Quality Control for Value Addition in Food Processing

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Dedicated to

Shorya Raj Pundir

&

Prisha Pundir

and to those

who beleive in

Honesty, Hardwork & Motivation

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FOREWORD

The food processing industry ranks fifth in size in the country and employs over 16 lakh workers which are 19% of the country's industrial labour. It accounts for 14% of the total industrial output with 18% of industrial GDP; thus, plays a vital role in India's prosperity. Concern about health, nutrition, convenience and freshness are likely to drive the Indian Food Processing Industry in the years ahead. Food processing involves a number of unit operations for food handling right from the field operations till it reaches the end users. However, there are always chances that the food may get contaminated or adulterated while undergoing different unit operations of food processing. Therefore, it should be mandatory for food manufacturers that food should not cause any harm to the consumer, as contaminated or adulterated food may become a silent vehicle for spread of pathogens and chemicals across border's causing severe adverse health effects to the consumers. To prevent such adverse effects, food quality should be given top priority and must be controlled by following Food Standards and Regulations to ensure the safety of food. A manuscript having such information would be the strongest link between the academia, consumers and the industry.

The book entitled **"Quality Control for Value Addition in Food Processing"** consisting of 12 chapters is a well written text book covering the most important informations pertaining to food processing, potential food hazards, quality management, food standards & safety assurance systems, additives, enzymes, waste utilization, marketing management and methods for quality control along with useful glossary and annexures. The text in each chapter has been illustrated with tables, figures and plates for better understanding of the contents.

I hope the book shall prove to be a boon to the food professionals like students, researchers, teachers and all those who have interest in the area of Postharvest Technology, Food Technology, Food Science and Technology as well as for professionals related to quality management systems in food processing. The book will be highly beneficial to the undergraduate as well as postgraduate students of various agricultural universities. I compliment the authors for making sincere efforts for bringing out this useful publication.

K. R. DHIMAN
Vice Chancellor

PREFACE

Food processing is application of techniques in a systematic manner for preventing losses through preservation, processing, packaging, storage and distribution and ultimately to ensure greater availability of a wide variety of foods. Concern about health, nutrition, convenience and freshness are likely to drive the Indian Food Processing Industry in the years ahead, as in the rest of the world. Evolution and changes of host, pathogen and environment are the emerging concern for food safety in food processing industries. Food should not cause any harm to the consumer when it is prepared and /or eaten. So, there is great need to provide consumer guarantee on the safety aspects of the product to be consumed and gain market confidence regarding the safety of the products exported. Contaminated food may become a silent vehicle for spreading pathogens and chemicals across borders. Food safety can be met out by managing safety tools. Food Standards and Regulations must be set to ensure the safety of food. So it is important to know facts and figures of food processing industries for maintenance of quality of their products. But to enforce these, some sort of documentation is needed. A manuscript having such information would be the strongest link between the industry, academia and the consumers.

The students, teachers, and researchers often need a direct reference which is complete on the subject for teaching undergraduate or postgraduate students. So the authors made an attempt to meet out this need. The book on **"Quality Control for Value Addition in Food Processing"** consists of 12 chapters. These chapters focus on Food Processing Industry: An Orientation, Processing Plant, Processing Plant Hazards, Quality Characteristics, Quality Control and Management, Food Standards and Statutes, Food Safety Assurance Systems, Additives in Food Processing, Enzymes in Food Processing, Waste Management

in Food Industry, Marketing and Export Management, Practical Methods for Quality Control along with glossary and annexures. The text in the chapter has been illustrated with tables, figures and plates for better understanding of the contents. The book chapters have been designed as per the ICAR syllabus for UG and PG students. At present, there is no book available which gives an orientation for quality control in food processing industry. The book will be highly beneficial to both UG and PG students undergoing courses in Postharvest Technology, Food Technology, Food Science and Technology as well as for professionals related to quality management systems in food processing industry.

We acknowledge from the core of our heart for the valuable guidance and support received from numerous publications of many committed and dedicated members of scientific community who have contributed tirelessly in the field of food quality and management system. Their assistance for the information obtained from literature and websites that were consulted during the preparation of the manuscript is thankfully acknowledged. With deep sense of pride and dignity, authors express heartfelt sense of gratitude and regards to Hon'ble Vice Chancellor, Dr K R Dhiman; Director of Research, Dr S K Sharma and Dean, Dr R C Sharma, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan with whose guidance, scientific knowledge, constructive criticism and constant encouragement, we have been able to publish this manuscript. Words are inadequate to express our gratitude towards our most venerable parents and family members whose constant inspiration and innumerable sacrifices have encouraged us to complete this goal.

It is hoped that the book will be welcomed and its benefits will be availed by an increased number of food professionals like students, researchers, teachers and all those who have interest in the subject. Although, every care has been taken by the authors while writing this text book even then spelling mistakes, overlapping; repetition of brief portion here and there could not be helped. Needless to say, errors and omissions are solely our. Constructive criticisms and suggestion by the readers are welcome for improving the quality of manuscript. Reader's indulgence in this regard is highly solicited.

Dev Raj
Rakesh Sharma
V K Joshi

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ACRONYMS/ABBREVIATIONS

APEDA	Agricultural and Processed Food Products Export Development Authority
ATP	Adenosine triphosphate
a_w	Water activity
BIS	Bureau of Indian Standard
CAC	Codex Alimentarius Commission
CCP	Critical Control Point
CFBB	Corrugated Fibre Board Box
DON	Deoxynivalenol or Vomitoxin
EU	European Union
EUREPGAP	Euro-Retailer Produce Working Group on Good Agricultural Practices
FAO	Food and Agricultural Organization of the United Nations
FDA	Food and Drug Administration (USA)
FPO	Fruit Product Order (1955)
GAP	Good Agricultural Practices
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic production
GHP	Good Hygeine Practices
GM Foods	Genetically Modified Foods
GMP	Good Manufacturing Practices
HACCP	Hazard Analysis Critical Control Point
IFS	International Food Standard
ISO	International Organization for Standardization

KMS	Potassium Metabisulphite
MAQ	Minimum Acceptable Quality
MFPO	Meat and Food Product Order (1973)
MMPO	Meat and Meat Product Order (1972)
MPEDA	Meat and Marine Food Products Export Development Authority
MRL	Maximum residue Limit
MSG	Monosodium glutamate
PFA	Prevention of Food Adulteration Act (1954)
PHM	Postharvest Management
ppm	Parts per million
psi	Ponds per square inch
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management Systems
RTE	Ready to eat
RTS	Ready to serve
SO_2	Sulphur dioxide
SOP	Standard Operating Procedures
SPS	Sanitation and Phytosanitary Measures
SQFI	Safe Quality Food Institute
SQFS	Safe Quality Food Standard
SRSV	Small round structured viruses
SSOP	Standardized Sanitary Operation Procedures
TBT	Technical Barrier to Trade
TSS	Total soluble solids or sugars
UN	United Nations
USDA	United State Department of Agriculture
WHO	World Health Organization (UN)
WTO	World Trade Organization (UN)

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Chapter 1

Food Processing Industry : An Orientation

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1.0 INTRODUCTION

Any commodity, produce or harvest in organic or inorganic form to be fit to eat by a particular society, and contributes materially towards growth and repair of tissue is known as food. Food processing is application of techniques in a systematic manner for preventing losses through preservation, processing, packaging, storage and distribution to ensure greater availability of a wide variety of foods. It is a set of methods and techniques used to transform raw ingredients into food for consumption by humans or animals.

The early stages of food processing were largely confined to primary processing of food crops, commodities and produce whereby all these rendered fit for consumption or sale in the markets. Processing of rice and oil seeds were the necessities of that time for living. Later on, World War II gave a fillip to some of other food processing industries to meet the demand of the defence forces of the country. Fruits and vegetables processing; wheat and sugar milling drew support and sustenance from the exigencies created by war. Post war situation almost merged into the post-independence scenario. However, food processing industry received its first major impulse after independence. During this time, all the primary food processing industries received top most priority and all necessary support from the Governments in the country.

The major land mark in the primary food production is Green revolution during sixties, eventually leading the country to self-sufficiency in the food grains. At present agriculture and allied sector contributes 22% of GDP in India. Total arable area in India is 184 million hectares contributing a total food grain production of 210.01 million tones. In the production of fruits and vegetables also India has attained global supremacy, occupying the first and second positions, respectively. According to recent estimate, horticultural crops occupy 10% gross cropped area (17.95 million ha) with a production of 214.73 million tonnes. Fruit's production is 79.97 million tonnes from an area of 9.5 million ha while that of vegetable's production is 129.1 million tonnes from an area of 7.9 million ha. India's share in world fruit production is 12% and vegetable production is 13.25%. India is largest producer of Mango, banana, and acid lime. India produces world's 41% mango and 23% banana. India has prime position in cauliflower, second in onion and third in cabbage in world. India is largest producer, consumer and exporter of spices and spice products. Among plantation

crops, India is largest producer and consumer of Cashew nut. Cashew Production is 0.57 million tones from an area of 0.24 million ha. India is 3rd largest producer of Coconut with total production of 12, 148 million nuts from an area of 1.93 million ha. Bulk of agriculture produce is utilized for fresh handling/marketing purposes. During different handling and marketing operations there is huge post harvest loss of agriculture produce. Post harvest loss in cereal and legumes crops is 15-20% while it is 20-30% in fruit and vegetables. The major cause of post harvest loss is availability of poor infrastructure for Post Harvest Management (PHM) and processing of commodities. These losses can only be minimized by proper handling, marketing and processing of the agricultural commodities.

1.1 Food Processing Industry

The food processing industry ranks fifth in size in the country and employs 16 lakh workers which is 19% of the country's industrial labour. It accounts for 14% of the total industrial output with 18% of industrial GDP and 6.3% of country's GDP. So, food processing plays a vital role in India's prosperity. The Food Processing Industry sector in India is one of the largest sector in terms of production, consumption, export and growth prospects. The government has accorded it high priority with a number of fiscal relief and incentives to encourage commercialization and value addition to agricultural produce for minimizing pre-and post harvest wastage and generating employment and export growth. Food processing industry broadly comprises primary processing category and the other categories embracing the secondary, tertiary and further stages of down stream processing.

As a result of several policy initiatives undertaken since liberalization (August 1991), the Industry has witnessed fast growth in most of the segments. Besides this, Government has also approved proposals for joint ventures, foreign collaborations; industrial licences and 100% export oriented units. As per the recent study on the food processing sector, the turnover of the total food market is approximately Rs. 250,000 crores out of which value added food products contribute about Rs 80,000 crores. Processed food exports were at over Rs 8,975 crores during 2008-2009.

1.2 Specific Food Processing Sectors

Primary food processing is a major industry with lakhs of rice-mills/hullers, flour mills, pulse mills and oil-seed mills. There are several

thousands of bakeries, traditional food units and fruit/vegetable/spice processing units in the unorganized sector. In the organized sector, there are over 820 flour mills, 418 fish processing units, 6600 fruit/ vegetable processing units and 171 meat processing units. Indian processing industries has installed capacity of 21 lakh tones; however these industries actually processed 9.8 lakh tones of the produce. So the total capacity utilization of industries is <30%. There are 70% units in home/cottage/ small scale sector and 30% units in large scale sector with capacity of 250 tonnes per annum and 30 tonnes/ha., respectively. Large scale contributes 70% of the production. The principal crops and commodities which constitute the primary base for the food processing industry and considered important sub-sectors in food processing industries are illustrated in Fig. 1.1.

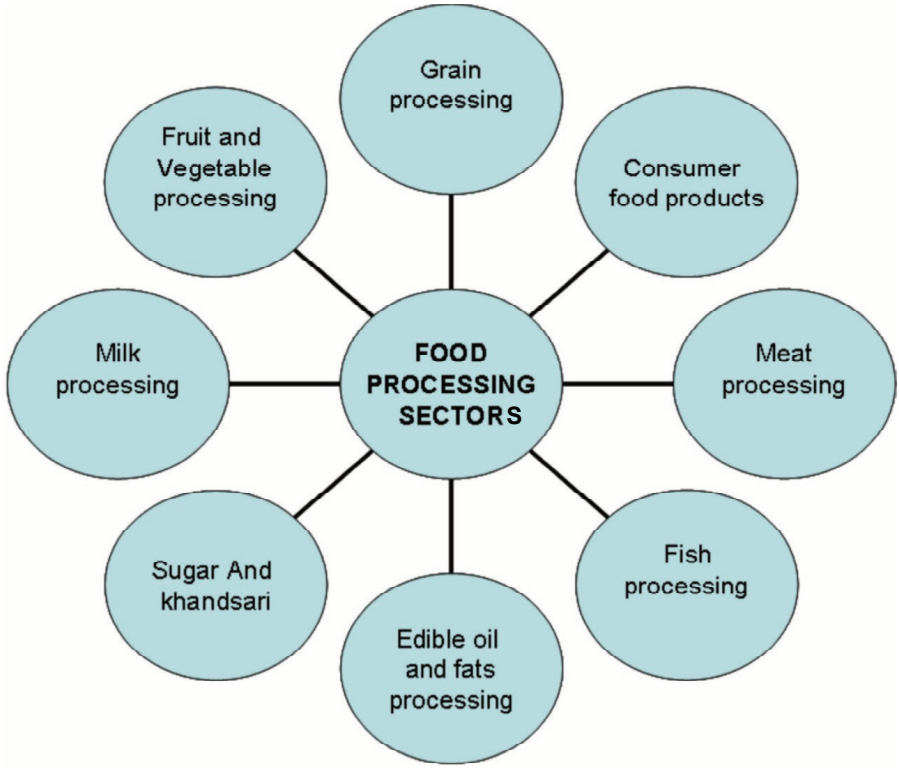

Fig. 1.1. Various food processing sectors available in the markets

1.2.1 Grain Processing

The production of grains in the country is about 210.01 million tones per annum. India is the second largest producer of rice and wheat

in the world after China. Grain processing is the biggest component of the food sector, sharing 40% of the total value.

1.2.2 Fruits and Vegetable Processing

Annual horticulture production is estimated around 214.73 million metric tones. India's share is 12% of the world fruit production and 13.25% of the world's vegetable production. Despite such a huge production of horticultural commodities there is only <2% processing and India's share in the world trade is around 1%. However, processing in advanced countries is too high as compared to India. Status of processing in India in comparison to advanced countries is presented in Fig 1.2 & 1.3. The per cent share of major food products in the markets is illustrated through Fig. 1.4. India is the land of spices producing all varieties worth Rs. 3500 crores amounting to 25-30% of world production, which is processed for value addition and export.

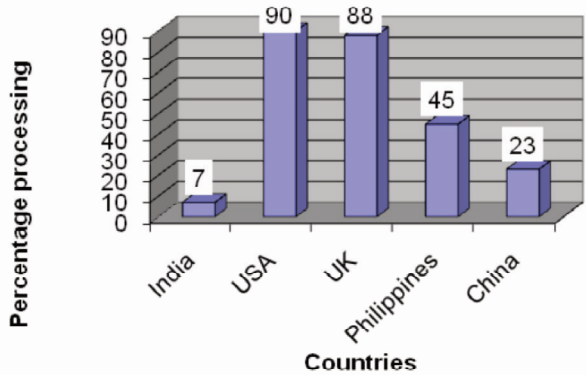

Fig. 1.2. Status of food processing in India in comparison to advanced countries

1.2.3 Meat and Poultry Processing

India's livestock population is the largest in the world with 50% of the world's buffaloes and 20% of cattle, but only about 1% of the total meat production is utilized for preparation of value added products. Production of meat and poultry products is about 4.1 million tones. Only about 1% of the meat produced is converted into value added products. India ranks fifth in the world egg production with a very small percentage being converted into egg products.

1.2.4 Milk Processing

India is the largest milk producer in the world with 75 million tones per annum. Consumption of liquid milk accounts for about 46%

of the total production and remaining 54% is utilized for conversion to milk products. Out of this, about 15% of the total milk production is processed through the organized sector. Among the products manufactured, ghee (clarified butter) alone accounts for 85%. The size of the semi-processed and ready to eat packaged food industry is over Rs 4,000 crores and is growing at over 20%.

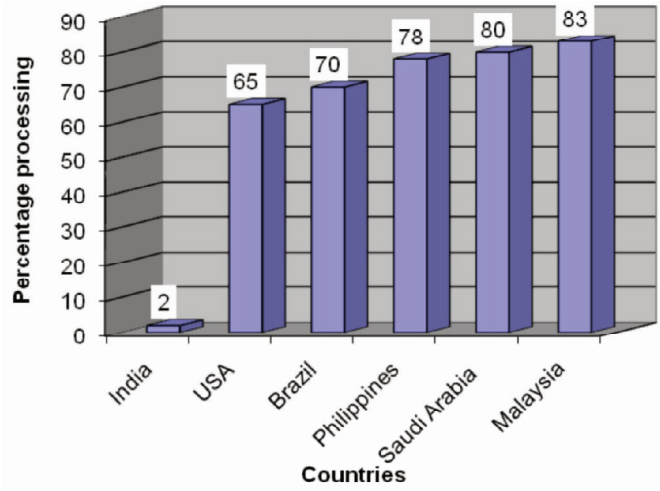

Fig. 1.3. Status of fruit and vegetable processing in India in comparison to advanced countries

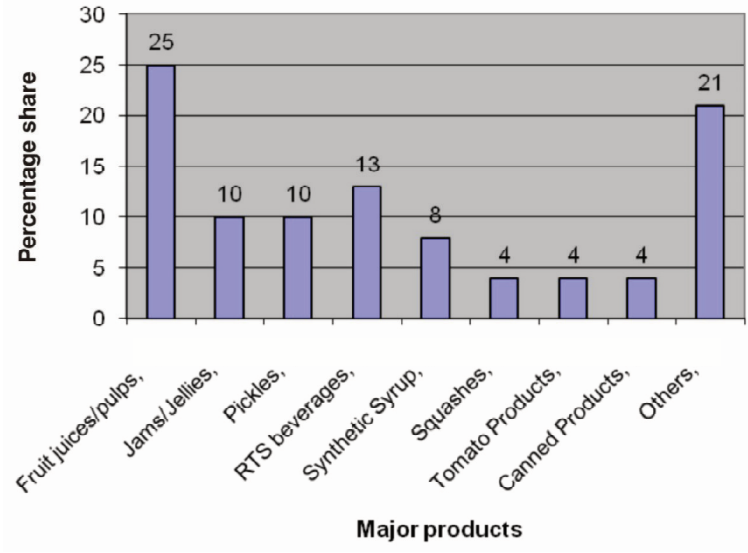

Fig. 1.4. Per cent share of major processed food products in the market

1.2.5 Fish Processing

India is the seventh largest in fish catching. Production of fish is about 3.8 million tones of which 60% is from marine sources. Processing of fish is done entirely for the export market.

1.2.6 Plantation Crop Processing

Tea, coffee, cashew, cocoa, sugarcane etc. are the major plantation crops in the country. India's principal crops accounted for 5-6% of the India's total export earnings. India is the world's largest producer of the tea. India is the largest producer (31% of world production), processor and exporter of the cashew kernels (48% of the world export).

1.2.7 Consumer Food Products

Consumer food comprises of group of products like chocolates, confectionery, cocoa products, soya based products, RTE foods, mineral waters, soft drinks etc. Among these, soft drinks enjoy the biggest share. Confectionery output is growing at the rate of 6-7% and chocolate production at the rate of 10-15%.

1.3 Problems and Constraints of Food Industries

The fortune of the Indian food industry is largely depends upon the caprices of the monsoon. The problems of the agro-industries, agri-businesses or any other economic activity related to or depends upon agriculture are therefore compounded. It is therefore imperative to know and understand the problems, risk and constraints associated with such food processing industries. The main constraints and problems of the food processing industry are given as under :

1. Food commodities are biological in nature and inherently subjected to variation in their physico-chemical composition and sensory characteristics as influenced by various factors.
2. Low productivity of the agricultural produce and non-availability of good quality fruits and vegetables for processing purposes.
3. Food commodities are mostly location and season specific.
4. Food commodities are mostly perishable or semi-perishable, leading to high degree of wastage of the produce.
5. Wide and violent fluctuations in the supplies, quality and price of the food as commodities may be location/region-specific, seasonal and often perishable or semi-perishable.

6. Low level of developed technology and management inputs.
7. Inadequate infrastructure for storage, distribution and marketing.
8. Poor post harvest management infrastructure and lack of awareness about procedures and technologies to improve shelf life.
9. Weak linkages in the supply chain.
10. Lack of integration with upstream (food production) and down stream (marketing and export) agencies.
11. Very less value addition and processing.

Other Problems Associated with Basic Constraints

1. High cost, high prices and high vulnerability due to wide variation in the prices of the agro-derived inputs.
2. In adequate trained man power and quality testing laboratories.
3. Low profit margins.
4. High investment cost is needed to establish an industry.
5. High investment cost is needed for publicity and promotion of the consumer products.
6. High cost of packaging.
7. Incidence of unduly high and irrational taxation.
8. Lack of suitable processing technologies.
9. Lack of regular and consistent supply of processing grade raw material at factory gate.
10. Lack of awareness regarding quality of food desired in international markets.
11. Lack of awareness regarding International Quality Standards and Measures.
12. Wastage of produce during transportation, storage and processing.

1.4. Future Strategy to Overcome Problems

The above problems and constraints have been overcome essentially through the employment of following modern tools and techniques of science and technology as well as professional management like :

1. Crop productivity and quality maintenance through selection, breeding, biotechnology and integrated pre and post harvest management.
2. Minimization / prevention of wastage and quality loss through development of cool chain technology.
3. Minimization of wastage and quality loss by reduction in the numbers of intermediary produce handling stages and agencies.
4. Stabilization of produce supply and prices by maintenance of proper procurement and distribution chain.
5. Increase in the farmer's share of the consumer price.
6. Expansion of raw material availability and up gradation of its quality.
7. Harmonization of various food laws.
8. Rationalization of taxes and levies.
9. Investment and improvement in infrastructure like rural roads, rural electrification, waste land development, cold chain etc.
10. Implementation of integrated processed food laws.

1.5. Prospects of Food Processing Industry

- Recognised as Sun-rise industry
- Reduces wastage and losses
- Handles gluts
- Generate employment
- Stabilizes farm prices and income
- Checks nutritional deficiency
- Earn foreign exchange. Different Products can be prepared and marketed (Fig. 1.4). These are fruit pulp, juices, jam, jellies, marmalades, squashes, sherbets, pickles, chutney, sauces, ketchups, dehydrated fruit/vegetables, frozen pulp, vegetables, fruit juice concentrates, vegetable curries in retortable pouches, canned mushroom & products, tomato products and fruit bars

1.6. Potential for Growth of Food Processing Industry

- Processed Products should be exempted from licencing purview
- Food processing must be priority sector

- Excise duty must be nil
- Income tax should be minimum or nil
- Licensing power must be given to regional offices

1.7. Future Outlook and Challenges

Health, fitness, wellbeing, nutrition, convenience and freshness are likely to drive the Indian Food Processing Industry in the years ahead, as in the rest of the world. So for the fulfillment of these needs; health oriented nutraceuticals and functional foods, minimally processed foods, fresh cut, pre-prepared vegetables and salads, heart healthy, diabetic friendly foods and food supplements, low sugar / salt / fat / cholesterol foods, organically grown foods and other kindred food products may be the drive foods of the future. Convenience foods like instant mixes, ready-to-cook, ready-to-bake, ready-to-eat and ready-to-drink foods and beverages already becoming popular may soon become the order of the day.

Evolution and changes of host, pathogen and environment are the arising concern for food safety in food processing industries (Fig 1.5). Food is expected to nourish people. Food should not cause any harm to the consumer when it is prepared and /or eaten according to its intended use. Unsafe food leads to food-borne diseases predominantly induced by micro-organisms. So, recently the concern is arising regarding food safety. There is great need to provide consumer guarantee on the safety attributes of the product to be consumed. There is also great need to gain market access and market confidence regarding the safety of the products exported. Contaminated food may become a silent vehicle for spreading pathogens and chemicals across borders. Food safety can be met out by managing safety tools like

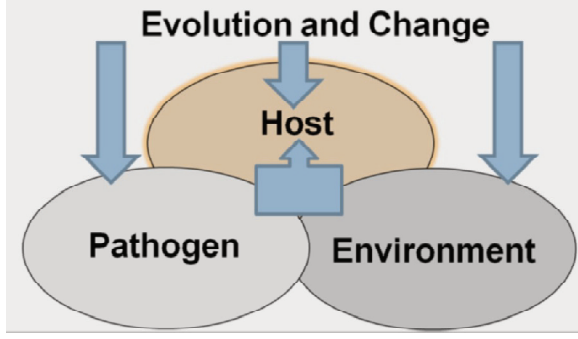

Fig. 1.5. Various factors imposing challenges to food safety.

Analysis and Critical Control Points (HACCP), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP). Food Standards and Regulations must be set to ensure the safety of food for consumers and to gain market access. So, it is important to know facts and figures of food processing industries for maintenance of quality of their products.