests on all the isolates
- Describe and identify those genus that proved pathogenic on the corresponding tests.

RESEARCH ASPECTS DEVELOPED

- Description of symptoms: necrotic lesions, stem-end and basal rots, superficial moulds and other superficial lesions, were defined under the stereocope and light microscope.
- Isolation and humid chamber preparations: diseased tissue was used for isolation of responsable organisms on Potato-Dextrose-Agar (five spots innoculation) as well as well as for humid chambers (100% R.H.)
- Obtention of pure cultures: Agar slants of isolates were prepared serially and checked for purity.
- Pathogenecity Tests: These tests were performed using spore filtrates of known concentration, as determined by Neubauer chamber, and inoculating "windows" (@ 3.0 cm of diam.) on sterile sound, healthy fruit surface. Fruits were incubated and checked for appearance of disease. Re-isolations were made from tissues that showed disease symptoms, and isolates from those lesions were checked to match the original inocula. Thus, according to Koch postulates, pathogenicity was considered positive or negative.
- Description and identification of isolates proved pathogenic to the fruit: Molds were described according to colony diameter, aspect, color and growth rate, mycelium characteristics, as well as any structure that could aid in identification. Conidia were microscopically checked for septation, pigmentation, and measurements were made of conidia width and length. Updated mycological identification keys and recent references on post-harvest diseases of papaya were consulted for final identification.

RESULTS AND DISCUSSION

This work was conducted in the context of the thesis: "A diagnostic of fungal post-harvest diseases in papaya (Carica papaya L.) and melon (Cucumis melo L. Var. Honeydew) grown in Venezuela for the export market" by Yajaira J. Albornett N., submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Agronomical Engineer.

Several fungic genus were isolated that proved to be pathogenic to papaya fruit. Results are presented in detail in the dissertation attached hereto (Annex 1). However, anthracnose produced by Colletrotichum spp., Fusarium spp. and Rhizopus stolonifer resulted to be responsable for post-harvest diseases of greater incidence in papaya fruit grown in Venezuela.

2.1.1.1.2. EFFECT OF GAMMA RADIATION AND HEAT ON COLETOTRICHUM sp. IN PAPAYA (Carica papaya L. Var. "Solo") GROWN IN VENEZUELA

OBJECTIVES

The general objective in this work was to investigate the response of Colletotrichum sp. to treatments of gamma radiation and heat and their combinations, on papaya fruit grown in the country for the export market.

More specific objectives were:

- Investigate the radiation-resistance of spore suspensions of Colletotrichum sp.
- Evaluate the effect of radiation treatments on radial growth of colonies of Colletotrichum sp.
- Evaluate the effect of gamma radiation treatment, heat and their combinations on "in vitro" development of Colletotrichum sp.
- Investigate the effect of combined treatments of gamma radiation and heat on "in vivo" development of Colletotrichum sp. on (papaya fruits)
- Evaluate microbial quality of fruits before and after the radiation treatment

RESEARCH ASPECTS DEVELOPED

- Radiation-resistance studies of spore suspensions of Colletotrichum sp. isolated from venezuelan papaya and proved pathogenic to the fruit.

The effect of increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500 Krads) was evaluated on spore suspensions oF known concentration, as determined by Neubauer chamber, and confirmed by plating on Potato-Dextrose-Agar (PDA).

After the radiation treatments applied, surviving out-growing spores on PDA Agar were ennumerated and the radioresistance curve was constructed in order to calculate the corresponding D-value. Three replicates were run (each by duplicate).

- The effect of gamma radiation on radial growth of colonies of Colletrotichum sp. was investigated. Spore suspensions (of known concentration) were irradiated with increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500). After the treatment, spore suspensions serially diluted, so as to obtain individual colonies that could be measured, were plated on PDA agar, and diameters recorded on days 3, 5 and 7. Three replicates were run (each by duplicate).

The effect of radiation gamma treatment, heat and their combination on "in vitro" development of Colletrotichum sp. was investigated. Spore suspensions of known concentration, were subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (50°C x 10 min., and 53°C x 5 min), and their combinations (25 krads + 50°C x 10 min., 25 krads + 53°C x 5 min., 50 krads + 50°C x 10 min, and 50 krads + 53°C x 5 min.). After these treatments, irradiated spore suspensions were plated on PDA agar in order to determine surviving population. Three replicates were run (each by duplicate).

The effect of radiation treatment, heat and their combination on "in vivo" development of Colletrotichum sp. in papaya fruits stored at 21°C was evaluated. Mature green papayas were inoculated with a spore suspension of known concentration, through two "windows"(10 x 15 mm, and 1 to 2 mm of depth in the peel of each fruit). Once inoculated, windows were sealed with scotch tape and subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (53°C x 5 min.) and their combinations (25 krads + 53°C x 5 min., and 50 krads + 53°C x 5 min). After application of these treatments, fruits were stored at 21°C x 10 days, and checked for lesion development, so as to determine and follow visible occurrence of disease. Two replicates were run.

The effect of treatments of gamma radiation, heat and their combination on microbial quality of papaya fruits stored at 21°C was investigated. Mature green papaya were subjected to the combination of gamma radiation and heat treatment that proved most effective in the previous

experiment (25 krad + 53°C x 5 min., and 50 krads + 53°C x 5 min.). After the treatment, fruits were stored at 21°C for 10 days. Total aerobic count on Plate Count Agar (PCA) and yeasts and molds on PDA were performed at the following times: Prior to treatment application, inmediately after treatment and at 5 and 10 days of storage.

RESULTS AND DISCUSSION

This work was conducted in the context of the Thesis: "Effect of Gamma Radiation and Heat on Development of Colletrotichum sp. in papaya (Carica papaya L.) Var. "Solo", by Isabella Papparoni Pahl, submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Licentiate in Biology.

The above mentioned dissertation with all results and detailed discussion is presented in Annex 2.

2.1.1.1.3. EFFECT OF GAMMA RADIATION AND HEAT ON FUSARIUM sp. IN PAPAYA (Carica papaya L.) Var. "Solo" GROWN IN VENEZUELA

OBJECTIVES

The general objective was to investigate the response of Fusarium sp. to treatments of gamma radiation and heat and their combinations, on papaya fruit grown in the country for the export market.

More specific objectives were:

- Investigate the pathogenecity of Fusarium sp. in papaya Var. "Solo" produced in Venezuela.
- Inactivation of spores of Fusarium sp. by gamma radiation (Radio-resistance studies)
- Evaluate the effect of radiation treatments on radial growth of colonies of Fusarium sp.
- Evaluate the effect of gamma radiation treatment, heat and their combinations on "in vitro" development of Fusarium sp.
- Investigate the effect of combined treatments of gamma radiation and heat on "in vivo" development of Fusarium (papaya fruits)
- Evaluate microbial quality of fruits before and after the radiation treatment

RESEARCH ASPECTS DEVELOPED

- Study of the pathogenecity of Fusarium sp. on papaya Var. "Solo". These tests were performed using spore filtrates of known concentration, as determined by Neubauer chamber, and inoculating "windows" (10 x 3 mm and 1 to 2 mm of depth) on sterile sound, healthy fruit surface. Fruits were incubated and checked for disease appearance. Symptoms were described under stereoscope and light microscope.

- Radiation-resistance studies of spore suspensions of Fusarium sp. isolated from venezuelan papaya and proved pathogenic to the fruit.

The effect of increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500 Krads) was evaluated on spore suspensions in known concentration, as determined by Neubauer chamber, and confirmed by plating on Potato-Dextrose-Agar (PDA).

After the radiation treatments hear applied, surviving out-growing spores on PDA Agar were ennumerated and the radioresistance curve was constructed in order to calculate the corresponding D-value. Three replicates were run (each by duplicate).

- The effect of gamma radiation on radial growth of colonies of Fusarium sp. was investigated. Spore suspensions (of known concentration) were irradiated with increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500). After the treatment, spore suspensions serially diluted, so as to obtain individual colonies that could be measured, were plated on PDA agar, and diameters recorded on days 3, 5 and 7. Three replicates were run (each by duplicate).

- The effect of radiation gamma treatment, heat and their combination on "in vitro" development of Fusarium sp. was investigated. Spore suspensions of known concentration, were subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (50°C x 10 min., and 53°C x 5 min), and their combinations (25 krads + 50°C x 10 min., 25 krads + 53°C x 5 min., 50 krads + 50°C x 10 min, and 50 krads + 53°C x 5 min.). After these treatments, irradiated spore suspensions were plated on PDA agar in order to determine surviving population. Three replicates were run (each by duplicate).

- The effect of radiation treatment, heat and their combination on "in vivo" development of Fusarium sp. in papaya fruits stored at 22°C was evaluated. Mature green papayas were inoculated with a spore suspension of known concentration, through two "windows"(10 x 15 mm, and 1 to

2 mm of depth in the peel of each fruit). Once inoculated, windows were sealed with scotch tape and subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (53xC x 5 min.) and their combinations (25 krads + 53xC x 5 min., and 50 krads + 53xC x 5 min). After application of these treatments, fruits were stored at 22xC x 10 days, and checked for lesion development, so as to determine and follow visible occurrence of disease. Two replicates were run.

- The effect of treatments of gamma radiation, heat and their combination on microbial quality of papaya fruits stored at 22xC was investigated. Mature green papaya were subjected to the combination of gamma radiation and heat treatmnent that proved most effective in the previous experiment (25 krad + 53xC x 5 min., and 50 krads + 53xC x 5 min.). After the treatment, fruits were stored at 22xC for 10 days. Total aerobic count on Plate Count Agar (PCA) and yeasts and molds on PDA were performed at the following times: Prior to treatment application, inmediately after treatment and at 5 and 10 days of storage.

RESULTS AND DISCUSSION

This work was realized in the context of the Thesis: "Effect of Gamma Radiation and Heat on Development of Fusarium sp. in papaya (Carica papaya L.) Var. "Solo", by Hector L'pez Freites, submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Licentiate in Biology.

Annex 3 presents only the results while the complete thesis is expected to be presented in May 1992.

2.1.1.2 MANGO

2.1.1.2.1 DIAGNOSTIC OF POST-HARVEST DISEASES OF FUNGAL ORIGIN IN SOME VARIETIES OF MANGO (Mangifera indica L.) GROWN IN VENEZUELA FOR THE EXPORT MARKET

OBJECTIVES

The general objective of this work was to diagnose some of the most important post-harvest diseases of fungal origin, affecting mango fruit grown in Venezuela for export purposes.

More specifical objectives were:

- To detect problems of post-harvest diseases affecting venezuelan mango in packing house, that could be controlled by ionizing radiation

- Isolate fungi from mango that could be a potential of post-harvest diseases

- Perform pathogenecity tests on all the isolates

- Describe and identify those genus that proved pathogenic in the corresponding tests.

RESEARCH ASPECTS DEVELOPED

- Description of symptoms: necrotic lesions, stem-end and basal rots, superficial moulds and other superficial lesions, were described under the stereocope and light microscope.

- Isolation and humid chamber preparations: diseased tissue was used for isolation of responsable organisms on Potato-Dextrose-Agar (five spots innoculation) as well as well as for humid chambers (100% R.H.)

- Obtention of pure cultures: Agar slants of isolates were prepared serially and checked for purity.

- Pathogenecity Tests: These tests were performed using spore filtrates of Known concentration, as determined by Neubauer chamber, and inoculating "windows" (@ 3.0 cm of diam.) on sterile sound, healthy fruits surface. Fruits were incubated and checked for disease appearance. Re-isolations were made from tissues that showed disease symptoms, and isolates from those lesions were checked to match the original inocula. Thus, according to Koch postulates, pathogenicity was considered positive or negative.

- Description and identification of isolates proved pathogenic to the fruit: Molds were described according to colony diameter, aspect, color and growth rate, mycelium characteristics, as well as any structure that could aid identification. Conidia were microscopically checked for septation, pigmentation, and measurements were made of conidia width and length. Updated mycological identification keys and recent references on post-harvest diseases of papaya were consulted for final identification

RESULTS AND DISCUSSION

This work was realized in the context of the thesis: "A diagnostic of fungal post-harvest diseases in mango (Mangifera indica L.) grown in Venezuela for the export market" by Petra N. Pino P., to be submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Agronomical Engineer.

Several fungic genus were isolated that proved to be pathogenic to mango fruit. However, anthracnose produced by

Coletrotichum sp. resulted to be the post-harvest disease of greater incidence in mango grown in Venezuela.

2.1.1.2.2. EFFECT OF GAMMA RADIATION AND HEAT ON COLLETROTICHUM sp. IN MANGO (Mangifera indica L. Var. Haden) GROWN IN VENEZUELA FOR THE EXPORT MARKET

OBJECTIVES

The general objective in this work was to investigate the response of Colletotrichum sp. to treatments of gamma radiation and heat and their combinations, mango Var. Haden grown in the country for the export market.

More specific objectives were:

- Investigate the pathogenecity of Colletotrichum sp. in mango Var. "Haden" produced in Venezuela.
- Inactivation of spores of Colletotrichum sp. by gamma radiation
- Evaluate the effect of gamma radiation treatment, heat and their combinations on "in vitro" development of Colletorichum sp.
- Investigate the effect of combined treatments of gamma radiation and heat on "in vivo" development of Colletotrichum sp. (on mango fruits)
- Evaluate microbial quality of fruits before and after the radiation treatment

RESEARCH ASPECTS DEVELOPED

- Radio-resistance studies of spore suspensions of Colletotrichum sp. isolated from venezuelan mango that proved pathogenic to the fruit.

  The effect of increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500 Krads) was evaluated on spore suspensions in known concentration, as determined by Neubauer chamber, and confirmed by plating on Potato-Dextrose-Agar (PDA).

  After the radiation treatments applied, surviving out-growing spores on PDA Agar were ennumerated and the radioresistance curve was constructed in order to calculation the corresponding D-value. Three replicates were run (each by duplicate).

- The effect of gamma radiation on radial growth of colonies of Colletrotichum sp. was investigated. Spore suspensions

(of known concentration) were irradiated with increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500). After the treatment, spore suspensions serially diluted, so as to obtain individual colonies that could be measured, were plated on PDA agar, and diameters recorded on days 3, 5 and 7. Three replicates were run (each by duplicate).

- The effect of radiation gamma treatment, heat and their combination on "in vitro" development of Colletotrichum sp. was investigated. Spore suspensions of known concentration, were subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (53°C x 3 min., and 57°C x 1 min), and their combinations (25 krads + 53°C x 3 min., 25 krads + 57°C x 1 min., 50 krads + 53°C x 3min, and 50 krads + 57°C x 1 min.). After these treatments, irradiated spore suspensions were plated on PDA agar in order to determine surviving population. Three replicates were run (each by duplicate).

- The effect of radiation treatment, heat and their combination on "in vivo" development of Colletrotichum sp. in mango fruits stored at 22°C was evaluated. Mature green mangoes were inoculated with a spore suspension of known concentration, through two "windows"(10 x 15 mm, and 1 to 2 mm of depth in the peel of each fruit). Once inoculated, windows were sealed with scotch tape and subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (53°C x 3 min.) and their combinations (25 krads + 53°C x 3 min., and 50 krads + 53°C x 3 min). After application of these treatments, fruits were stored at 22°C x 10 days, and checked for lesion development, so as to determine and follow visible occurrence of disease. Two replicates were run.

- The effect of treatments of gamma radiation, heat and their combination on microbial quality of mango fruits stored at 22°C was investigated. Mature green mangoes were subjected to the combination of gamma radiation and heat treatmnent that proved most effective in the previous experiment (25 krad + 53°C x 3 min., and 50 krads + 53°C x 3 min.). After the treatment, fruits were stored at 22°C for 10 days. Total aerobic count on Plate Count Agar (PCA) and yeasts and molds on PDA were performed at the following times: Prior to treatment application, inmediately after treatment and at 5 and 10 days of storage.

RESULTS AND DISCUSSION

This work was conducted in the context of the Thesis: "Effect of Gamma Radiation and Heat on Development of Colletotrichum sp. in mango (Mangifera indica L.) Var. "Haden", by Wilson R. Ruiz, to be submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the

degree of Licentiate in Biology.

Annex 4 presents only the results, while the complete thesis is expected to be presented in May 1992.

2.1.1.3. MELON

2.1.1.3.1. DIAGNOSIS OF POST-HARVEST DISEASES OF FUNGAL ORIGIN IN SOME VARIETIES OF MELON (*Cucumis melo* L.) GROWN IN VENEZUELA FOR THE EXPORT MARKET

OBJECTIVES

The general objective of this work was to diagnose some of the most important post-harvest diseases of fungal origin, affecting melons Var. Honeydew (Cucumis melo L.) grown in Venezuela for export purposes.

More specific objectives were:

- To detect problems in packing houses of post-harvest diseases affecting venezuelan Honeydew melons that could be controlled by ionizing radiation

- Isolate fungi from Honeydew melons that exhibited potential of post-harvest diseases

- Perform pathogenecity tests on all the isolates

- Describe and identify those genus that proved pathogenic in the corresponding tests.

RESEARCH ASPECTS DEVELOPED

- Description of symptoms: necrotic lesions, stem-end and basal rots, superficial moulds and other superficial lesions, were described under the stereocope and light microscope.

- Isolation and humid chamber preparations: diseased tissue was used for isolation of responsable organisms on Potato-Dextrose-Agar (five spots innoculation) as well as well as for humid chambers (100% R.H.)

- Obtention of pure cultures: Agar slants of isolates were prepared serially and checked for purity.

- Pathogenecity Tests: These tests were performed using spore filtrates of Known concentration, as determined by Neubauer chamber, and inoculating "windows" (@ 3.0 cm of diam.) on sterile sound, healthy fruits surface. Fruits

were incubated and checked for disease appearance. Re-isolations were made from tissues that showed disease symptoms, and isolates from those lesions were checked to match the original inocula. Thus, according to Koch postulates, pathogenicity was considered positive or negative.

- Description and identification of isolates proved pathogenic to the fruit: Molds were described according to colony diameter, aspect, color and growth rate, mycelium characteristics, as well as any structure that could aid to identification. Conidia were microscopically checked for septation, pigmentation, and measurements were made of conidia width and length. Updated mycological identification keys and recent references on post-harvest diseases of papaya were consulted for final identification.

RESULTS AND DISCUSSION

This work was conducted in the context of the thesis: "A diagnostic of fungal post-harvest diseases in papaya (Carica papaya L.) and melon (Cucumis melo L. Var. Honeydew) grown in Venezuela for the export market" by Yajaira J. Albornett N., submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Agronomical Engineer.

Several fungic genus were isolated that proved to be pathogenic to papaya fruit. Results are presented in detail in the dissertation attached (Annex 1). However, Colletrotichum spp., Fusarium spp. and Rhizopus stolonifer resulted to be responsable of post-harvest diseases of greater incidence in Honeydew melons grown in Venezuela.

2.1.1.2.3. STUDY OF GAMMA RADIATION AND HEAT AS METHODS TO PREVENT GROWTH OF FUSARIUM sp. IN HONEYDEW MELONS (Cucumis melo L.)

OBJECTIVES

The general objective aimed in this work was to investigate the response of Fusarium sp. to treatments of gamma radiation and heat and their combinations, on Honeydew melons grown in the country for the export market.

More specific objectives were:

- Inactivation of spores of Fusarium sp. by gamma radiation. (Radiation-resistance studies)

- Evaluate the effect of gamma radiation treatment, heat and their combinations on "in vitro" development of Fusarium sp. isolated from venezuelans melons and

proved pathogenic to this fruit.

- Investigate the effect of combined treatments of gamma radiation and heat on "in vivo" development of Fusarium sp. (on melon fruits)

RESEARCH ASPECTS DEVELOPED

- Radiation-resistance studies of spore suspensions of Fusarium sp. isolated from venezuelan melon and proved pathogenic to the fruit.

  The effect of increasing doses of gamma radiation (50, 100, 150, 200, 250, 300, 350, 400 and 500 Krads) was evaluated on spore suspensions on known concentration, as determined by Neubauer chamber, and confirmed by plating on Potato-Dextrose-Agar (PDA).

  After the radiation treatments applied, surviving out-growing spores on PDA Agar were counted and the radioresistance curve was constructed in order to calculate the corresponding D-value. Three replicates were run (each by duplicate).

- The effect of radiation gamma treatment, heat and their combination on "in vitro" development of Fusarium sp. was investigated. Spore suspensions of known concentration, were subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (52°C x 2 min.) and their combinations (25 krads + 52°C x 2 min., and 50 krads + 52°C x 2 min.). After these treatments, irradiated spore suspensions were plated on PDA agar in order to determine surviving population. Three replicates were run (each by duplicate).

- The effect of radiation treatment, heat and their combination on "in vivo" development of Fusarium sp. in melon fruits stored at 21°C was evaluated. Mature green melons were inoculated with a spore suspension of known concentration, through three "windows"(3 to 4 mm of depth in the peel of each fruit). Once inoculated, windows were sealed with scoth tape and subjected to the following treatments: gamma radiation (25 and 50 krads), hot dip (53°C x 5 min.) and their combinations (25 krads + 53°C x 5 min., and 50 krads + 53°C x 5 min). After application of these treatments, fruits were stored at 21°C x 10 days, and checked for lesion development, so as to determine and follow visible occurrence of disease. Two replicates were run.

RESULTS AND DISCUSSION

This work was presented in the context of the Thesis: "Effect of Gamma Radiation and Heat on Development of Fusarium sp. on Honeydew melons (Cucumis melo L.), by María

Isabel Cardillo, submitted to Universidad Central de Venezuela in partial fulfillment of the requirements for the degree of Master of Science.

The above mentioned dissertation with all results and detailed discusion is presented in Annex 5.

2.1.2. EFFECT OF IONIZING RADIATION ON QUALITY PARAMETERS OF TROPICAL FRUITS AND VEGETABLES

The following aspects were considered in the original plan:

- Determination of maturity
- Texture profile
- Appearance parameters
- Chemical composition
- Sensory evaluation
- Effect of irradiation on the above mentioned parameters as monitored at different time intervals after treatment.

-Research aspects developed were the following:

2.1.2.1.MANGO

SOME STUDIES ON THE RESPONSE OF MANGOES (Mangifera indica L. Var. Haden) CULTIVATED IN VENEZUELA, TO COMBINED TREATMENTS OF HEAT AND GAMMA RADIATION.

OBJECTIVES

The objective of this work was to determine the effects of combined treatments of heat and gamma radiation on certain quality aspects of mangoes Var Haden , as well as the storage temperature and initial quality of the fruit in senescence retardation as a consequence of the treatments applied.

RESEARCH ASPECTS DEVELOPED

EXPERIMENT 1.

Fruits were subjected to twelve different treatments of hot-dip, gamma irradiation and their combination:

-53°C x 3min
-57°C x 1min
-25 krads
-53°C x 3min + 25 krads
-57°C x 1min + 25 Krads
-50 Krads
-53°C x 3 min + 50 krads

-57°C x 1 min + 50 krads
-25°C
-25°C + 25 krads
-25°C + 50 krads
-No treatment

After treatments, fruits were stored for 25 days at 18°C. Color evaluation, visible anthracnose, external damage, and stem-end rot were evaluated throughout the storage period.

EXPERIMENT 2

Fruits were subjected to seven different treatments of hot-dip, irradiation and their combination.

-53°C x 3min
-53°C x 3min + 25 krads
-53°C x 3 min + 50 krads
-25°C + 25 krads
-25°C + 50 krads
-No treatment
-25°C

After treatments, fruits were stored for 25 days at 18°C. Color evaluation, visible anthracnose, external damage, and stem-end rot were evaluated throughout the storage period.

EXPERIMENT 3

Fruits were subjected to ten different treatments of hot-dip, gamma irradiation and their combination:

-53°C x 3min
-57°C x 1min
-25 krads
-53°C x 3min + 25 krads
-57°C x 1min + 25 Krads
-50 Krads
-53°C x 3 min + 50 krads
-57°C x 1 min + 50 krads
-25°C
-No treatment

After treatments, fruits were stored for 16 days at 18°C. Color evaluation, anthracnose, external damage, stem-end rot, texture changes, weight changes, pH, °Brix, and titable acidity were evaluated through the storage period.

RESULTS AND DISCUSSION.

All these experiments and detailed discussion of results are presented in the report :"Algunos estudios sobre la respuesta de

mangoes (Mangifera indica L. Var. Haden) cultivados en Venezuela, a tratamientos combinados de irradiación gamma y calor", which corresponds to Annex 6.

2.1.3. TROPICAL FRUIT AND VEGETABLE TOLERANCE TO LOW DOSES IRRADIATION OF Manihot esculenta C.

OBJECTIVES

The general objective of this work was to investigate the effect of of low dose ionizing radiation (such as necessary for disinfestation) on the post-harvest physiology of tropical crops, since subtle changes may affect the deterioration process of the product during storage.

More specific objectives were:

-To identify and quantify the lipid classes of fresh cassava roots (Manihot esculenta C. cv Algodona)

-To relate changes in composition of lipids to subsequent deterioration changes such as darkening and possible textural changes.

RESEARCH ASPECTS DEVELOPED

Fresh roots were processed for lipid analysis within five hours after harvest. The total lipid content was 0.25% fresh weight and the lipid mixture obtained was complex. Polar lipids plus sterols and steryls esters made up the major part of the extracted lipids (77.0 mol%). Seven phospholipids were identified. Those in higher amounts were: phosphatidylcholine, 265.4 nmol/g fresh weight; phosphatidylethanolamine 151 nmol/g; phosphatydylinositol, 143.1 nmol/g. Among the six glycolipids identified digalactosyldyacylglycerol with 333,2 nmol/g and monogalactosyldiacylglycerol with 217.1 nmol/g were the most abundant. free sterols were 304.3 nmol/g and triacylglycerol 444.4 nmol/g. Thus eighteen lipid classes were identified: 7 phospholipids with 706 nmol/g; 6 glycolipids with 816.6 nmol/g; 5 neutral lipids with 892.6 nmol/g weight. Of the seven phospholipids that were measured, phosphotidylcholine, phosphotydilethanolamine, phosphotydilinositol and phosphotydilglycerol showed concerted changes in content and proportion. These changes were correlated with the root discoloration. Overall decreases in total phospholipids and glycerolipids content and increase in the ratio of total sterol containing lipids to phospholipids and to total glyceroglycolipids, suggest alterations of membranes, similar to those occurring in other senescent plant organs. The results indicate a causal relationship between the changes in the lipids and the parenchyma discoloration that occur in cassava roots after unearthing.

Also, the effect of low dose irradiation on the changes in

the lipid classes was studied, with the purpose of relating these changes to senescence manifestation and storage behavior. The hypothesis that considers the cassava discoloration as a manifestation of senescence is sustantiated.

Results are presented in three publications attached here to. (Annex 7).

2.2. ISRAEL

2.2.1. MANGO

EFFECT OF COMBINED TREATMENTS HEAT-RADIATION, ON POST-HARVEST MATURATION OF MANGO

OBJECTIVE

The general objective of this work was to evaluate the ability of gamma radiation alone and in combination with heating, to extend the useful post-harvest life of mangoes intended for export.

RESEARCH ASPECTS DEVELOPED

Fruits were dipped in hot water bath for 5 min. at 55°C and irradiated on the same day with 25 and 75 Krad doses. Untreated fruits, as well as fruits which were exposed to heating or to irradiation alone, served as controls.

RESULTS AND DISCUSSION

Heating alone was found to stimulate ripening and thus to shorten post-harvest life of the fruit. Irradiation alone at 25 Krad caused a delay of 2 days in ripening, as compared to the untreated control, without causing peel damage or changing the good taste of mango.

Combined heating (55°C) and irradiation (25 Krad) treatments resulted in delay in softening similar to tht caused by irradiation alone, and no stimulation in color development caused by heating alone was recorded. Higher irradiation doses resulted in peel injury. A 50 Krad dose alone stimulated softening and inhibited color development. However, when this dose was combined with heat treatment, no injury was induced. A 75 Krad dose alone or in combination with heating resulted in serious peel damage.

The reports on this experiments are still to be received, as notified.

2.2.2. MELON

EFFECT OF COMBINED HEAT-RADIATICN TREATMENT ON POST-HARVEST LIFE OF MELONS

The general objective of this work was to evaluate the possibility of combining suitable heat treatments with low dose irradiation, to improve the efficiency of each treatment alone in supressing decay development.

RESEARCH ASPECTS DEVELOPED

- Fruits were picked at their yellow-green stage and immersed in a hot water bath at 52, 55 and 60 °C one day after harvest. Fruits were dried at ambient temperature and irradiated 90 minutes after heating with 50 or 100 Krad dose of gamma radition. Fruits which were exposed to heating alone or irradiation alone, as well as unirradiated fruits served as controls.

- Fruits were stored for 12 days at 6°C and 3 additional days at 18°C, and examined, both on the day of removal from cold storage to shelf life conditions and at the end of the shelf life period. Fruit examination included the incidence of infected fruits and the rate of induced peel damage.

RESULTS AND DISCUSSSION

Combining hot water treatment (5 min. in 52°C hot water) with 50 Krad irradiation, which by itself was inefective in decay control, increased the inhibitory effect of heating alone on decay development without causing peel damage. Similar results were obtained by increasing the water temperatures to 55°C, while reducing the dipping time to 2 min. A further increase in the time of immersion markedly reduced the supressive effect of the combined treatment. Increasing the irradiation dose in the combines treatment to 100 Krad did not result in better disease control achieved with a 50 Krad dose and sometimes resulted in decreased antifungal effect. Heating the fruits at 60°C, although preventing decay development during storage, resulted in marked heat injury to the peel.

2.2.3. AVOCADO

LOW DOSE IRRADIATION FOR DELAYING THE RIPENING OF "ETHINGER" AVOCADOS

OBJECTIVES

The general objective of this work was to study possible shelf life extension of "Ethinger" avocados, which is limited by the softening of the fruit after harvest, with the use of low dose gamma irradiation.

More specific objectives were:

- To evaluate the possibility of delaying of ripening of cv. Ethinger under conditioned simulating sea transportation to Europe at 5°C or at higher storage temperature (14°C) prior to its removal to shelf life conditions.

- To investigate the effect of irradiation on fruit respiration and on enzymatic activity involved in fruit ripening

RESEARCH ASPECTS DEVELOPED

- Fruits were packed in carton containers , 10 fruits per carton. The containers were irradiated one day after harvest at doses 7.8 - 9.4 Krad per minute. Following irradiation the fruits were waxed, dried at ambient temperature, stored at 5 or 14°C for 14 days and then transferred to 22°C

- Firmness of fruits was checked daily during storage, by using Chatillon equipment. Organoleptic tests were carried out by the triangular tests with fifteen testers.

- Cellulolytic and pectolytic activity of the fruit tissues was studied viscosimetrically by measuring the percent decrease in carboxymethyl cellulose and pectin substrates respectively

- Respiration tests were carries out by gas chromatography

RESULTS AND DISCUSSION

Initiation of softening in the unirradiated fruits preceded that of irradiated ones by 2 to 5 days. These results were obtained for fruits held both at 5°C and 14°C prior to their removal to shelf life conditions.

No significant organoleptic differences were found between the irradiated and unirradiated fruits. The peak in the polygalacturonase of the control fruit was found to precede the peak in the irradiated fruit. No significant differences were found between the unirradiated and the irradiated fruits regarding their cellulotitic activity. Peaks in the cellulase activity were recorded while fruits were still held at 14°C. No differences were recorded between the respiratory climacterium of the irradiated fruit and that of the control.

The reports on this experiment are still to be received, as notified.

2.2.4. TOMATOES

COMBINED HEAT RADIATION-TREATMENTS TO CONTROL DECAY OF TOMATO FRUITS

OBJECTIVES

The general objective of this work was to investigate the effect of combined heat and radiation treatments as a means to control post-harvest losses of tomato fruits.

RESEARCH ASPECTS DEVELOPED

Hot water dip and gamma radiation were investigated in order to see their combined effect in reducing **Botritis cinerea** and **Rhizopus stolonifer** decay in inoculated light-red tomatoes.

RESULTS AND DISCUSSION

Hot water dip at 50°C for 2 min. was more effective than 100 Krad of gamma radiation in reducing decay caused by the above mentioned organisms. The combined heat-radiation treatment acted synergistically on fungal development resulting in 1.7 and 6.7% infection after 5 days at 23°C. The suppressive effect of each of the treatments was reduced after 8 days' storage. Under natural infection conditions, heating alone reduced **Alternaria alternata** decay by 90%, while decay reductions of 40 and 60% were recorded after 50 and 100 Krad, respectively, of irradiation alone. Heating followed by irradiation at 50 Krad was more effective in decay supression than heating with irradiation at 100 Krad and totally eliminated decay development during 8 days at 23°C. Twenty percent of the combined treated fruits lost their firmness.

2.2.5. CORN

EFFICACY OF IONIZING RADIATION IN PREVENTING MOLDINESS IN CORN GRAIN AT DIFFERENT MOISTURE LEVELS AND PRESERVATION OF THE NUTRITIONAL VALUE OF CORN GRAINS

OBJECTIVES

The general objective of this work was to study the effect of irradiation dose, moisture content and storage temperature on the development of spoilage molds in corn grain destined for broiler chicken feed.

RESEARCH ASPECTAS DEVELOPED

- Moisture-Irradiation experiments: the moisture content of grains was 14% and 16%, the latter was adjusted by the addition of water and mixing. The corn was irradiated at 700 Krad for the first experiment and stored at 13-21°C for the first 10 days, and then at @ 28°C for 70 days. In the second experiment the corn was irradiated at 1000 Krad

and stored under ambient conditions for 96 days (19-40°C). At predetermined dates, the containers were opened and 500 g. samples were taken for analysis of moisture and grain contamination.

Chicken feeding experiments: These experiments started after 120 and 173 days of storage in experiments 1 and 2 respectively.

RESULTS AND DISCUSSION

It was determined that that in grain irradiated at 700 Krad, very low fungal activity existed for the initial 48 days irrespective of low moisture content. There was 4 % CO_2 activity in grain with 14% moisture compared to 4.5% for grain with 16%. The controls showed a much higher activity of 17.2% and 17.5 %. After 60 days the CO_2 activity for the drier irradiated grain was only 4.6%.

In the second experiment, irradiation at 1000 Krad and storage at temperatures that reached 40°C, the effect of irradiation was still evident after 24 days but only in the drier (14% moisture) grain.

After 96 days the CO_2 percentage was the following:

Control	(14% humidity)	9.5% CO_2
Moist	(16% ")	16.6% "
Irradiated grain	(14% ")	7.8% "
Irradiated moist grain	(16% ")	17.2% "

The two experiments showed that irradiation delayed the development of molds, being more effective with less moist material, but even higher level of irradiation (100 Krad) could not detain the development of mold at 16% moisture and higher storage temperature.

In the chick feeding experiment, the moistened corn did not adversely affect chick performance in experiment 1, while in trial 2, it significantly improved feed intake and weight gain and depressed feed efficiency.

It is concluded that gamma irradiation at the dosage applied was effective in preventing the moldiness only of the low moisture grain for about 60 days. However, moldiness per se does not necessarily disqualify the grain for the use in poultry nutrition. Before use, such grains should be analysed for the presence of mycotoxins and their fat content determined to insure their safety and economical use.

Irradiation could be a means of prolonging the storage life of corn grain but specific storage conditions and perhaps higher dosis of irradiation should be considered.

Results are presented in publication attached hereto. (Annex 8)

3.TRAINING AND DISSEMINATION

3.1. WORKSHOPS CARRIED OUT BY THIS PROJECT

3.1.1."USO DE RADIACION IONIZANTE PARA REDUCIR PERDIDAS POST-COSECHA"

INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS
Caracas, Venezuela
April 28, 29 and 30 1990.

Proceedings of these workshop are presented in Annex 9.

3.1.2."USO DE RADIACION IONIZANTE PARA REDUCIR PERDIDAS POST-COSECHA"

INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS
Caracas, Venezuela
May 2-18 1990

3.1.3."USO DE RADIACION IONIZANTE PARA REDUCIR PERDIDAS POST-COSECHA"

ESCUELA POLITECNICA NACIONAL
Quito, Ecuador
May-June 1990?

3.2.SEMINARS SUBMITTED TO UNIVERSIDAD CENTRAL DE VENEZUELA

(In partial fulfillment of the requirements for the degree of Licentiate in Biology and Master of Science)

-Díaz de Tablante, R.V. 1989. "Medidas de control, control químico, y técnicas de erradicación de moscas de la fruta en el campo". Seminario de Post-Grado. Post-Grado Interfacultades en Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Instituto de Ciencia y Tecnología de Alimentos. Universidad Central de Venezuela. Caracas, Venezuela.

-Tablante, A. 1989. "Aspectos fitosanitarios en frutas para exportación". Plagas. Seminario de Post-Grado. Post-Grado Interfacultades en Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Monascal, J. 1990. "Uso de radiaciones ionizantes para la produccion industrial de almidones modificados". Seminario Especial de Grado. Instituto de Ciencia y Tecnologia de Alimentos. Escuela de Biología. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Borneo, R. 1991. "Toxicología de algunos alimentos irradiados: Trigo y almidón de maíz". Seminario de Post-Grado. Post-Grado

Interfacultades en Ciencia y Tecnología de Alimentos.Instituto de Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Paparoni, I. 1991. "Mecanismos de penetracion de hongos en tejidos vegetales".Seminario Especial de Grado. Instituto de Ciencia y Tecnologia de Alimentos. Facultad de Ciencias. Escuela de Biología. Universidad Central de Venezuela. Caracas, Venezuela.

-Trujillo, I. 1991. "Aplicaciones de radiaciones gamma en bajas dosis sobre frutas tropicales. Alternativas para reducir perdidas post-cosecha: 1. Efectos fisiológicos. 2. Ventajas y Desventajas. Seminario de Post-Grado. Post-gado en Biología, Area de Botánica. Facultad de Ciencias. Universidad Central de Venezuela. Caracas. Venezuela.

-Ruíz, W. 1992. "Uso de la radiación ionizante para el control de enfermedades post-cosecha de algunas frutas tropicales". Seminario de Grado. Escuela de Biología. Instituto de Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-López, H. 1992. "Radiación ionizante. Principios y usos prácticos en Tecnología de Alimentos". Seminario de Grado. Escuela de Biología. Instituto de Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

Copies of these seminars are kept in the library of these Institute and are available on request.

3.3. THESIS SUBMITTED TO UNIVERSIDAD CENTRAL DE VENEZUELA.
(In partial fullfillment of the requirements for the degree of Licentiate in Biology or Master of Science)

-García, E. 1990. "Efectos de las radiaciones ionizantes sobre algunas propiedades físicas, químicas, y reológicas del almidón de **Canavalia ensiformis** y **Manihot** sp." Trabajo Especial de Grado para optar al título de Licenciado en Biología. Escuela de Biología. Instituto de Ciencia y Tecnología de Alimentos. Universidad Central de Venezuela. Caracas, Venezuela.

-Monascal, J. 1990. "Efecto de las radiaciones ionizantes sobre algunas propiedades del almidón de **Amaranthus cruentus**. Trabajo Especial de Grado para optar al título de Licenciado en Biología. Escuela de Biología. Instituto de Ciencia y Tecnología de Alimentos. Universidad Central de Venezuela. Caracas, Venezuela.

-Papparoni, I. 1991."Efecto de la radiación gamma y calor sobre el desarrollo de Colletrotichum sp en lechosa (Carica papaya L) Var "Solo". Trabajo Especial de Grado para optar al título de

Licenciado en Biología. Escuela de Biología. Instituto de Ciencia y Tecnología de Alimentos. Caracas, Venezuela.

-Cardillo, E. 1991. "Estudio de la radiación gamma y el calor como métodos para prevenir el desarrollo de **Fusarium** sp en melón (**Cucumis melo** L. Var. Honeydew. Trabajo Especial de Grado para optar al título de Magister Scientarum en Ciencia de los Alimentos. Post-Grado Interfacultades en Ciencia y Tecnología de Alimentos. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Albornett, N. Y. 1991. "Diagnóstico de las enfermedades fungosas en frutos de lechosa (**Carica papaya** L.) y melón (**Cucumis melo** L.) para exportación. Trabajo Especial de Grado para optar al título de Ingeniero Agrónomo-Mención Fitotecnia. Facultad de Agronomía. Universidad Central de Venezuela. Maracay, Venezuela.

-López, H. 1992. "Efecto de la radiación gamma y calor, sobre el desarrollo de **Fusarium** sp en lechosa (**Carica papaya** L.). Trabajo Especial de Grado para optar al título de Licenciado en Biología. Escuela de Biología. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Ruíz, W. 1992. "Efecto de la radiación gamma y calor sobre el desarrollo de Colletrotichum sp en mango (**Mangifera indica** L.). Trabajo Especial de Grado para optar al título de Licenciado en Biología. Escuela de Biología. Facultad de Ciencias. Universidad Central de Venezuela. Caracas, Venezuela.

-Pino P. P. 1992. "Diagnóstico de enfermedades post-cosecha de origen fungoso en algunas variedades de mango (**Mangifera indica** L.) para exportación. Trabajo Especial de Grado para optar al título de Ingeniero Agrónomo-Mención Fitotecnia. Facultad de Agronomía. Universidad Central de Venezuela. Maracay, Venezuela.

Copies of these thesis are kept in the library of this Institute and are available on request.

3.4.PRESENTATIONS AT SYMPOSIA AND CONGRESSES

-Seminario: Acceleratori di Electroni e luci di Sincrotoni, loro Utilizzacione nella Ricerca e nell' Industria. Nono Centenario ell'Universita di Bologna. Bologna, Novembre 1988:

Ludin, A. 1988. "Investigaciones y Aplicaciones Industriales de Irradiaciones Ionizantes en Venezuela. Presentación de Proyecto C.D.R."

-Second F.A.O./I.A.E.A. Research Coordination Meeting on Latin American Regional Cooperative Program on Food Irradiation. (L.A.F.I.P.). San José, Costa Rica, Interamerican Institute for Cooperation in Agriculture, (I.I.C.A.), October 10-14, 1988:

Ludin. A. 1988. Presentation of the Project C.D.R.: "Utilización de bajas dosis de irradiación para el retardo de la senescencia y desinfestación de cultivos importantes para el desarrollo de países tropicales".

-International Workshop on the Use of Food Irradiation to Prevent Post-harvest Losses. I.A.E.A.-F.A.C.-W.H.O., Netania, Israel, Feb-March 1989:

Tapia de Daza, M. 1989. Actual status of Post-Harvest Losses in Venezuela. Possible use of Irradiation. Short Seminar.

-VII Seminario Latinoamericano y del Caribe en Ciencia y Tecnología de Alimentos. San José, Costa Rica, Mayo. 1990:

Lalaguna, F. and Agudo, M. "Comportamiento durante el almacenamiento de los lípidos, y descoloración de la yuca (**Manihot esculenta** Crantz) tratada con radiaciones gamma".

Ludin, A., Tapia de Daza, M. and Lalaguna, F. 1990. "Utilización de irradiación a bajas dosis para retardación de senescencia y desinfestación de productos agrícolas de importancia para países tropicales".

-Second International Workshop on Dosimetry for Radiation Processing. University of Maryland. Conference Center, College Park, Maryland. U.S.A. October 6-11, 1991:

Lalaguna, F., Tapia de Daza, M. and Ludin, A. 1991. "Activities on Food Irradiation in Venezuela".

-XL Convención Anual de ASOVAC. 18-23 de Noviembre de 1990. Universidad de Oriente, Cumaná, Estado Sucre, Venezuela:

Tapia de Daza, M., Guevara, Y., Lalaguna, F., Borges, G. and Ludin, A. "Algunos estudios sobre la respuesta de mangos (**Mangifera indica** L.) cultivados en Venezuela a tratamientos combinados de agua caliente y radiación gamma.

Tapia de Daza, M., Díaz de Tablante, R.V., Lalaguna, F., Ruíz, W. y Rojas, G. 1990. "Estudio de radioresistencia de algunos mohos patógenos de lechosa (**Carica papaya** L.) y mango (**mangifera indica** L.)

Monascal, J. y Perez, E. 1990. "Modificación de las propiedades reológicas del almidón de **Amaranthus cruentus** por irradiación con rayos gamma

García, E. and Perez, E. 1990. "Modificación de las propiedades reológicas y funcionales del almidón de **Canavalia ensiforme** y **Manihot** sp. con rayos gamma".

-V Congreso Venezolano de Microbiología Dr. Alejandro Divo. 04-08 de Noviembre de 1991. Valencia, Venezuela:

Cardillo, E. y Martínez, R. 1991. "La radiación Gamma y el calor como métodos para prevenir el desarrollo de **Fusarium sp.** en melón (**Cucumis melo** L. Var. Honeydew)

-XLI Convención Anual de ASOVAC. Universidad del Zulia, Maracaibo, Edo. Zulia. Venezuela, Proyecto C.D.R.

Borges, G., Rodríguez, H., Tapia de Daza, M. y Lalaguna, F. 1991. Efecto de la radiación Gamma sobre la calidad de mangos (**Mangifera indica** L.) cultivados en Venezuela.

Copies of these presentations are kept in the library of this Institute and are available on request.

3.5.REPORTS AND PUBLICATIONS

-Ludin, A., Tapia de Daza, M. and Lalaguna, F. 1990. "Utilización de irradiación a bajas dosis para retardación de senescencia y desinfestación de productos agrícolas de importancia para países tropicales.(Proyecto C.D.R.). (Proc. abastrct) VII Seminario Latinoamericano y del Caribe de Ciencia y Tecnología de Alimentos. pp not indicated. San José, Costa Rica.

-Lalaguna, F. and Agudo, M. 1990. "Comportamiento durante el almacenamiento, de los lípidos, y descoloración de la yuca (**Manihot esculenta** Crantz) tratada con radiaciones Gamma". (Proc. Abstract) VII Seminario Latinoameriano y del Caribe de Ciencia y Tecnología de Alimentos. pp. not indicated. San José, Costa Rica.

-Monascal, J. y Perez, E. 1990. "Modificación de las propiedades reológicas del almidón de **Amaranthus cruentus** por irradiación con rayos gamma (Proc. Abstract) Acta Cientif. Venez., 41:349

-García, E. and Perez, E. 1990. "Modificación de las propiedades reológicas y funcionales del almidón de **Canavalia ensiforme** y **Manihot** sp. con rayos gamma". (Proc. Abstract) Acta Cientif. Venez., 41: 349.

-Tapia de Daza, M., Guevara, Y., Lalaguna, F., Borges. G. y Ludin, A. 1990. "Algunos estudios sobre la respuesta de mangos (**Mangifera indica** L.) cultivados en Venezuela, a tratamientos combinados de agua caliente y radiación gamma. (Proc. Abstract) Acta Cientif. Venezol., 41:346

-Tapia de Daza, M., Díaz de Tablante, R.V., Lalaguna, F., Ruíz, W. y Rojas, G. 1990. "Estudio de radioresistencia de algunos mohos patógenos de lechosa (**Carica papaya** L.) y mango (**mangifera indica** L.(Proc. Abstract) Acta Cientif. Venez., 41: 349.

-Borges, G., Rodríguez, H., Tapia de Daza, M. y Lalaguna, F.

1991. Efecto de la radiación Gamma sobre la calidad de mangos (**Mangifera indica** L.) cultivados en Venezuela. (Proc. Abstract) Acta Científ. Venez. 49:243

-Lalaguna, F. and Agudo, M. 1988. Relationship between changes in lipids with ageing of cassava roots and senescence parameters. Phytochemistry, (28)8:2059-2062

-Lalaguna, F., and Agudo, M. 1988. Lipids classes of fresh cassava roots (**Manihot esculenta** Crantz): Identification and quantification. JAOAC, (65)11:1808-1811.

-Paster,N., Bartov, I., Mazal, M., Padova, R., and Ross, I. 1990. Efficacy of gamma irradiation in preventing moldiness and preserving the nutritional value of corn grain for broiler chicks. Poultry Sci. 69:??. (Manuscript received for publication March 16, 1990).

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