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APPLICATION OF HAZARD ANALYSIS AND CRITICAL CONTROL POINT FOR IMPROVEMENT OF QUALITY OF PROCESSED FOODS

Access to good quality, safe and nutritious food is considered a basic right of the people. Consumption of unsafe, contaminated food leads to food-borne diseases which cause considerable morbidity and mortality. In India the diseases transmitted by food are commonly referred to as food poisoning and are characterized by abrupt onset of gastrointestinal disturbances *viz.* abdominal pain, vomiting and diarrhoea. The foods most commonly involved in food-borne disease are meat and meat products, poultry, eggs, milk and milk products, sweetmeats and rice preparations.

Besides domestic consumption, more and more food is moving across international borders for a combination of social, economic and technological reasons. The establishment of the World Trade Organization paved the way for several multilateral agreements on trade which include agreements on the Application of Sanitary and Phytosanitary (SPS) measures and on Technical Barriers to Trade (TBT). These agreements encourage countries to adopt international standards. In its pursuance of harmonization the SPS agreement specifically mentions the Codex Alimentarius Standards as the international standard and guideline. Within the context of the TBT agreement, the Codex Alimentarius Commission has been recognized as an international standardizing body. The Codex Alimentarius

Commission, a body of 165 member countries, administered jointly by the Food and Agricultural Organisation and the World Health Organization (FAO/WHO) is committed to protecting the health of the consumers, ensures fair practices in the food trade and facilitates international trade in food. The Codex General Principles of Food Hygiene has recommended a Hazard Analysis Critical Control Point (HACCP) based approach as a means to enhance food safety and has indicated how to implement the principles¹.

The HACCP concept was developed in the 1960s as a system to ensure the safety of food products. The HACCP can be defined as a system which identifies, evaluates and controls hazards which are significant for food safety. Its introduction signaled a shift in emphasis from end product testing to preventive control at all stages of food production. The HACCP system was initially developed for use by food processors for preventing food-borne hazards. However, the application of the HACCP system has been expanding to form a basis for regulated food control and as a standard for international food trade. It is being promoted internationally as a preventive system of hazard control that is considered to be the most effective and efficient way to ensure food safety. It is an action oriented programme to identify and reduce food-borne diseases.

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

The HACCP system consists of the following seven principles: (i) Conduct a hazard analysis; (ii) Determine the Critical Control Points (CCPs); (iii) Establish critical limits; (iv) Establish a system to monitor control of the CCP; (v) Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control; (vi) Establish procedure for verification to confirm that the HACCP system is working effectively; and (vii) Establish documentation concerning all procedures and records appropriate to these principles and their application.

Food Regulation in India and HACCP

In India, quality control with regard to food products is being enforced through various regulatory mechanisms like the Prevention of Food Adulteration Act (PFA), Agriculture Grading and Marketing (AGMARK), Fruit Products Order (FPO), *etc.* The Bureau of Indian Standards (BIS) has recently launched a HACCP certification programme for the food industry. The Mother Dairy of Delhi and the Punjab Cooperative Milk Federation have received HACCP certificates. The Agriculture and Processed Food Export Development Agency (APEDA) has helped mango processing units in Andhra Pradesh in implementation of HACCP.

While efforts are being made to implement HACCP in the organised sector of the food industry, there is a need to implement HACCP in the unorganised sector also as it accounts for 70-80% of food produced and processed in India.

Application of HACCP to Individual Foods

Khoa

Khoa (partially desiccated milk), a traditional Indian milk product, is used in the preparation of sweets. About 7% of milk produced in India is converted to *khoa*². It is rich in nutrients and has high water activity (0.96) which is conducive for the growth of bacteria³. Studies carried out in different parts of India indicated that *khoa* is often contaminated with pathogenic organisms such as *Staphylococcus aureus* and *Bacillus cereus*^{4,5} and has been implicated in many food-borne diseases. In order to reduce the microbiological hazard from *khoa* the HACCP has been applied.

The analysis of samples from raw material to final product at various time points had indicated that (Table I)

Table I. Microbial quality of *khoa* (cfu/g) at different time points

	Immediately after preparation	After 8 hours	At the time of sale
Aerobic plate count	5.2 x 10 ²	2.1 x 10 ⁶	> 10 ⁸
Staphylococcus	3.8 x 10 ²	9.5 x 10 ⁴	5.3 x 10 ⁶
Coliforms	1.0 x 10 ²	2.0 x 10 ³	1.0 x 10 ⁶

though the microbial quality of *Khoa* was satisfactory at the time of production, it deteriorated by the time it was displayed for sale at the market place [National Institute of Nutrition (NIN), Hyderabad; Unpublished observation]. The Critical Control Point for the deterioration was identified as airtight packaging. Changing the packaging material to muslin cloth which allows free air flow, reduced the microbial proliferation (Table II).

Table II. Microbial profile of *khoa* (cfu/g) in relation to the packaging material

	0 hours		After 24 hours	
	Before packing	Muslin cloth packing	Polythene cover and jute bag	
Aerobic plate count	5.3 x 10 ³	6.2 x 10 ⁴	3.8 x 10 ⁶	
Staphylococcus	3.8 x 10 ³	4.4 x 10 ⁴	3.3 x 10 ⁶	

Bacillus and Coliforms were not detected

Paneer

Paneer (a coagulated product of milk) is used in the preparation of certain curries and about 5% of the milk produced is converted to *paneer*⁶. *Paneer* may contain as high as 70% moisture which is conducive for microbial growth. Studies carried out on microbial quality of *paneer* have indicated that it is often contaminated with *Staphylococcus aureus* and Coliforms^{7,8}. The HACCP has been applied to identify the Critical Control Point for Coliforms and *Staphylococcus* contamination.

The analysis of various samples from raw material to the final product had indicated that (Table III) the contamination is due to food handlers using bare hands to remove the excess water in *paneer* (NIN, Hyderabad; Unpublished observations). The food handlers were informed about the importance of personal hygiene and they were

Table III. Microbial quality (cfu/g) at different stages of paneer production.

Sample	Aerobic plate count	Coliforms
Milk	1.8 x 10 ⁷	ND
Citric acid solution	ND	ND
Coagulated milk	> 10 ⁷	7 x 10 ²
Chilled water	2.0 x 10 ⁴	ND
<i>Paneer</i>	6 x 10 ³	3 x 10 ³
Handwashings of food handler (1)	> 10 ⁷	2.5 x 10 ³
-do- (2)	> 10 ⁷	3.0 x 10 ³

ND – Not detected

asked to wash their hands with soap before touching the *paneer*, and the quality of *paneer* was tested after the intervention. Results (Table IV) indicated that cleaning of hands with soap before starting the operation drastically reduced Coliform contamination in the final product.

Table IV. Microbial quality (cfu/g) of paneer after intervention (hand washing)

	Before intervention	After intervention
Total aerobic count	6.5 x 10 ⁶	1 x 10 ¹
Coliforms	4.5 x 10 ⁷	ND

ND – Not detected

Mushroom

Mushrooms are now being cultivated in India and the annual production is about 10,000 tonnes. Many export oriented mushroom producing units have been set up. These units are being encouraged to implement the HACCP programme to improve the safety and quality of mushrooms.

A HACCP study was conducted in a 100% export oriented unit producing white button mushrooms. The major reported microbial hazards from mushrooms are *Clostridium*, *Salmonella*, *Bacillus* and Coliforms. After preparing a process flow diagram for a mushroom production unit, samples were collected and analysed at various time points. Results indicated (Table V) that fresh mushrooms had high Coliform contamination while canned mushrooms were absolutely sterile (NIN, Hyderabad;

Unpublished observations). The food handlers who grade the fresh mushrooms were carrying Coliforms and were introducing the Coliforms into fresh mushrooms.

Table V. Microbial quality (cfu/g) through the process of mushroom processing

	Total aerobic plate count	Staphylococcus	Coliforms
Container swab	3 x 10 ³	ND	ND
Conveyer belt	ND	ND	ND
Handwashings of food handler (1)	> 10 ⁴	2.2 x 10 ³	> 10 ⁴
- do - (2)	> 10 ⁴	ND	1.5 x 10 ³
Fresh mushrooms	1.0 x 10 ⁴	ND	5 x 10 ³
Canned mushrooms	ND	ND	ND

ND – Not detected

Critical Control Point for fresh mushrooms has been identified as the food handler's personal hygiene and they were informed about the importance of personal hygiene, and a thorough soap wash of the hands after using the toilet has been suggested as the intervention strategy to improve the microbial quality of fresh mushrooms.

These case studies carried out on HACCP, indicated that the HACCP can be applied in the unorganized sector of the food industry such as the production of *khoa* and *paneer*. Critical Control Points for microbial contamination or proliferation varied depending upon the method of preparation in each case. A unit producing mushroom in the organized sector had mushrooms for export and the domestic market. While the canned mushrooms were free of contamination, the fresh mushrooms for local sale had high Coliform count.

In *khoa* it was the airtight packaging that was responsible for microbial proliferation while the food handlers were responsible in introducing Coliforms in mushroom and *paneer*. Simple and economical solutions like muslin cloth packing for *khoa* and thorough hand washing by food handlers before touching the *paneer* or mushrooms had totally eliminated the problem of microbial contamination.

It is obvious that the application of HACCP is possible in the Indian context and would yield the desired results of improving the safety of food. Thus, in the context of globalization and the post WTO era, the Codex Alimentarius Commission guidelines on food safety issues

such as HACCP could be implemented in India. However, adequate education and extension programme on the subject, needs to be undertaken and training programmes organized.

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This write-up has been contributed by Dr. Ramesh V. Bhat, Dy. Director (Sr.Grade) and Dr. V. Sudershan Rao and Sh. Kashinath Lingerkar, Technical Assistants, Food and Drug Toxicology Research Centre, Hyderabad.

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