

THE ROLE OF MICROBIOLOGY IN THE PRODUCTION OF SAFE FOODS FOR CONSUMERS

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MICROBIOLOGY

- An indispensable component in many industries
- Involved in:
 - quality control
 - testing the **acceptability** of products in terms of **microbial counts** (meeting the standards) and **presence of pathogens**

Food Microbiology

- Deals with the study of microorganisms associated with food and food products, their activities and effects on the food and on the consumer
- Has gained more importance due to the unabated incidence of **foodborne diseases** and frequent occurrence of **food spoilage**;

Food Microbiology

- An ever-growing concern over food and related products' safety and quality
- Proper methods of **food preservation**
- **Development of food products** has successfully been done through the use of microorganisms (*product innovation*)

Food Microbiologist

- Needs to be **familiar with microorganisms** important to the industry which will enable him/her to apply appropriate methods to **control and destroy harmful microorganisms** and to **optimally utilize the beneficial ones**
- Duties/Responsibilities: culture maintenance and preservation, monitoring microbial growth, determination of microbial population, detection of both harmful and beneficial microorganisms

Food Microbiologist

- Duties/Responsibilities: Microbiological examination of products or materials that are used in the manufacture, and of different molds, yeasts and bacteria associated with the products made by the company
- Additional knowledge on the **intrinsic parameters** of the food and food products such as A_w , pH, nutrients, among others

Food Microbiologist

- Additional knowledge on the **extrinsic parameters** such as temperature, gases and relative humidity that can affect storage of the commodities

Specific Competencies of Microbiologists in the Food and Beverage Industry

- Ability to determine the heat resistance of microorganisms of concern – a consideration in the production of safe and shelf-stable foods
- Test for commercial sterility (if applicable)

HACCP(Hazards Analysis and Critical Control Points)

- Preventive tool employed by the industry to protect products against hazards
- Involves the identification of physical, chemical and biological hazards throughout the entire process involved in the production
- Focuses on control measures
- Universally recognized and recommended as the most effective way to prevent foodborne illness

ROLE OF MICROBIOLOGY



- **Tailor-fitted HACCP system for the organic sector**
 - **Risk assessment**
 - **Proper documentation**
(Orriss & Whitehead, 2000)

CHALLENGES

- Challenges that confront the food and beverage **market** have always been the same, but the **degree** gets a notch **higher**

Challenges..

- Pressure of getting more of the market:
Innovation has to be made. The same products cannot be put out year in and year out.

Modify the products and in case of fermented foods – **cultures** should be continuously selected to give better products which have more desirable organoleptic properties or which can be preserved better.

Cater to a specific market

ORGANIC FOOD PRODUCTION

- A farm production that:
 - sustains the health of soils, plants, animals, and people
 - Relies on ecological systems to conserve resources and maintain natural balance
 - Builds fair relationships that account for social and environmental costs
 - Cares for the long term productivity of the living landscape
(Sheng & Shen, 2009)



ORGANIC FOOD CONSUMERS

- **Health motives as important driving force for purchase**
- **Rising obesity rates**
- **Appeals from the concerned sector** (Aschemann-Witzel, Maroscheck, & Hamm, 2013)



Organic Food Consumers

- Believe that these are more safe compared to foods which have been raised in the conventional way
- Foremost in their minds are the absence of chemicals which otherwise would contaminate the foods that they take in and would somehow affect the health of the individual

GLOBAL TRENDS, China

2005

- **China NOPS and Organic Products Certification**

2006

- **Organic exports reached USD800 million**

2007

- **China became the 2nd largest area of certified organic land**

(Sheng et al. 2009)

GLOBAL TRENDS, USA



**40%, organic
food
market
growth in
2009-2019
(Nie and
Zepeda,
2011)**

Microbiology in Organic Farming

- Use of **biofertilizers** – fertilizers that contain microorganisms that increase the amount of nutrients needed by the plants

Cheaper than chemical fertilizers and not as energy-requiring in their manufacture

Environment friendly and do not harm the farmers applying them or the animals fed with the plants

Yields comparable if not better than crops grown with chemical fertilizers

Biofertilizers

- Current status on the use of biofertilizers in the **Philippines**:

Widely applied, distributed on a commercial scale

Permitted/licensed by the Fertilizer and Pesticide Agency and are now available nationwide

BIOFERTILIZER



Microbiology in Organic Farming

Composting

- Not new, but **rapid** composting utilizing microbial inoculants has led to a better compost
- Has gained momentum in the Philippines in the last few years

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BIO-FIX™

COMPOST ENHANCER

Bacterial Inoculant (*Azotobacter* sp.) for Nitrogen Activity Enhancement of Compost

DIRECTION FOR USE. After composting, add **BIO-FIX™** to the mature compost. For every ton of mature compost, 2 packs of **BIO-FIX™** are needed. Mix compost thoroughly then incubate for one week.

Net Wt. 1000g

Mfg. Date: _____

Best Before: _____

A product of
National Institute of Molecular Biology and Biotechnology

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BIO-QUICK™

COMPOST RIPENER

Fungal Inoculant (*Trichoderma* sp.) for Degradation of Organic Wastes

DIRECTION FOR USE. Mix 2 packs of **BIO-QUICK™** to one ton of organic wastes moisten thoroughly with water. Incubate compost heap for three weeks with weekly turning of heaps to ensure aeration.

Net Wt.: 1000g

Mfg. Date: _____

Best Before: _____

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POSTHARVEST ISSUE



- Heavy loads of microorganism primarily due to the farming system(Troller, 1993)

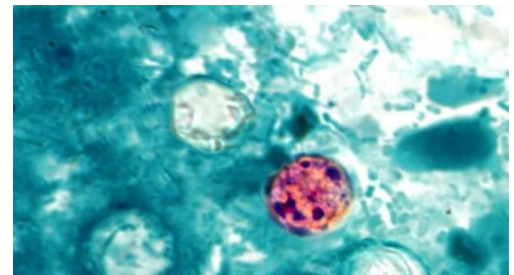


- no heat treatment for fresh salad vegetables, **4-6 log CFU mesophiles** (Baur, et al. 2004)

Cyclospora cayatenensis

- Single-celled parasite causing cyclosporiasis
- 2013 multistate outbreak, 631 persons became ill (8% were hospitalized but none died)
 - **Salad mix and cilantro** from Mexico (cdc.gov)
- 2014 outbreak, 304 persons became ill and none died
 - **Fresh cilantro** from Mexico (cdc.gov)

To date, only gaseous ClO_2 was found to be effective against *C. cayatenensis* (Ortega et al. 2008)



Role of Microbiology

- Recent trends in food consumerism shows more people patronizing organic produce. With this major shift in agricultural production, **disinfection of raw produce using chemical methods was limited.**
- **Chlorine and other chlorine-derived compounds** that have long been used in raw produce disinfection are **banned/limited.** With such limitation, foodborne incidence rate may increase as water does not have a disinfecting capability.

Role of Microbiology

- Development of a sanitation protocol that could match the efficacy of chlorine-derived compounds
- **Aqueous ozone** proved to have equal disinfection capacity as hypochlorite solution when tested *in vivo* against *E. coli* (Oliveros, 2014)



Role of Microbiology

- **Screening natural compounds for antimicrobial properties**

➤ **Essential oil** of indigenous plants

(De Jesus and Oliveros, 2015)



TESTING BOTTLENECKS IN RAW PRODUCE

- **Hygienic standards vary from country to country**
 - **In Europe and North America, there are higher standards, thus, there should be closer monitoring to make a distinction between domestic and imported fresh produce (Hoofar and Feng, n.d.)**

TESTING BOTTLENECKS IN RAW PRODUCE

- Qualitative vs Quantitative testing
 - depending on the objective, qualitative data are sufficient for **product safety** and market release while quantitative data are useful for **risk assessment** (Hoofar and Feng, n.d.)

TESTING BOTTLENECKS IN RAW PRODUCE

- **Sampling plans**
 - **Attribute vs variable sampling**
 - **Attribute sampling tests against a single criterion, e.g. presence of *Salmonella***
 - **Variable sampling uses the full range of numerical data describing microbial loads e.g. all pathogenic foodborne microorganisms (Hoofar and Feng, n.d.)**

TESTING BOTTLENECKS IN RAW PRODUCE

- **Sampling preparations**
 - **Handling issues e.g. refrigeration after collection**
 - **Use of selective enrichment media for samples of known high microbial load**

DETECTION METHODS

- **PCR (Polymerase Chain Reaction)**
 - **A number of laboratories now employ PCR as the only screening method for produce samples**
 - **PCR inhibitory substances are known to exist in produce**
 - **May give false negative result (Hoofar and Feng, n.d.)**

DETECTION...

- **VBNC- Viable but non-culturable**
 - **May be detectable by PCR but may not actually become a threat as the pathogen may not grow or propagate to become infectious (Hoofar and Feng, n.d.)**

DETECTION

- **IMS-LAMP assay (Alvarez, 2015)**
 - **Immunomagnetic separation (IMS) will be coupled with loop-mediated isothermal DNA amplification (LAMP)**
 - **Antigen-antibody magnetic beads and custom designed primers will enhance the detection of targeted foodborne pathogen**



IMS and LAMP

IMS

- Nanobeads coated with Ab which trap the pathogen → lysed to obtain DNA
- Higher specificity than ELISA

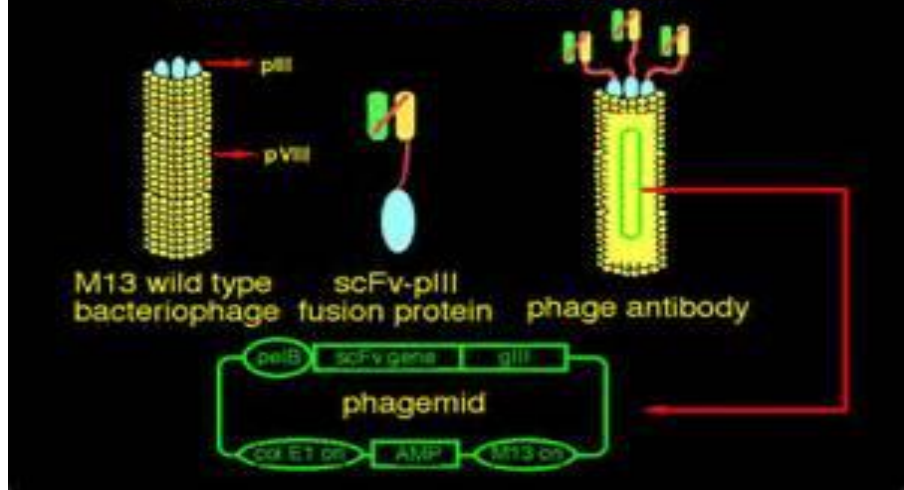
LAMP

- Amplification of a few copies of DNA to a billion copies in less than an hour under isothermal conditions
- A water bath can be used for amplification for the isothermal condition

OTHER RAPID METHODS FOR PATHOGEN DETECTION



PHAGE DISPLAY TECHNOLOGY



RA 10068

- **Organic Agriculture Act of 2010**
 - **This shall apply to the development and promotion of organic agriculture and shall include, but not limited to:**
 - **Policy formation**
 - **Research, development, and extension**
 - **Implementation of organic agriculture programs**

RA 10611



- **Food Safety Act of 2013**

- **20 Feb 2015, IRR was released**
- **To strengthen the food safety and regulatory system of the Philippines, to protect consumer health, and to facilitate market access of local food and food products and for other purpose**

Food Safety Act

- Rule 14a 1.3 Large and medium scale business engaged in manufacture of processed and preprocessed food shall designate a FSCO who is preferably a graduate of food-related courses including but not limited to food technology, food and nutrition, chemistry, microbiology, chemical/sanitary engineering, veterinary medicine, fisheries, and agriculture.

SUMMARY

- Delivery of safe foods can be achieved if all the stakeholders do their share:
 1. People engaged in food manufacturing applying hygienic and proper methods, e.g. HACCP
 2. The farmers who are the source of the raw materials seeing to it that their harvest are acceptable
 3. The government to pass and implement laws to safeguard consumers.
 4. The consumers themselves to be aware of the quality of the foods they are purchasing.