TOTAL QUALITY MANAGEMENT IN TEA
Through
Quality, Safety & Risk Management: An HACCP Perspective

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Abstract

Total Quality Management in Tea through application of the principals of quality, safety and risk management are essential for competitiveness in case of both the small and large growers, in this era of WTO regime. At this juncture, when tea prices are globally depressed, it is particularly important to understand the application of the principles of HACCP perspective in plantation sector, which is discussed in this conceptual paper, with special application for tea producers
Keywords: TQM; HACCP; Hazard analysis, Critical control; Tea manufacture; quality-safety-risk

The Concept

HACCP is an abbreviation for Hazard Analysis Critical Control Point. It is the most effective management system of maximizing product safety and cost effective system. It targets system to critical areas of processing and reducing the risk of manufacturing and selling unsafe products. Critical control points are the steps in manufacture where control is essential to guarantee that potential hazards do not become manifest as actual hazards. A CCP is a location, a practice, a procedure or a process, which, if not controlled, could result in an unacceptable safety risk in agri-commodity trade. This paper recounts and elaborates the principles of HACCP and its application in tea sector as well as future R&D needs to prevent the occurrence of identifiable food borne biological, chemical and physical hazards.

Introduction

The unholy connection between an unsanitary, pest-infested environment and ill health amongst the masses has been recognized since very early ages. Sanitary practices now form an integral part of production process in the agri-food industry "(Roday, 1999)". Major changes in the fields of agri-commodity in recent years, including technological acceleration in food production, economic and market development, have brought to the fore a variety of issues which are relevant to food quality, safety and risk management. But the elimination of pests by use of pesticides requires an extreme caution and the producer should not go over-board in this quest.

For this reason, the landmark publication *"Silent Spring"* by Carson was a timely warning to those who ignored the impact of scientific developments on quality, safety and risk (QSR) with respect to environment and human health. For these very concerns, the FAO has recognized the international food security as a priority area of focus. With first technological developments, "Our capacity to produce food has grown in recent years. [But] our capacity to ensure that it is safe has sometimes lagged behind," says the FAO consumer protection expert Ezzedine Boutrif. In the era of

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WTO, "This damages trade as well as health." For example, failure to meet aflatoxin regulations for groundnut products cost African countries, US$250 million in lost trade a year. Concerns about cholera in fish cost Peru US$700 million in 1991. Sweden's National Food Administration (SNFA), 2002, stated the acrylamide "probable human carcinogen" is formed during heating of starch-rich food to high temperatures. It causes DNA damage and at high doses neurological and reproductive effects have been observed (please see: www.slv.se).

According to FAO Press release on Evaluation of Codex Alimantarius (2002), in both developed & developing countries, the number and variety of food safety threats are on the increase. If the key players in every country work together, they can prevent much of these unfortunate happenings. To cite a three decade old case, timely withdrawal of a recommended use of an arsenical (herbicide) prevented the possible damage to the export of Indian tea as a wholesome product. Similarly in a recent case, the timely preventive action scotched a rumored use of blood additive to tea, which could have been disastrous to tea trade. However, now greater support is available to individual efforts, which could be more vulnerable. Since 1963, FAO and WHO have jointly administered the Codex Alimentarius Commission, which sets and updates standards on a wide range of food issues. These include microbial contamination, natural and environmental toxins, acceptable levels of pesticide residues, veterinary drugs, their labeling and much more.

History & Development of HACCP

The HACCP system for managing food safety concerns grew from two major developments. The first breakthrough was associated with W.E.Deming, whose theories of quality management are widely regarded as a major factor in turning around the quality of Japanese products in the 1950s. Dr. Deming and others developed total quality management (TQM) systems, which emphasized a total systems approach to manufacturing that could improve the quality while lowering the costs "(Dhanakumar, 1999)".

The second major breakthrough was the development of the HACCP concept itself. The HACCP concept was pioneered in the 1960s by the Pillsbury Company, the United States Army and the United States National Aeronautics and Space Administration (NASA) as a collaborative development for the production of safe foods for the United States space programme. NASA wanted a "zero defects" programme to guarantee the safety of the foods that astronauts would consume in space. Pillsbury therefore introduced and adopted HACCP as the system that could provide the greatest safety while reducing dependence on end-product inspection and testing.

More recently, numerous groups, including for example the International Commission on Microbiological Specifications for Foods (ICMSF) and the International Association of Milk, Food and Environmental Sanitarians (IAMFES), have recommended the broad application of HACCP to food safety.

The application of the HACCP system is compatible with the implementation of TQM systems such as the ISO 9000 series. However, HACCP is the system of choice in the management of food safety within such systems.

Many countries now require competitiveness on food safety & risk management through Hazard Analysis Critical Control Point, or HACCP. In this system, instead of relying solely on inspection of foodstuffs before delivery, the producer works out

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exactly where problems might occur and introduces measures to prevent them. For tea, this should be done with the help of the experts in tea research bodies within international parameters. It will make the product competitive in terms of quality and cost in the global market. The International organizations like the FAO have made some provision for technical assistance in food safety. The Codex Alimentarius Commission has produced guidelines and training materials for the application of the HACCP system. The CFC & FAO have set up a Trust Fund to help the developing countries to improve their food safety "(Boutrif, 2001)".

THE CONCEPT OF QSR IN THE CONTEXT OF TEA COMMODITY

Food quality, food safety and related risk in business management are a vast subject area. To understand and analyse it fully would require a discussion of the complete chain of steps in tea production, through primary agriculture, primary, secondary and tertiary processing, packaging, storage and, finally, consumption. Production, processing and marketing (PPM) play an increasingly important part in our experience of QSR. In many ways the story of tea industry is one of the great progress and success. However, the industry is partly a victim of its own success: the consumer has come to expect and demand quality and value to improve constantly and at the same time is increasingly intolerant of the failures in either in safety (or) quality.

This paper sets out to identify those areas that require further managerial and R&D endeavor to make safer tea commodity of premium quality and price. Therefore, the industry must continue to harness good management of science & technology to continue the journey towards zero defect products which command still greater value, safety and quality in global trade to minimize risk.

ISSUES RELATED TO QSR IN THE TEA SECTOR

QSR is not limited to agri-microbiological safety. It also includes a discussion of the organoleptic quality, food-borne infection, pesticide-residues and undesirable physical contaminants.

Organoleptic quality has proper proportion of TF/TR polyphenols components as well as does the tea cup-quality taste good. Tea safety risk analysis is an emerging discipline, and the methodological basis for assessing and managing QSR in tea is still in developing phase. It is important to recognize the difference between *"hazard"* & *"risk"*. Hazard may be a biological, chemical or physical contaminant or condition of food, which has the potential to cause harm. Risk is an estimate of the probability and severity of the adverse health effects in populations, which are exposed, to hazards in consumable food. Understanding the association between a reductions in hazards, associated with tea and the reduction in the risk to consumers of adverse health effects, is of particular importance in development of appropriate QSR in tea.

For example, as an HACCP expert while assessing the design of a tea-processing unit it is important to ask if it is possible to manufacture tea safely. Equipment should be designed to minimise any cross-contamination risk. Alternatively, we need to assess if equipment has any dead areas, is difficult to clean (or) microbiological build-up area at the time of design.

Where a product is being made by fermentation, it is important to understand the possibilities of microbiological hazards growth in a layout. In case of tea "drum oxidation", equipment is not designed with necessary outlet for drainage of cleaned

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water everyday (or) capable of being disassembled freely to allow for cleaning & disinfection. In order to overcome these barriers, QSR approach facilitate to evolve HACCP team & R&D scientists an idea to enhance the credibility and effectiveness of the food safety measures. Accordingly, an individual is allocated the position of scribe to ensure that all ideas are recorded and a time limit is set to keep the operations on.

HAZARD ANALYSIS AND CRITICAL CONTROL POINT (haccp) SYSTEM AND GUIDELINES FOR ITS APPLICATION

The HACCP system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments.

HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. As well as enhancing food safety, implementation of HACCP can provide other significant benefits. In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

The successful application of HACCP requires the full commitment and involvement of management and the work force. It also requires a multidisciplinary approach; this multidisciplinary approach should include, when appropriate, expertise in agronomy, production, microbiology, quality management, extension education, food technology and engineering. The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series, and is the system of choice in the management of food safety within such systems.

PRINCIPLES OF THE HACCP SYSTEM

The HACCP system consists of the following seven principles, which outline how to establish, implement and maintain a HACCP plan for the operation in tea sector.

Principle 1

Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventative measures.

Principle 2

Determine the Critical Control Points (CCPs) in the process.

Principle 3

Establish Critical Limit(s) for preventative measures associated with each identified CCP.

Principle 4

Establish CCP monitoring requirements. Establish procedures from the results of monitoring to adjust the process and maintain control.

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Principle 5

Establish corrective actions to be taken when monitoring indicates a deviation from an established critical limit.

Principle 6

Establish procedures for verification to confirm that the HACCP system is working effectively.

Principle 7

Establish documentation concerning all procedures and records appropriate to these principles and their application.

GUIDELINES FOR THE APPLICATION OF THE HACCP SYSTEM

Prior to application of HACCP to tea sector, the sector should be operating according to the Codex General Principles of Food Hygiene, the appropriate Codex Codes of Practice, and appropriate food safety legislation. Management commitment on good manufacturing practices (GMP) and good hygiene practices (GHP) are necessary for implementation of an effective HACCP system. During hazard identification, evaluation, and subsequent operations in designing and applying HACCP systems, consideration must be given to the impact of raw materials, ingredients, food manufacturing practices, role of manufacturing processes to control hazards, likely end-use of the product, categories of consumers of concern, and epidemiological evidence relative to food safety. The intent of the HACCP system is to focus control at CCPs. Redesign of the operation should be considered if a hazard which must be controlled is identified but no CCPs are found.

Application

The application of HACCP principles consists of the following tasks as identified in the Logic Sequence for Application of HACCP (Diagram 1) as per the guidelines of FAO-CAC/RCP 1-1969, Rev 3:97 & 99. The relevant modification has been made to suite tea sector.

1. Assemble HACCP team

The food operation should assure that the appropriate product specific knowledge and expertise is available for the development of an effective HACCP plan. Optimally, this may be accomplished by assembling a multidisciplinary team. Where such expertise is not available on site, expert advice should be obtained from other sources. The scope of the HACCP plan should be identified. The scope should describe which segment of the food chain is involved and the general classes of hazards to be addressed (e.g. does it cover all classes of hazards from plucking to packeting or only selected classes).

2. Describe product

A full description of the product should be drawn up, including relevant safety information such as: composition, physical/chemical structure (including A_w, pH, etc.), microcidal/static treatments (heat-treatment, oxidation, residue, etc.), packaging, durability and storage conditions and method of distribution.

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3.   Identify intended use

The intended use of tea should be based on the expected uses of the product by the end user or consumer. In specific cases, vulnerable groups of the population (e.g., youth, elders, sick person) may have to be considered.

4.   Construct flow diagram

The flow diagram on tea processing should be constructed by the HACCP team. The flow diagram should cover all steps and sufficient technical details in the operation. When applying HACCP to a given operation, consideration should be given to steps preceding and following the specified operation. A model flow diagram on tea is illustrated in Diagram 2.

5.   *On-site confirmation of flow diagram*

The HACCP team should confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate. It is also necessary to confirm the assumptions made with respect to the management of product and employees on the premises.

6.   *List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards (SEE PRINCIPLE 1)*

The HACCP team should list all of the hazards that may be reasonably expected to occur at each step from primary production, processing, manufacture, and distribution until the point of consumption. The HACCP team should next conduct a hazard analysis to identify for the HACCP plan, which hazards are of such a nature that their elimination or reduction to acceptable levels is essential to the production of a safe food.

In conducting the hazard analysis, wherever possible the following should be included:

- the likely occurrence of hazards and severity of their adverse health effects;
- the qualitative and/or quantitative evaluation of the presence of hazards;
- survival or multiplication of micro-organisms of concern;
- production or persistence in foods of toxins (biological, chemical or physical agents); and,
- conditions leading to the above.

The HACCP team must then consider what control measures, if any, exist which can be applied for each hazard. More than one control measure may be required to control a specific hazard(s) and more than one hazard may be controlled by a specified control measure.

7.   DETERMINE Critical Control Points
(SEE PRINCIPLE 2)

There may be more than one CCP at which control is applied to address the same hazard. The determination of a CCP in the HACCP system can be facilitated by the application of a decision tree (e.g. Diagram 3), which indicates a logic reasoning approach. Application of a decision tree should be flexible, given whether the

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operation is for production, processing, storage, distribution or other. It should be used for guidance when determining CCPs. Training in the application of the decision tree is recommended to R&D Scientists and Managers in tea sector.

If a hazard has been identified at a step where control is necessary for safety, and no control measure exists at that step, or any other, then the product or process should be modified at that step, or at any earlier or later stage, to include a control measure. *Table No. 1* illustrates the examples of CCP & CL related to tea.

8. Establish critical limits for each CCP
(SEE PRINCIPLE 3)

Critical limits must be specified and validated if possible for each Critical Control Point. In some cases more than one critical limit will be elaborated at a particular step. Criteria often used include measurements of temperature, time, moisture level, pH, A_w, R^h and sensory parameters such as visual appearance and texture. Possible sources of information on CL may be obtained from published data, expert, experiential data, mathematical modelling, etc

9. ***Establish a monitoring system for each CCP***
(SEE PRINCIPLE 4)

Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP. Further, monitoring should ideally provide this information in time to make adjustments to ensure control of the process to prevent violating the critical limits. Where possible, process adjustments should be made when monitoring results indicate a trend towards loss of control at a CCP. The adjustments should be taken before a deviation occurs. Data derived from monitoring must be evaluated by a designated person with knowledge and authority to carry out corrective actions when indicated. If monitoring is not continuous, then the amount or frequency of monitoring must be sufficient to guarantee the CCP is in control. Most monitoring procedures for CCPs will need to be done rapidly because they relate to on-line processes and there will not be time for lengthy analytical testing. Physical and chemical measurements are often preferred to microbiological testing because they may be done rapidly and can often indicate the microbiological control of the product. All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official(s) of the company.

10. ***Establish corrective actions***
(SEE PRINCIPLE 5)

Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the affected product. Deviation and product disposition procedures must be documented in the HACCP record keeping. Please refer the Diagram 3 for details on corrective action.

11. ***Establish verification procedures***
(SEE PRINCIPLE 6)

Establish procedures for verification. Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working correctly. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. Examples of verification

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activities include:

- Review of the HACCP system and its records;
- Review of deviations and product dispositions;
- Confirmation that CCPs are kept under control.

Where possible, validation activities should include actions to confirm the efficacy of all elements of the HACCP plan.

12. *Establish Documentation and Record Keeping*
(SEE PRINCIPLE 7)

Efficient and accurate record keeping is essential to the application of a HACCP system. HACCP procedures should be documented. Documentation and record keeping should be appropriate to the nature and size of the operation. An example of a HACCP worksheet is attached as Diagram 4.

Documentation examples are:
- Hazard analysis;
- CCP determination;
- Critical limit determination.

Record examples are:
- CCP monitoring activities;
- Deviations and associated corrective actions;
- Modifications to the HACCP system.

Conclusion

The Codex General Principles of Food Hygiene lay a firm foundation for ensuring food hygiene. They follow the food chain from primary production through to the final consumer, highlighting the key hygiene controls at each stage, and recommend an HACCP-based approach based on article 3.1 of SPS. The application of the General Principles of Food Hygiene and of good manufacturing practices (GMPs) allows the producer to operate within environmental conditions favourable to the production of safe food.

In implementing an HACCP system in tea sector, the first step is to review existing programmes for compliance with the General Principles of Food Hygiene and GMPs and to verify whether all the necessary controls and documentation (e.g., programme description, individual responsible and monitoring records) are in place. The importance of these programmes cannot be overstated, as they are the foundation of the implementation of the HACCP plan. Inadequate programmes may lead to additional critical control points that would have to be identified, monitored and maintained under the HACCP plan. In summary, adherence to the General Principles of Food Hygiene and GMPs will simplify the implementation of HACCP plans and will ensure that the integrity of HACCP plans is maintained and that the manufactured product is safe within the framework of QSR. It is appropriate to start with rigorous requirements for "Tea Safety Evaluation (TSE)" and then to relax the specifications in the light of experience, rather than having to tighten regulations once evidence of damage to human health and price fall has occurred.

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INTERRELATIONSHIP BETWEEN THE HACCP AND ISO 9001:2000 SYSTEMS

ISO 9001 focuses on customers' needs and expectations. one of the most important customer expectations (and often one which is implicit rather that stated directly) is to have safe food products. ISO 9001 allows an organisation to integrate its quality management system with the implementation of food safety systems such as HACCP. the internationally recognised principles and steps of HACCP are defined by the codex alimentarius commission in its recommended international code of practice on general principles of food hygiene. any other accepted food safety system can, of course, also be integrated into the quality management system. however, considering the fact that HACCP is widely used comprehensively, this system was chosen to demonstrate how integration may be achieved.

the application of HACCP within the ISO 9001 quality management system can result an food safety system that is more effective than the application of either ISO 9001 or HACCP alone, leading to enhanced customer satisfaction and improved organizational effectiveness. as an example, the application HACCP for the identification of hazards and control of risks is related to quality planning and preventive actions required by ISO 9001. once the critical points have been identified, the principles of ISO 9001 can be used for control and monitoring. procedures for conducting an HACCP study can easily be documented within the quality system (ISO/fdis-15161:2001).

The Food Hygiene Basic Texts of Codex Alimentarius States that: "The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9001 series, and is the system of choice in the management of food safety within such systems." It also states: "Prior to the application of HACCP to any sector of the food chain, that sector should be operating according Codex General Principles of Food Hygiene, the appropriate Codex Codes of Practice and appropriate food safety legislation." Good Hygiene Practice (GHP) and Good Manufacturing Practice (GMP) are useful procedures and can provide a basis for systems such as ISO 9001 and HACCP. Figure 1 shows the main relationships between ISO 9001 and the seven principles of HACCP. The clauses shown in figure either particularly support the HACCP principles or the output from the HACCP study can be aligned and managed by with clause of ISO 9001:2000.

HAZOP for HACCP

Hazard & Operability (HAZOP) analysis is recognized as one of the most powerful computer tools for identifying potentially hazardous scenarios and for developing a course of action to minimize the risks. It may also be used to enhance process efficiency. The HAZOP method (short for Hazard and Operability) was firstly introduced by engineers from ICI Chemicals in UK, in midst 70s.

The method entails the investigation of deviations from the design intention for a process facility by a team of individuals with expertise in different areas such as engineering, operations, maintenance, safety and chemistry. The team is guided in a structured brainstorming process, by a leader who provides structure by using a set of guidewords to examine deviations from normal process conditions at various key points (nodes) throughout the process. The guidewords are applied to the relevant process parameters, e.g., flow, temperature, pressure, composition-in order to identify

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the causes and consequences of deviations in these parameters from their intended values.

Although the HAZOP method is still the new to many tea companies, it is rapidly becoming the preferred hazard analysis technique. It has been proven that HAZOP, if carried out by experienced personnel, results in the most comprehensive evaluation of a plant's safety and operability. Computational aids are available to enhance the quality of both the HAZOP study and its reporting. Widely used is the package HAZOP-PC, developed by Prima Tech Inc., USA.

Implications

HACCP is now widely embrace by the agri-commodity sector and by government regulatory bodies because it has proven to be a cost effective means to prevent the occurrence of identifiable food borne hazards. The available publications (or) training programmes on HACCP as per the norms of FAO:WHO-Codex General Principles of Food Hygiene are quite inadequate in this regard within TQM dimensions, for a particular sector. A model training-cum-workshop was conducted to Coffee Board Scientists, extension officials and for planters/traders as a Trainers Training Programme with the experts from FAO-Rome, CFC, Amsterdam, Coffee Board and IIPM to provide assurance of Coffee Safety at an international level.

It is recommended that the government agencies, planters and traders of tea sector to plan and design a QSR based HACCP programme in the following phases:

Phase : I	*QSR HACCP workshop to the scientists to validate and design CCP & CL regulatory requirements for tea sector.*
Phase : II	*Corporate Executive & Traders HACCP programme on cost effectiveness as well as risk management techniques.*
Phase : III	*Grassroots HACCP and its application at the estate level*
Phase : IV	*Certification of HACCP by the reputed agencies.*

Quest of "QES" to tea quality in totality is an essential tool for a search of competitive advantage in liberalized era. In this context, the FAO has prepared training-cum-workshop modules on the application of the HACCP system to lead a harmonized food safety approach for agri-commodity sector.

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Table No. 1 : Examples of CCP and CL related to HACCP for Tea Sector

Sl. No.	Field & Process Operations	Critical Control Point (CCP)	Critical Limit (CL)	Remarks
1.	A. Chemical Hazards a. **Residual Effect of Dicofol**	**Stage of plucking to avoid residual effect on tea leaves**	Pluck after 7 days of spraying	• **Maximum residue level (MRL)-5ppm** • **Persistence of chemical residue of dicofol above 5 ppm presence upto 7th day "(Singh and Agnihothri, 1984)"**
	b. Ethion	"	**Pluck after 10 days of spraying**	• **Maximum residue level (MRL)-2mg/kg "(Muraleedharan et. al, 2001)"**
	c. Quinalphos	"	**Pluck after 4 days of spraying**	• **Maximum residue level (MRL)-0.1mg/kg "(Muraleedharan et. al, 2001)"**
	d. Chlorophyripos	"	**Pluck after 12 days of spraying**	"
2.	B. Biological Hazards Hygiene and Sanitation of Oxidation Unit	High pressure boiling water jet cleaning of oxidation floor/drum with alkaline free soft water to prevent microbial growth	**Water - pH 6.8 to 7** Iron content - <2ppm	• **Tea juice adhering to fermentation unit becomes a source of contamination, which influence the risk related to safety of tea. "(Dev Choudhury, 1993)"**

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Sl. No.	Field & Process Operations	Critical Control Point (CCP)	Critical Limit (CL)	Remarks
3.	**Storing and Packaging**	**Maintaining appropriate moisture level to avoid microbial contamination at the time of storage & transportation**	• **Moisture content - < 3 percent** • **To avoid O_2, N & moisture in tea packet, use polyethylene Tetrephthalate film such as BA, LLBPE, BOPP etc.**	• **Moisture content above 7 percent leads to microbial growth and become unfit for consumption. For e.g., water activity level (A_W) of 0.61 in tea (i.e.,) 11% of moisture content enables E.coli to grow. "(Pepper Marketing Board, 1999)"** • **The equilibrium moisture content of tea at a RH of 10% is about 4g/100g. It rises to about 16gm/100gm if tea is left exposed at 90% RH. "(Mitra, 1999)"**
4.	Optimum Oxidation	Appropriate period (or) duration of oxidation to prevent microbial growth	(a). Orthodox - 3 to 4 hours (South) 3.10 hrs in April, 2.10 hrs in June, 2 hrs in July/May (Assam) (b). CTC - 60 to 90 minutes (South) 1.4 hrs in April, 1.10 hrs n July, August, 1.20 hrs in November (N. India)	• Prolonged oxidation induce bacterial growth "(UPASI-KVK factory manual, 2000, Arunachalam, 1995 & Dev Choudhury, 1993)"
5.	Withering	Removal of excessive surface moisture of leaves to prevent microbial growth	Warm air with hygrometric difference of 8 to 10^0F for 1-2 hours	• Avoid bacterial growth dull infusion and soft liquor "(CTC tea manufacture, UPASI, 2000)"

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Sl. No.	Field & Process Operations	Critical Control Point (CCP)	Critical Limit (CL)	Remarks
6.	CTC Processing Unit	Accumulation of crushed leaves in CTC roller after cleaning	Cleaning once in 24 hours in accordance with sub clause no. 7.3 of the General Principles of Food Hygiene (Ref. No. CAC/RCP 1-1969, Rev. 2-1925)	• If conditions for growth are favourable, these bacteria could multiply to over one million in a short span of 3-4 hours. "(Roday, 1999)"
7.	Bacterial contamination or intoxication in orthodox or CTC processing unit	Staph food poisoning is one of the most common type of food toxication caused by Staphylococcus aureus. This bacteria found in the throat and nose of the people. On the skin, it is present on the pimples, boils and infected wounds. Droplets from the nose or sneeze or cough into the air could contaminate the product. The toxin is heat resistant and it may survive at $100^{0}c$	To be assessed based on scientific data for factory personnel hygiene	• Prevent sick personnel entry to processing unit
8.	C. Physical Hazards Withering trough & rotarvane	Presence of stone, glass pieces, wood, metal etc in raw materials	Presence of powdered form of physical material per sample of tea is to be assessed and limits may be validated with scientific data	• For example, contamination of metallic particles (CTC profile) with tea may be identified with minimum and maximum limits as per food adulteration act

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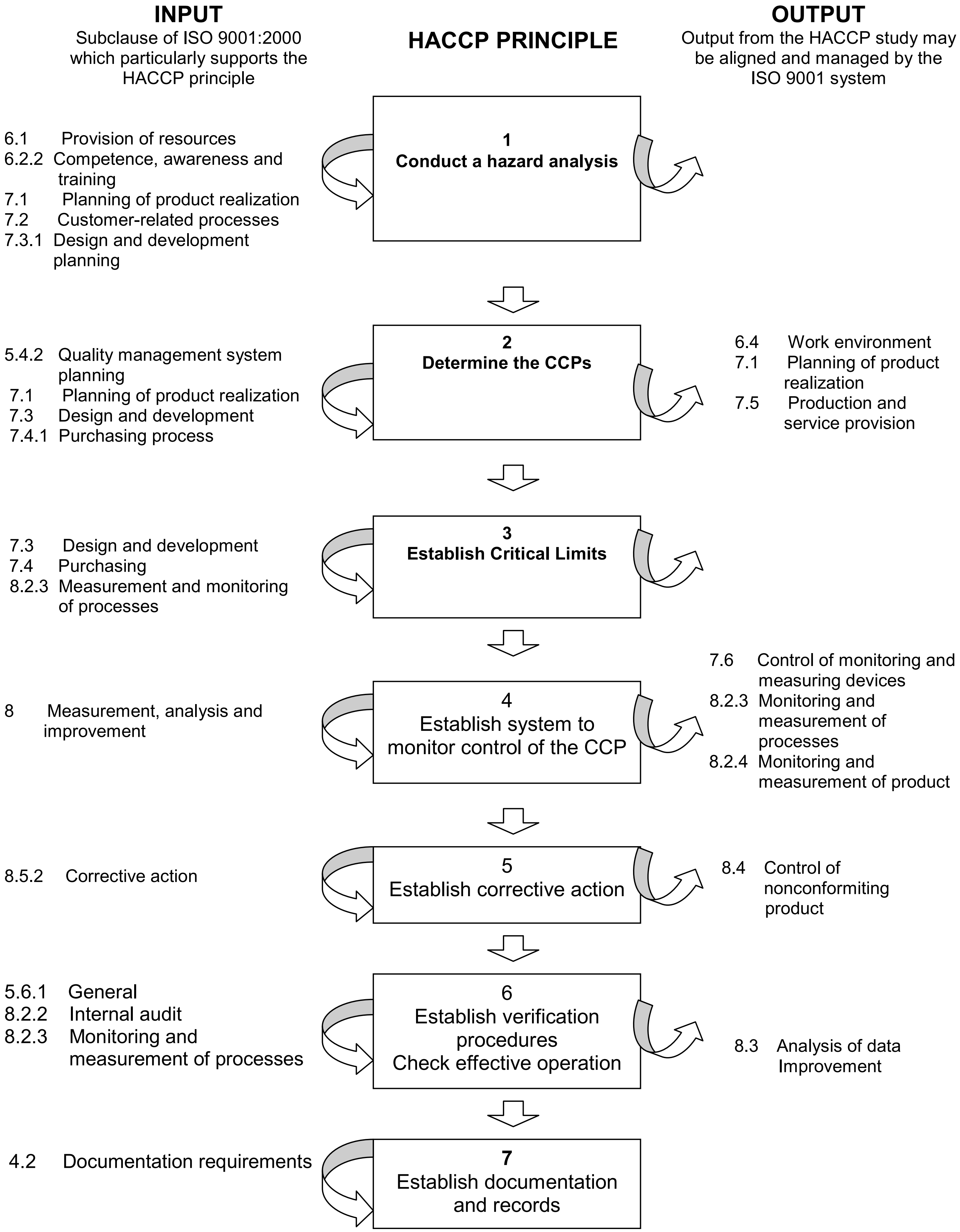


Figure. 1. Linkages between the HACCP method and the ISO 9001 system

DIAGRAM 1

LOGIC SEQUENCE FOR APPLICATION OF HACCP

1. Assemble HACCP Team
2. Describe Product
3. Identify Intended Use
4. Construct Flow Diagram
5. On-site Confirmation of Flow Diagram
6. List all Potential Hazards
   Conduct a Hazard Analysis
   Consider Control Measures
7. Determine CCPs — *See Diagram 2*
8. Establish Critical Limits for each CCP
9. Establish a Monitoring System for each CCP
10. Establish Corrective Actions
11. Establish Verification Procedures

See Diagram 3 (steps 10–11)

12. Establish Documentation and Record Keeping

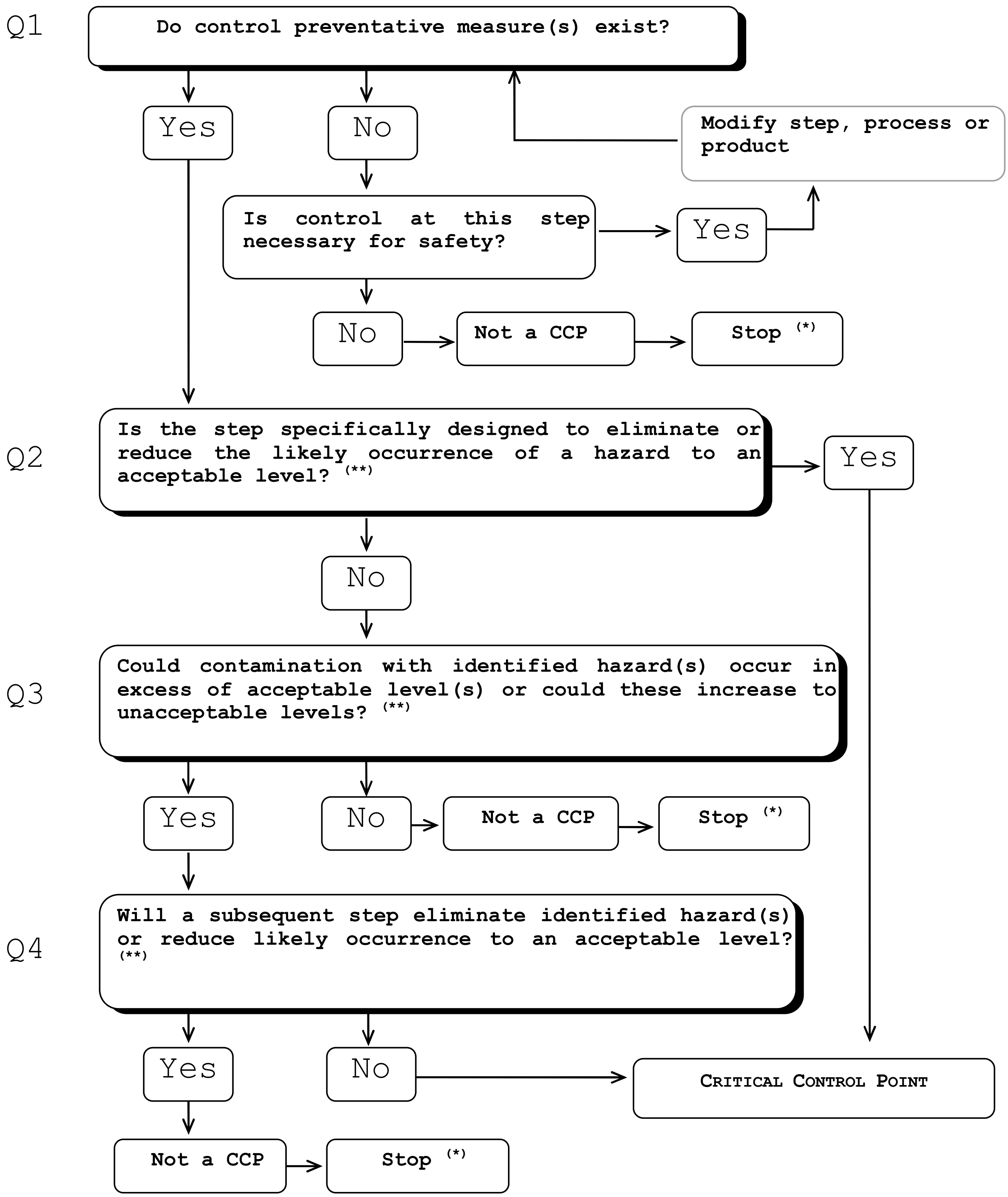
Source: FAO:FQSS, 1998

Diagram 2. Model Flow Diagram for Different Types of Tea

Black Tea Processing (Orthodox)	***CTC Tea Manufacturing***	***Green Tea Processing***
Withering (16-20 hours) ↓ Rolling (Cells are broken down to enhance oxidation process, temperature - 27-32^{0}c) ↓ Sifting (Separates the finer tea & dissipates the heat produced in the leaves during rolling) ↓ Oxidation (Oxidation process, time - 3-4 hours, temperature - 24-27^{0}c) ↓ Drying (Moisture of tea leaf reduced to 2-3%, temperature - 82-99^{0}c) ↓ Sorting (Removal of stalks and fibers) ↓ Grading ↓ Gapping (Before final packing, excess moisture required to proper level)	Withering (10-12% removal of moisture, 12-18 hours, 2.5-3 kg/sq. ft) ↓ Pre-conditioning • Green leaf sifter • Green leaf shredder • Roller / rotarvane (<35^{0}c) ↓ Oxidation (Oxidation process, temperature - 27^{0}c, relative humidity - 95%) • Floor • Drum • C F Machine ↓ Drying (Reduction of moisture level to 2.5-3%, *ECP drier* - inlet temp - 100^{0}c Outlet temp - 55^{0}c *FBD drier* - inlet temp - 120-127^{0}c Outlet temp - 65-70^{0}c) ↓ Sorting (Leaf & dust grades)	Steaming (Inactivate the enzymes & helps to stop the oxidation process) ↓ Centrifugation (Removal of excess moisture) ↓ Rolling (Rolled in the roller for 10-30 minutes without pressure) ↓ Drying (Removal of 40% of its moisture content) ↓ Rolling (Semi-dried leaf is rolled again with medium pressure for 20 minutes) ↓ Sifting ↓ Rolling (With medium heavy pressure for about 40 minutes ↓ Sifting (To break leaf balls) ↓ Drying, graded & packed

DIAGRAM 3

EXAMPLE OF DECISION TREE TO IDENTIFY CCPs
(answer questions in sequence)



(*) Proceed to the next identified hazard in the described process.

(**) Acceptable and unacceptable levels need to be defined within the overall objectives in identifying the CCPs of HACCP plan. *Source: FAO:FQSS, 1998*

DIAGRAM 4

EXAMPLE OF A HACCP WORKSHEET

1. Describe Product

2. Diagram Process Flow

HACCP based Documentation and Record Keeping System						
Step	Hazard(s)	CCPs	Critical Limit(s)	Monitoring Procedure(s)	Corrective Action(s)	Record(s)
Black Tea (CTC) Drying	**Moisture content**	**Inadequate heat (or) over heat in dryer**	**3% by mass (maximum level)**	**Continuous visual monitoring of meter by dryer room operator**	**Redry if moisture is >3% and establish practice of controlling temperature and retention time. *E.g.,* Temperature 93-104^{0}c Duration - 18-23 minutes** **For Black Tea (orthodox) Temperature 88-104^{0}c Duration - 25-30 minutes**	**CCP dryer room record no. D1 and D2 for recording tempera-ture and final moisture content** respectively

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Camellia Biotechnology: A Bibliographic Search

Dr. Tapan Kumar Mondal

Abstract

This bibliographic search covers the references till December 2001 on various aspects of tissue culture, molecular biology and genetic engineering work on tea and other related *Camellia* species.

Key words: Camellia, tea, micropropagation, DNA, genetic transformation, molecular markers.

Introduction

The genus *Camellia* of family Theaceae comprise of more than 325 species. Among them tea is the most important economic species. Several other species are also important due to their ornamental value. Although vegetative propagation and conventional breeding are the only means for propagation and improving the plant, there is tremendous scope to assist the conventional breeding by using various biotechnological techniques to improve this crop. Thus there is an increasing effort towards biotechnological research on tea.

More than 200 research papers including abstracts, review etc published till December 2001, are included here. The areas covered in the present search are micropropagation, protoplast culture, cry preservation, synthetic seed production, genetic transformation, molecular markers like RAPD, RFLP, AFLP, SSR, ISSR, organelle DNA analysis and cloning of gene.

Thus the bibliographic search will be of immense help for the researches working on tea or other *Camellia* species with same interest across the world.

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