Preparation of Indonesia Banana Experiment at KIBO

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Japan Aerospace Exploration Agency (JAXA)
Background

- 2005: APRSAF (Asia Pacific Regional Space Agency Forum), Fukuoka, Japan, 2005 JAXA (Japan Aerospace Exploration Agency) offer little experiment (< 5 kg) at JEM ‘KIBO’
- LAPAN –ITB accepted the offer and proposed a research proposal
- 2007: Feasibility study at ITB
- 2008: Preliminary Experiment at JAXA
- 2009-2012: Ground based experiment
Fruit Ripening Process

S-adenosyl-L methionine (AdoMet) → 1-aminocyclopropane-1-carboxylic acid (ACC) → Ethilen

ACC Synthase
- Induced by: Ripening, IAA, wounding, Flower senescence, water stress, flooding

ACC Oxidase
- Induced by: Ripening, O₂
- Inhibited by: anaerob, CO₂

Altered ripening-related gene expression:
- Autocatalytic ethylene production
- Cell wall modification
- Volatile production
- Color development
- Carbohydrate metabolism

Taiz & Zeiger, 2002; Alexander & Grierson, 2002
Earth and Space Environment is Different

Elevated levels of ethylene or CO₂, reduced levels of available O₂, all contributed factors to metabolic stress in plants, are all common in closed environments such as those experienced in orbital vehicles.

Fig. 6. On Earth (1g, top), buoyancy-driven convective mixing causes boundary layers around plant organs to be smaller than in microgravity (bottom). At 1g, the boundary layers are thin enough so that metabolic processes like respiration and transpiration are rarely diffusion-limited.
Preliminary Study: Ground Based Experiment

• Research on the effect of space environment in ripening process has not been conducted.

• 3D clinostat, equipped with 2 rotation axes and closed chamber made from glass was made to mimic microgravity.
Preliminary Conclusion

• The physical and physiological analysis showed that banana shelf life was longer at microgravity simulation condition

• Molecular analysis also showed that Microgravity simulation using 3D clinostat can affect the ripening related gene expression.
Space Experiment Proposal

• Conduct fruit ripening process study in real microgravity condition.

• Observe Fruit ripening process using data record (physical and environment condition)

• Analyze returned sample for Transcriptomics and Metabolomics
Top 10 Banana Producing Country (2012)

- India
- China, mainland
- Philippines
- Ecuador
- Brazil
- Indonesia
- Angola
- Guatemala
- United Republic of Tanzania
- Mexico

(FAO Stat, 2012)

Diagram courtesy of the CRCTPP (Sue McKell).
Application for Fruit Industry

- Apply SOP (Standard Operation Procedure) of packaging for fruits supply chain without electricity in Indonesia
Alternatives technology for delay ripening
Team

- LAPAN (Lembaga Penerbangan & Antariksa Nasional)
- JAXA (Japan Aerospace Exploration Agency) → NASA
- ITB (Institut Teknologi Bandung)
- OSAKA University
Environment Effect on Fruit Ripening Related Gene to Develop a New Post Harvest Technology

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Abstract. Ripening process of fruits is a very complex process, which involves ethylene production, causing alteration on molecular and physiology level. Environmental stress caused by biotic and abiotic stress conditions (such as pathogens, mechanical stress, physical and physiology stress) can stimulate ethylene production. High levels of ethylene in turn can also inhibit growth, cause premature ripening and induce the onset of senescence, which then potentially reduce plant productivity. The ACC Synthase (ACS) and ACC Oxidase (ACO) genes are genes that have role in the ethylene production. By regulating these genes, especially ethylene biosynthesis genes, we might improve the quality of fruit at post harvest condition. Therefore, in this research we studied fruit ripening related genes expression on banana such as Musa family at different environment.

Effect of Microgravity Simulation using 3D Clinostat on Cavendish Banana (Musa acuminata AAA Group) ripening process

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Abstract. This research aimed to determine the effect of simulated microgravity by 3D clinostat on Cavendish banana (Musa acuminataAAA group) ripening process. It has been studied that microgravity conditions resulting in a change in the composition of O2 and CO2 as well as movement of heat and water vapor in the surface around the plant since air convection is limited. Ripening process in climatic chamber fruit such as banana are marked by rise in respiration and increasing of ethylene. Ethylene is an important hormone which has a role in fruit ripening process. Ethylene biosynthesis depends on two important enzymes, ACC oxidase and ACC synthase which are encoded by ACO gene and ACS gene family, respectively. The expression of these two gene families is regulated by various environmental factors, such O2 and CO2. In this study, we used ethylene treated bananas that have been placed in for different conditions for seven days: control-open chamber (placed outside, such as bananas in general), control-closed chamber (placed in a closed container), clinostat-open chamber (placed in clinostat without closed.
THANK YOU--ARIGATO