

The Application of International Standards related to Irradiation for Sanitary and Phytosanitary Purposes

Food Irradiation Activities in Thailand

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Introduction

Irradiated foodstuffs currently account for 60% of total value of throughput in the Thai Irradiation Center's facility due to the food products (eg. fermented pork sausages, fruits, spices and herbs) preferable for preservation by gamma radiation.

Thailand is located in the heart of Southeast Asia, the abundance of exotic fruits are all year around. Thailand has exported fresh fruit for many years and increased constantly, but the exported quantities are still a small proportion compared with the total production. Thus, the campaigns of Thai exotic fruits directed to foreign importers and consumers would be one of promoting to increase exportation. Mostly exportation of any fresh fruits around the world have been obstructed by Sanitary and Phytosanitary Measures (SPS) to protect their fruits from foreign pests such as fruit flies and the mango seed weevils into the import country especially for tropical fruits. Numerous methods have been offered to solve this trade barrier, such as vapor heat, cold and fumigation treatment. Chemical fumigation is the preferred and very common disinfestations method; however the use of the some chemical fumigants depleting ozone layer has faded out by 2005, according to Montreal Protocol. The common treatments often cause severe damage to the fruits, leading to substantial change of taste, color and numerous losses of vitamins and other nutrients. In addition, the treatments can only be used effectively on fruit harvested before there ripe and they can only be used on certain types of fruits. Then, the irradiation seems to be a potential alternative for the fumigation⁽⁵⁾. Irradiation offers a better alternative. It is safe for human consumption, will not alter the taste or the appearance of the fruits and it can apply to the more mature fruits than the others. In many Thai technical conferences, Thai scientists have compared the advantage of the irradiation to other methods. They have an agreement that irradiation is the most effective and efficient method to ensure that the quality of Thai fruits maintained at a very high level^(3, 4). Irradiation could be the best solution to satisfy consumers demand for tasty food with full nutritional value and no health hazard⁽¹²⁾. In 2007, Thailand successfully negotiated for market access for fresh fruits to USA by using Irradiation as a Phytosanitary Measure and in November 2007, the first shipment of fresh mango was irradiated by TIC and exported to USA by air freight. The trade barrier was demolished by the irradiation since then.

Besides, the irradiation is one of the solutions for Phytosanitary barrier, it also have been used for food safety aspect. The food safety has been considered as an important issue for human consumption since it leads to a basic good health to people. There are many techniques that have been utilized to demolish microorganism including pathogens (e.g. *Bacillus cereus*, *Staphylococcus aureus*, *E. coli*, *Salmonella* spp., Yeast and Molds). For example, pasteurization, hot air-dried, food additives and biological control have been extensively used for the purpose of microorganism reduction. Use of gamma irradiation source from Co-60 is another alternative method. Many gamma irradiation researches have been conducted in Thailand as a high technology technique for bacterial decontamination and pathogenic elimination in foods such as fermented pork sausages (Nham), sweet tamarind, white pepper, vegetable seasonings^(9, 10, 11).

As the commercial scale facility owned by the government, Thai Irradiation Center (TIC) have a role of study advantages and affects of gamma radiation compared to conventional techniques such as chemical preservation, dried heat etc. in many kind of fruits and food including studying the dose distribution typical known as dose mapping to obtain the best absorbed doses.

In Thailand, food irradiation is currently generally permitted by the Notification of the Ministry of Public Health (No. 297) B.E. 2549 (2006) on "Irradiated food". However; the acceptance of the food irradiation is not clear. The public resistance was occurred tremendously due to fears of radioactivity (radionuclides) from the accident of unauthorized disposal and breakage of radiotherapy heads of Co-60 source at Samutprakarn, Thailand, 2000 ⁽¹³⁾. At the present, TIC try to encourage the consumers that irradiation can reduce the risk from microbial and parasitic infection, such as the raw fermented pork sausages (Nham) in which Thai people like to consume. Two manufacturers of the pork sausages (Nham) have successfully sold irradiated Nham at many retail stores in Bangkok. Furthermore, one merchant has successfully exported irradiated dried banana to Mexico. Thus, the success of food irradiation on a commercial scale requires an education campaign not only how and why foods are normally treated before they launch to the market but also how and why irradiation will provide the consumers with wider choices and a safer food supply ⁽⁶⁾. According to TIC policy, TIC provide accurate information about safety, benefits, limitations, development of new product of food irradiation and market testing also retail sales of irradiated food and fruit Irradiation for domestic and international markets. The advances of the irradiation facility in Thailand was occurred in 2007 when two facilities (TIC and Isotron Co.,Ltd) in Thailand were approved by USDA, the United States to irradiate five fresh fruits (longan, mango, mangosteen, rambutan and pineapple) exported to USA and also certified by European Union (EU) to irradiate spices exported to EU.

However; Thailand still need to broaden the knowledge of occupational safety, analytical method to detect actual irradiated dose applied, potential for development of microorganisms resistant to irradiation, oxidation of fat-soluble compounds and fatty acids and development of rancidity in fatty food in irradiated food⁽¹⁾.

a) Current national legislation and applications of international standards relating to irradiation used for sanitary and phytosanitary purposes;

Facility in Thailand will be regulated and standardized on food irradiation from Ministry of Public Health by the Notification of the Ministry of Public Health (No. 297) B.E. 2549 (2006) on "Irradiated food" ⁽⁷⁾. The Ministry of Public Health hereby issues the notification as follows:

Clause 1 The Notification of the Ministry of Public Health (No. 103) B.E. 2529 (1986), Re: Prescribed production processes of irradiated food, date 18th November B.E. 2529 (1986) shall be repealed.

Clause 2 Irradiated food is prescribed food for production processes and labelling.

Clause 3 This notification:

"Irradiated food" means foods processed by ionizing radiation in order to achieve purpose of irradiation.

"Food irradiation" means processing of food by ionizing radiation to achieve purpose of the irradiation.

"Food radiation processor" means one who is granting approval for processing of food irradiation.

"Dosimetry" means the measurement of the absorbed dose of radiation after irradiation.

"Absorbed Dose" means the amount of energy absorbed per unit mass of irradiated food product having unit in Grey.

“Technological Purpose” means radiation of food for control of foodborne pathogens, extension of durable life, delaying of maturity, reduction of parasite level, inhibition of the germination during storage, destruction and control of insect infestation or others; in this respect an irradiation of food shall have minimum absorbed dose to achieve effective radiation processing of food products and maximum absorbed dose that are safe to consumer; in a manner that maintains nutrition value of food and does not destroy structure integrity, functional properties and sensory characteristics.

Clause 4 Processing of food irradiation shall be carried out in accordance with the Recommended International Code of Practice for Radiation Processing of Foods (CAC/RCP 19-1979, Rev.1-2003) and also principles, procedures and provisions shall be as followed;

- (1) The sources of ionizing radiation shall be as followed;
 - (a) Gamma rays from radionuclides Cobalt-60 (^{60}Co) or Cesium -137 (^{137}Cs);
or
 - (b) X-rays generated from machine sources operated at or below an energy level of 5 MeV; or
 - (c) Electrons generated from machine sources operated at or below an energy level of 10 MeV.
- (2) Absorbed Dose shall be in accordance with each purposes of irradiation; in this respect absorbed dose shall not exceed the level prescribed in the Table 1 with this Notification; this may be exempted if there is technical reason or necessity for approval from the Food and Drug Administration or as the Food and Drug Administration prescribed according to an approval of the Food Committee.
- (3) Control of process
 - (a) Radiation treatment of foods shall be carried out in facilities licensed for this purpose by the competent authority.
 - (b) The facilities shall be designed to meet the requirements of safety, efficacy and good hygienic practices of food processing.
 - (c) The facilities shall be adequately staffed by competent personnel trained in its application in radiation processing.
 - (d) Control of the process within the facility shall include the keeping of records concerning with radiation treatment of food and including quantitative dosimetry.
 - (e) Information as in (d) shall be clear and shall be kept at least for 3 years in appropriate environment to prevent from damage or deterioration.

Clause 5 Food intended for radiation process shall be prepared, processed and transported with good hygienic practice to achieve food safety purposes, raw materials and end product shall comply with applicable hygienic codes, food standards, and transportation codes.

Clause 6 Foods irradiated shall not be re-irradiated except for foods with low moisture content such as cereals, pulses, dehydrated foods and other such commodities, irradiated for the purpose of controlling insect reinfestation, with the cumulative maximum absorbed dose delivered to a food shall be as specified in clause 8.

Clause 7 Food is not considered as having been re-irradiated when:

- (1) Food is prepared from materials which have been irradiated at low dose levels e.g. quarantine control, prevention of sprouting of roots and tubers; and is irradiated for other purpose;
- (2) The food, containing less than 5% of irradiated ingredient, is irradiated;
- (3) The full dose of ionizing radiation required to achieve the desired effect is applied to the food in more than one increment as part of processing for a specific technological purpose.

Clause 8 Irradiated foods in clause 6 and clause 7 shall have cumulative maximum absorbed dose delivered to a food not exceed 10 kGy except when it is necessary to achieve a legitimate technological purpose, and shall not compromise consumer safety or wholesomeness

of the food; in this regard, if cumulative maximum absorbed dose exceeds 10 kGy must have an approval from the Food and Drug Administration.

Clause 9 Irradiation of food whether is beneficial for the protection of consumer health or not, it shall be complied with technological requirements and shall not be used as a substitute for good manufacturing practices or good agricultural practices.

Clause 10 Labelling of irradiated foods shall display the following additional details, other than follows to the Notification of Ministry of Public Health, Re: Label and Notification of Ministry of Public Health for each particular food (see in figure 2):

- (1) Name and location of head office of manufacturers and food radiation processor;
- (2) Display the words “irradiated” or other statements that convey the same meaning;
- (3) Specify the purpose of irradiation with the following clause “For.....” (specify the purpose of irradiation in the blank)
- (4) Display of irradiation symbol is optional, but when it is used, it shall be displayed as presented in Figure1, in close proximity to the name of the food.
- (5) Date, month and year of irradiation.

Clause 11 When an irradiated food is used as an ingredient in another food, this shall be expressed as in clause 10(2) in the list of ingredients.

Clause 12 In case there is only one irradiated raw material as an ingredient in the food, it shall be expressed as clause10(2) accompanied with the name of the food.

Clause 13 Packaging of irradiated foods shall be of suitable quality, acceptable hygienic condition and appropriate for this purpose and shall be in accordance with good manufacturing practices, before and after irradiation.

Clause 14 Producers or importers of irradiated foods, whose Labels do not follow clause 10 and having approval from the Food and Drug Administration prior this Notification come into force, shall amend the labelling to conform to this Notification within 1 year after this Notification come into force.

Clause 15 This notification shall come into force after 180 days as from the day following date of its publication in the Government Gazette.

Table 1 Absorbed Dose shall be in accordance with each purposes of irradiation.

	Objective	Maximum absorbed dose (kGy)
1.	Sprout inhibition	1
2.	Slow down ripening	2
3.	Disinfestation (control insect)	2
4.	Reduce parasite	4
5.	Prolong preservation period	7
6.	Reduce microorganisms and pathogenic microorganisms	10



Figure 1 Radura : Circle with green bold edges, the top part of the circle is separated in equal parts, with five equal spaces between them, the bottom part of the circle is bold edge throughout. Within the top part of the circle there is a green bold circle, and at the bottom part there are two oblong signs, with one end of the sign connect to the others, there is a green bold.

b) Phytosanitary / quarantine treatments applied;

Facility in Thailand will be standardized for plant quarantine on fresh fruit irradiation from National Plant Protection Organization (NPPO), Ministry of Agriculture Cooperatives by the Manual for Exporting of Fresh Fruits to the United States⁽⁸⁾, SOP of each facility that were approved from inspector of USDA, US and regulated by Ministry of Public Health by the Notification of the Ministry of Public Health (No. 297) B.E. 2549 (2006) on “Irradiated food”⁽⁷⁾.

A manual for exporting of fresh fruits to the United States⁽⁸⁾ would capture all essences and be of the most benefits for all stakeholders either public or private agencies through the exporting processes (such as farmers, GAP inspectors, treatment facility, exporters). Facility will follow by “**Guidelines for the use of irradiation as a phytosanitary measures**”⁽⁸⁾

Authority

The NPPO is responsible for the phytosanitary aspects evaluation, adoption and use of irradiation as a phytosanitary measure. To the extent necessary, it is the NPPO’s responsibility to cooperate with other national and international regulatory agencies concerned with the development, approval, safety and application of irradiation, or the distribution, use or consumption of irradiated products. Their respective responsibilities should be identified to avoid overlapping, conflicting, inconsistent or unjustified requirements.

Treatment Objective

The objective of using irradiation as a phytosanitary measure is to prevent the introduction or spread of regulated pests. This may be realized by achieving certain response in the targeted pest(s) such as:

- mortality ;
- preventing successful development (e.g. non-emergence of adults) ;
- inability to reproduce (e.g. sterility) ; or
- inactivation

Phytosanitary uses of irradiation also include the devitalization of plants (e.g. seeds may germinate but seedlings do not grow; or tubers, bulbs or cuttings do not sprout).

Efficacy

The required treatment efficacy should be specifically defined by the NPPO of the importing country. It consists of two distinct components:

- a precise description of required response;
- the statistical level of response required.

It is not sufficient to only specify a response without also describing how this is to be measured. The choice of a required response is based on the risk as assessed through PRA, considering in particular the biological factors leading to establishment and taking into account the principle of minimal impact. A response such as mortality may be appropriate where the treatment is for the vector of a pathogen, whereas sterility may be an appropriate response for pest(s) that are not vector and remain on or in the commodity. If the required response is mortality, time limits for the effect of the treatment should be established. A range of specific options may be specified where the required response is the inability of the pest to reproduce. These may include:

- limited fertility of only one sex;
- egg laying and/or hatching without further development;
- altered behaviour; and
- sterility of F1 generation

Treatment

Ionizing radiation may be provided by radioactive isotopes (gamma rays from cobalt-60 or cesium-137), electron generated from machine sources (up to 10 MeV) or by x-rays (up to 5 MeV) (limits set by Codex Alimentarius³). The unit of measurement for absorbed dose should be gray (Gy). Variables to consider when implementing treatments include the dose rate, treatment time, temperature, humidity, ventilation, and modified atmospheres; these should be compatible with treatment effectiveness. Modified atmospheres may reduce treatment efficacy at a prescribed dose. Treatment procedures should also ensure that the minimum absorbed dose (D_{min}) is fully attained throughout the commodity to provide the prescribed level of efficacy. Owing to the differences in the configuration of treatment lots, higher doses than the D_{min} may be required to ensure that the D_{min} is achieved throughout the configured consignment or lot.

The intended end use of the product should be considered when conducting irradiation treatments. Because mortality will rarely be technically justified as the required response, live target pests may be found. Therefore it is essential that the irradiation treatment ensures they are unable to reproduce. In addition, it is preferable that such pest(s) are unable to emerge or escape from the commodity unless they can be practically distinguished from non-irradiated pest(s).

Application

Irradiation can be applied:

- as an integral part of packing operations;
- to bulk unpackaged commodities (such as grain moving over a belt);
- at centralized locations such as the port of embarkation.

When safeguards are adequate and transit movement of the untreated commodity is operationally feasible, treatment may also be performed at:

- the point of entry;
- a designated location in a third country;
- a designated location within the country of final destination.

Treated commodities should be certified and released only after dosimetry measurements confirm that the D_{min} was met. Where appropriate, re-treatment of consignments may be allowed, provided that the maximum absorbed dose is within the limits allowed by the importing country.

The purpose of Annex 1 [to be completed] is to list the doses for specific approved treatments as part of this ISPM. Appendix 1, which is attached for information only, provides some published information on absorbed dose ranges for certain pest groups.

According to the pest risks to be addressed and the available options for pest risk management, irradiation can be used as a single treatment or combined with other treatments as

part of a systems approach to meet the level of efficacy required (see ISPM No.14: The use of integrated measures in a systems approach for pest risk management).

Dosimetry

Dosimetry ensures that the required D_{min} for a particular commodity was delivered to all parts of the consignment. The selection of the dosimetry system should be such that the dosimeter response covers the entire range of doses likely to be received by the product. In addition, the dosimetry system should be calibrated in accordance with international standards or appropriate national standards (e.g. Standard ISO/ASTM 51261 *Guide for Selection and Calibration of Dosimetry Systems for Radiation Processing*).

Dosimeters should be appropriate for the treatment conditions. Dosimeters should be evaluated for stability against the effects of variables such as light, temperature, humidity, storage time, and the type and timing of analyses required. Dosimetry should consider variations due to density and composition of the material treated, variations in shape and size, variations in orientation of the product, stacking, volume and packaging. Dose mapping of the product in each geometric packing configuration, arrangement and product density that will be used during routine treatments should be required by the NPPO prior to the approval of a facility for the treatment application. Only the configurations approved by the NPPO should be used for actual treatments.

Calibration of component of the dosimetry system

All components of the dosimetry system should be calibrated according to documented standard operating procedures. An independent organization recognized by the NPPO assesses performance of the dosimetry system.

Dose mapping

Dose mapping studies should be conducted to fully characterize the dose distribution within the irradiation chambers and commodity, and demonstrate that the treatment consistently meets the prescribed requirements under defined and controlled conditions. Dose mapping should be done in accordance with documented standard operating procedures. The information from the dose mapping studies is used in selection of locations for dosimeters during routine processing. Last process load is required to determine if the absorbed-dose distribution is significantly different from a routine load and to adjust the treatment accordingly.

Routine dosimetry

An accurate measurement of absorbed dose in a consignment is critical for determining and monitoring efficacy and is part of the verification process. The required number, location and frequency of these measurements should be prescribed based on the specific equipment, processes, commodities, relevant standards and phytosanitary requirements.

Approval of Facilities

Treatment facilities should be approved by relevant nuclear regulatory authorities where appropriate. Treatment facilities should also be subject to approval (qualification, certification or accreditation) by the NPPO in the country where the facility is located prior to applying phytosanitary treatments. Phytosanitary approval should be based on a common set of criteria plus those specific to the site and commodity programmes (see Annex 2).

Phytosanitary re-approval should be done on an appropriate regular basis. Documented dose mapping should be done following repairs, modifications or adjustments in equipment or processes that affect the absorbed dose.

Phytosanitary System Integrity

Confidence in the adequacy of an irradiation treatment is primarily based on assurance that the treatment is effective against the pest(s) of concern under specific treatment conditions and the has been properly applied and the commodity adequately safeguarded. The NPPO of the country where the facility is located is responsible for ensuring system integrity, so that treatments meet the phytosanitary requirements of the importing country.

Efficacy research and dosimetry provide assurance that only effective treatments are used. Well-designed and closely monitored systems for treatment delivery and safeguarding

assure that treatments are properly conducted and consignments protected from infestation, reinfestation or loss integrity.

Phytosanitary security measures at the treatment facility

Because it is not usually possible to visually distinguish irradiated from non-irradiated products, treated commodities should be adequately segregated, clearly identified, and handled under conditions that will safeguard against contamination and/or infestation, or misidentification. A secure means of moving the commodity from receiving areas to treatment.

Areas without misidentification or risk of cross-contamination and/or infestation are essential. Appropriate procedures specific to each facility and commodity treatment program should be agreed upon in advance. Commodities that are unpackaged or exposed in packaging require safeguarding immediately following treatment to ensure that they are not subject to infestation, reinfestation or contamination afterwards. Packaging prior to irradiation may be useful to prevent reinfestation if irradiation is done prior to export, or to prevent the accidental escape of target pest(s) if treatment is done at the destination.

Labelling

Packages should be labeled with treatment lot numbers and other identifying feature allowing the identification of treatment lots and trace-back (i.e. packing and treatment facility identification and location, dates of packing and treatment).

Verification

The adequacy of treatment facilities and processes should be verified through monitoring and audit of facility treatment records that include, as necessary, direct treatment oversight. Direct, continuous supervision of treatments should not be necessary provided treatment program are properly designed to ensure a high degree of system integrity for the facility, process and commodity in question. The level of oversight should be sufficient to detect and correct deficiencies promptly.

A compliance agreement should be concluded between the facility and the NPPO of the country where the facility is located. Such an agreement may include the following elements:

- approval of the facility by the NPPO of the country where the facility is located;
- the monitoring program as administered by the NPPO of the country where treatments are conducted;
- audit provisions including unannounced visits;
- free access to documentation and records of the treatment facility; and
- corrective action to be taken in cases of non-compliance.

Documentation by the Treatment Facility

The NPPO of the country where the facility is located is responsible for monitoring recordkeeping and documentation by the treatment facility and ensuring that records are available to concerned parties. As in the case of any phytosanitary treatment, trace-back capability is essential.

Documentation of procedures

Documented procedures help to ensure that commodities are consistently treated as required. Process controls and operational parameters are usually established to provide the operational details necessary for a specific authorization and/or facility. Calibration and quality control program should be documented by the facility operator. At a minimum, an agreed written procedure should address the following:

- consignment handling procedures before, during and after treatment;
- orientation and configuration of the commodity during treatment;
- critical process parameters and the means for their monitoring;
- dosimetry;
- contingency plans and corrective actions to be taken in the event of treatment failure or problems with critical treatment processes;
- procedures for handling rejected lots;

- labelling, recordkeeping, and documentation requirements.

Facility records and traceability

Packer and treatment facility operators should be required to keep records. These records should be available to the NPPO for review, e.g. when a traceback is necessary. Appropriate treatment records for phytosanitary purposes should be kept by the irradiation facility for at least one year to ensure traceability of treated lots. The facility operator should keep all records for every treatment. Dosimetry records should be kept by the treatment facility for at least one full year after treatment. In most cases, these records are required under other authorities, but these records should also be available to the NPPO for review. Other information that may be required to be recorded includes:

- identification of facility and responsible parties;
- identify of commodities treated;
- purpose of treatment;
- target regulated pest(s);
- packer, grower and identification of the place of production of the commodity;
- lot size, volume and identification, including number of articles or packages;
- identifying markings or characteristics;
- quantity in lot
- absorbed doses (target and measured);
- date of treatment;
- any absorbed deviation from treatment specification.

Inspection and Phytosanitary Certification by the NPPO

Export inspection

Inspection to ensure the consignment meets the phytosanitary requirements of the importing country should include:

- documentation verification; and
- examination for non-target pests.

Documentation is checked for completeness and accuracy as the basis for certifying the treatment. Inspection is done to detect any non-target pests. This inspection may be done before or after the treatment. Where non target tests are found, the NPPO should verify whether these are regulated by the importing country. Live target pests may be found after treatment but should not result in the certification being refused except when mortality is the required response. Where mortality is required, live target pests may be found during the period immediately following the treatment application depending on the specification for efficacy (see section 2.1). If live pests are found, certification could be based on audit checks which confirm that mortality will be attained. When mortality is not the required response, it is more likely that live target pests may persist in the treated consignment. This should also not result in the certification being refused. Audit checks, including laboratory analyses, may be undertaken to ensure that the required response is achieved. Such checks may be part of the normal verification program.

Phytosanitary certification

Certification in accordance with the IPPC validates the successful completion of treatment when required by the importing country. The Phytosanitary Certificate or its associated documentation should at least specifically identify the treated lot(s), date of treatment, the target minimum dose and the verified Dmin. The NPPO may issue Phytosanitary Certificates based on treatment information provided to it by an entity approved by the NPPO. It should be recognized that the Phytosanitary Certificate may require other information supplied to verify that additional phytosanitary requirements have also been met (see ISPM No.7: Phytosanitary Certificates).

Import inspection

When mortality is not the required response, the detection of live stages of target pests in import inspection should not be considered to represent treatment failure resulting in

non-compliance unless evidence exists to indicate that the integrity of the treatment system was inadequate. Laboratory or other analyses may be performed on surviving target(s) to verify treatment efficacy. Such analyses should only be required infrequently as part of monitoring unless there is evidence to indicate problems in the treatment process. Where mortality is the required response, this may be confirmed. Where mortality is required, live target pests may be found when transport times are short, but should not normally result in the consignment being refused, unless the established mortality time has been exceeded. The detection of pests other than target pest(s) on import should be assessed for the risk posed and appropriate measures taken, considering in particular the effect the treatment may have had on the non-target(s). The consignment may be detained and any other appropriate action may be taken by the NPPO of the importing country. NPPO should clearly identify the contingency action to be taken if live pests are found:

- target pests-no action to be taken unless the required response was not achieved;
- non-target regulated pests:
 - no action if the treatment is believed to have been effective;
 - action if there is insufficient data on efficacy or the treatment is not known to be effective;
- non-target non-regulated pests-no action, or emergency action for new pests.

In case of non-compliance or emergency action, the NPPO of the importing country should notify the NPPO of the exporting country as soon as possible (see ISPM No.13: *Guidelines for the notification of non-compliance and emergency action*).

Verification methods for treatment efficacy in export and import inspection

Verification methods, including laboratory tests or analysis to determine if the required response has been achieved should be described by the exporting country at the request of the importing country.

Administration and documentation by the NPPO

The NPPO should have the ability and resources to evaluate, monitor, and authorize irradiation undertaken for phytosanitary purposes. Policies, procedures and requirements developed for irradiation should be consistent with those associated with other phytosanitary measures, except where the use of irradiation requires a different approach because of unique circumstances.

The monitoring, certification, accreditation and approval of facilities for phytosanitary treatment is normally undertaken by the NPPO where the facility is located, but by cooperative agreement may be undertaken by:

- the NPPO of the importing country;
- the NPPO of the exporting country; or
- other national authorities.

Memoranda of Understanding (MOUs), compliance agreements, or similar documented agreements between the NPPO and the treatment applicator/facility should be used to specify process requirements and to assure that responsibilities, liabilities and the consequences of non-compliance are clearly understood. Such documents also strengthen the enforcement capability of the NPPO if corrective action may be necessary. The NPPO of the importing country may establish cooperative approval and audit procedures with the NPPO of the exporting country to verify requirements.

All NPPO procedures should be appropriately documented and records, including those of monitoring inspections made and Phytosanitary Certificates issued, should be maintained for at least one year. In cases of non-compliance or new or unexpected phytosanitary situations, documentation should be made available as described in ISPM No.13: *Guidelines for the notification of non-compliance and emergency action*

Irradiated fresh fruits (longan, mango, mangosteen, rambutan and pineapple) were exported to the United States from November 1, 2007 to present.

c) Sanitary treatments applied;

Facility in Thailand has adequate systems in place to ensure that irradiated and non-irradiated products are identifiable including: physical separate of product, color indicator to identify product, labelling for each product and product release procedures which follow verification of all process data and the dosimetry certificate.

In summary, irradiation processes in TIC are as follows:

- In coming products are placed in unprocessed product storage areas where they are documented and staged.
- Product is loaded into irradiator carriers.
- Total time of exposure to the Co-60 source for gamma irradiation is established, by quantity of Co-60 installed, the radiation dosage required and the product density.
- The entire sterilization process is rigorously monitored by quality control professionals, to insure that it complies with all current Good Manufacturing Practice (GMP).
- Following irradiation, the carriers move the product through an exit maze conveyer system into a processed storage conveyer area.
- Product is documented with “certificate of irradiation” and prepared for shipment. At this point, product can be released to the market place without further testing.

The labelling information for food which facility provides to customers concerning the dose which foodstuffs have received, see in Figure 2 and follow by The Notification of the Ministry of Public Health No. 297 (B.E. 2549) on “Irradiated food”: labelling (Figure 2)



Figure 2 Labelling information for food which facility provides to customers concerning the dose which foodstuffs have received

The labelling information for food included:

- The nature and quantity of product irradiated.
- Irradiated date
- Irradiated by
- The objective of the treated product
- The number of FDA, Thailand
- Net weight
- Radura for the irradiated product (international food irradiation symbol)

The labelling information for certifying product irradiation which facility provides to customers concerning the dose which foodstuffs and non-foodstuffs have received, see in Figure 3.



Figure 3 Labelling information for certifying product irradiation which facility provides to customers concerning the dose which foodstuffs and non-foodstuffs have received

The labelling information included:

- Irradiated date
- Job number
- Minimum dose required (kGy or Gy)
- Irradiated by TIC and radura

The record for certification of irradiation and dosimeter included:

- The nature and quantity of product irradiated
- The batch number
- The person ordering the irradiation treatment
- The objective of the treated product
- The date of irradiation
- The packaging materials used during treatment (size, weight)
- The data for control of the irradiation process
- The dosimetry checks carried out and results obtained

Current status of irradiated food product development in Thailand

Many kind of processed food will be developed as to be irradiated food such as rice, dried chili, dried paprika, seasoning pork, fried crispy pork, fermented pork sausage, pork sausage, fermented fish, fermented shrimp, shrimp paste, salted crab, dried banana, banana sheet, banana candy, mango cake, dried mango dusted with sugar, sweet tamarind, sour tamarind, preserved tamarind in syrup, tamarind dusted with crystal sugar, sweet fired fish with herb, sweet fired squid, crispy seafish, sweet fired fish, salty bread stick, crispy banana, and dried longan.

d) Future legislation planned and/or needs identified for irradiation for food safety and quarantine purposes.

Ministry of public health will reach out the new notification for food irradiation process and preservation of irradiated food.

Ministry of Agriculture Cooperative and Ministry of Science and Technology will research and develop for new fruit irradiation for exportation to US and other country.

Summary

Based on radiation policy in Thailand, the application of radiation will be the beneficial technology of Thailand in preparing safe fruit and food for human consumption. This radiation technology rapidly grows, and will be widely used as the current sterilization, food irradiation of animal and plant origin, processed foods, spices and herbs. Recently, fruit irradiation as a

quarantine treatment overcome to trade barriers. Food irradiation (such as preserved and processed food) with combination method to improve the hygienic quality are perceived. Irradiation Technology, which can give products shelf life stability, will be of great benefit for economic and safety for health significantly. It will boost the demand for and enhance the distribution of such product in Thailand and will also facilitate the exportation ⁽²⁾.

Acknowledgment

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