

Sudan University of Science and Technology
College of Graduate Studies

**Assessment of Food Safety Knowledge, Attitudes and Practices
among Slaughterhouses Workers in Khartoum State- Sudan**

تقييم معرفة وسلوك وممارسات سلامة الغذاء بين عمال مسالخ اللحوم بولاية
الخرطوم- السودان

A Thesis submitted for partial fulfillment of the requirement for the
M.sc degree of Total Quality Management and Excellence

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October 2017

الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال الله تعالى:

(رَبِّ أَوْزَعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ

وَأَنْ أَعْمَلَ صَالِحاً تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ

الصَّالِحِينَ)

صدق الله العظيم

سورة النمل الآية (19)

Dedication

I dedicate my thesis to my father and mother mainly and to my family who always support me.

Acknowledgement

First of all thank Allah, who giving me good health, ability and strength to fulfil this work.

I express my deep and sincere gratitude and appreciation to my supervisor Prof. Dr. Mohamed Abdel Salam Abdallah for the support.

Finally, I am thankful, all my friends who helped me during this work.

Abstract

The aim of the present study was to evaluate the knowledge, attitudes and practices (KAP) of workers in two abattoirs in the state of Khartoum in the period from October to November (2017), with regard to food safety. Sixty workers were selected randomly in two slaughterhouses with 30 workers of each, and interviewed using face-to-face questionnaire to collect information. Results showed that the respondents had acceptable level of knowledge, excellent attitudes and poor practices toward food hygiene measure. Seventy percent from the workers had acceptable level of knowledge, while 30% do not know about food safety. Most of the respondents 95% were agreed with principles of food safety, while a few (1.7%) were disagreed. But 60% of them had poor practices, whereas, only 31.7% of workers were practiced the food safety and hygiene measures. In conclusion, the workers need more education and training about food safety and food-borne diseases. Also good slaughterhouse facilities must be used to raise the level of hygiene.

ملخص الاطروحة

الهدف من الدراسة الحالية هو تقييم معرفة، سلوك وممارسات العاملين بمسالخين من مسالخن تصدير اللحوم بولاية الخرطوم في الفترة ما بين أكتوبر الي نوفمبر (2017) بشأن صحة وسلامه الغذاء. تم اختيار ستون عامل من العاملين بطريقة عشوائية في مسالخين من مسالخن تصدير اللحوم بولاية الخرطوم بواقع 30 عامل من كل مسالخن لجمع المعلومات بواسطة استبيان ومقابلات شخصية. اظهرت النتائج ان المستهدفين لديهم مستوي مقبول من المعرفة وامتياز في السلوك وضعف في ممارسات او تطبيق قياس صحة وسلامة الغذاء. سبعون بالمائة كان لديهم مستوي مقبول من المعرفة, في حين 30% ليس لديهم المعرفة عن صحة وسلامة الغذاء. معظم المشاركين (95%) متفقين علي مبادي صحة وسلامة الغذاء, في حين قليل (1.7%) غير متفقين. لكن 60% منهم كان لهم ممارسات سيئة , في حين 31.7% فقط من العاملين يمارسون صحة وسلامة الغذاء و تدابير النظافة العامة الخاتمة ان العاملين في حوجه للمزيد من التعليم والتدريب عن سلامه الغذاء و الامراض المنقولة بالغذاء. ايضا يجب وجود معينات جيدة في المسالخن والتي تساهم في رفع مستوي النظافة .

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Introduction

Introduction

Contamination of meat carcasses has pointed to many sources including abattoir workers. Food can transmit disease from person to person as well as serve as a growth medium for bacteria that can cause food poisoning. Food borne-disease, intoxication and zoonoses are important public health problems that affect health and disrupt community, business and economic activities in both developed and developing countries. The foods most frequently involved in disease outbreaks are those of animal origin especially beef, poultry, pork, milk, fish and eggs. One third of the human population in developed countries is affected by food-borne diseases every year and, the problem is likely to be even more widespread in developing countries. Globally, unsafe food causes disease in at least one person in three every year. Mead *et al.*, (1999) reported that, in the USA, 76 million food-borne cases occur annually, 325,000 hospitalizations and 5000 deaths each year. The high incidence of food-borne illnesses has led to an increase in global concern for food safety. According to Johns (1991) personal hygiene can be defined as follows: as clean as is reasonably practical of hand, forearms, neck, hair and any clothing liable to come into contact with food. Several food-borne-disease outbreaks have been reported to have been associated with poor personal hygiene of people handling foodstuffs (Bryan, 1988, Altekruze *et al.*, 1998, Vought and Tatini, 1998, Shapiro *et al.*, 1999). Personal hygiene is critical in preventing contamination of food and food-borne illness, they must wash their hands properly to prevent contaminating other foods, and surfaces they touch (Medeiros *et al.*, 2001). There is an approved association between slaughter practice and hygienic practice of the workers. The washing and disinfection with hot water rarely take place, and both hygienic disposition and easy access to hygienic facilities were important for hygienic behavior in slaughterhouse (Gerats *et al.*, 1982). Hands, as well as contaminated gloves, serve as vectors for transmission of

transient microorganisms (Fendler *et al.*, 1998). For many years there have been requirement regarding the clothing and personal hygiene of workers, if properly enforced, these should control contamination from workers bodies(Restino and wind, 1990., Kasprowiak and Hechelmann, 1992).All employees working in the slaughterhouses must wear hair nets, should wash their hands before and after breaks,visits to the toilets and as necessary during production, clean and sanitize gloves,knives,aprons as necessary during productionto minimize contamination and all equipment and tables are cleaned and sanitized throughout the day (Brendan *et al.*, 2009). Morrone and Rathbun (2003) indicated that risks along the food chain can be minimized through educating consumers and employees on safe food handling.Without knowledge of food safety practices and proper food handling procedures, food borne illnesses cannot be reduced (Redmond and Griffith,2005).Gould(1994)reported that all food handlers must have participated in training programme in personal hygiene, good manufacturing practice,cleaning and disinfection procedures before starting to work in the plant. Training helps to improve overall employee knowledge of food safety (Howes *et al.*, 1996; Costello *et al.*, 1997, Finch and Daniel, 2005; Robertset *al.*, 2008) although others have found that training is not consistently associated with improved knowledge (luby *et al.*, 1993).In Sudan, Siham (2010) recorded that all persons in contact with food and food products must know hygienic practices during their duty to prevent thefood and its products from contamination.Also Ali (2007) reported that proper application of systemic hygienic practices, the food can be safe from many food- borne diseases.

Objectives:

- 1- To assess the knowledge of workers with regard to food safety and hygiene.
- 2- To determine the attitudes of workers towards food safety and hygiene.
- 3- To raise the safety standard of meat in Sudan.

Chapter One

Literature Review

Literature Review

1.1 Food safety:

Food safety is the assurance that food will not cause any harm to the consumers when taken in its current state and as it is (FAO/WHO, 2001). Food-borne diseases and zoonoses exerts a major toll on health as thousands of millions of people fall ill and many die as a result of unsafe food. Serious outbreak of food -borne diseases and zoonoses has been documented on every continent illustrating both their public health and social significance. Due to this, WHO (2000) recognized food safety as an essential public health priority and later on adopted the WHO global food safety strategy. According to the WHO (2000) global food safety strategy, traditional food safety management systems have not been effective in preventing food-borne diseases and zoonoses over the last decades. The strategy therefore, advocates food safety programmes based on a broader science based concept of risk assessment, risk management.

Defined food safety as the inverse of food risk-the probability of not suffering some hazard from consuming a specific food (Henson *et al.*, 1998). Food safety is considered as a concept of central importance because it plays an essential public health function (WHO, 2000).

1.2 History of food safety:

Food safety remains a critical issue with outbreaks of food -borne illness resulting in substantial costs to individuals, the food industry and the economy (Kafarstein *et al.*, 1997). Within England and Wales the number of food poisoning notification rose steadily from approximately 15,000 cases in the early 1980s to a peak of over 60,000 cases in 1996 (Wheeler *et al.*, 1999). This may be partly attributed to improved ,but may equally reflect increased global trade and travel, changes in modern food production, the impact of modern lifestyles, changes in food consumption and the

emergence of new pathogens (Collins *et al.*, 1997). Recent years have seen a reversal in this trend but food poisoning remains a high priority for the public and government (Parliamentary Office of Science and Technology, 2003). Mishandling of food plays a significant role in the occurrence of food-borne illness. Improper food handling may be implicated in 97% of all food-borne illness associated with catering outlets (Howes *et al.*, 1996). Improper practices responsible for microbial food-borne illness have been well documented (Bryan, 1988) and typically involve cross-contamination of raw and cooked foodstuffs, inadequate cooking and storage at inappropriate temperatures.

Food safety is related to the presence of food-borne hazards in food at the point of consumption (intake by the consumer). As the introduction of food safety hazards can occur at any stage of the food chain, adequate control throughout the food chain is essential. Thus, food safety is ensured through the combined efforts of all the parties participating in the food chain. FAO/WHO (2001) required that people who do not maintain an appropriate degree of personal cleanliness, they have certain illnesses or conditions and behave inappropriately, can contaminate food and transmit illness to consumers.

Rough estimating of 48 million food-borne diseases occur each year in the United States (USA) alone, leading to 128,000 hospitalizations and 3000 deaths (Center for Disease Control (CDC), 2010). In Europe, it was reported that approximately 5,196 food-borne outbreaks (including water-borne outbreaks) occurred in 2013 (European Food Safety Authority (EFSA), 2012). It is also reported by the (WHO) 2013 that food-borne diseases largely reduce the health and economic growth of both developed and developing countries. Food-borne and water-borne outbreaks of diarrhea kill nearly 2.2 million people worldwide every year. Apart from diarrhea, food-borne illnesses can also trigger other serious complications such as

kidney and liver failure, brain and neural disorders, reactive arthritis, cancer and death (WHO, 2013). Therefore, the causes of food-borne outbreaks need to be investigated carefully to prevent these outbreaks (Center of Disease Control (CDC), 2010).

A study to assess knowledge, attitudes, and behavior concerning food-borne diseases and food safety issues amongst formal food handlers conducted in Italy found that the majority of food handlers who had attended a training course had knowledge and positive attitude toward food-borne diseases control and preventive measure. The positive attitude was not supported when asked about self-reported behaviors and when observed during food preparation for practice of hygienic principle. This was on the basis that only 20% used gloves when touching raw, unwrapped food. Predictors of the use of gloves were educational level and attending training courses. The authors suggested that emphasis should continue on improving knowledge and control of food-borne diseases amongst food handlers (Angelillo *et al.*, 2000).

Wie *et al.*, (1997) studied the impact of a sanitation and food safety course on attitudes and knowledge of hospitality students. This researcher analyzed data from 68 students required to take a sanitation and safety course in the hospitality major. Researchers compared students' knowledge and attitudes toward sanitation and food safety before and after completion of the course. Results of this study showed student' knowledge and attitude improved after completion of the course, they concluded that offering a foodservice sanitation and safety training course, coupled with continuing education was very important for increasing knowledge .

Hsu *et al.*, (1995) studied sanitation knowledge, attitudes, and behaviors of 178 university foodservice non- managerial workers in nine universities. Results indicated that foodservice workers were most knowledgeable about dishwashing procedures (91.9%) and mold-related food poisoning issues

(88.6%). Respondents were least knowledgeable about microorganisms (68.2%). Results also showed that respondents had positive attitude and behaviors. Variables influencing sanitation knowledge, attitude and behaviors were educational level, age, gender, work experience and amount of employee training. These researchers concluded that design of future training programs should allow employee to apply the new knowledge they learn in real life situation and work environments. It is recommended that managers of university foodservice conduct food safety training on a routine basis for both new employee and current employee and update new food safety knowledge and materials when those become available. Repeated training could improve employee' food safety knowledge, increase employees' positive attitudes toward food safety, and influencing their food safety behaviors.

Mukhola (1998) in assessing the factors influencing the safety and quality of street food in a rural area in Limpopo examined the knowledge, attitude perception in both street food vendors and consumers. The findings indicated that the majority of street food vendors and consumers had little information regarding the proper preparation and storage of food as well as environmental conditions that may be detrimental to health. Furthermore 64.4% of consumers thought that street food is sold under unacceptable conditions and these needed improvement.

Noor (2012) evaluated the knowledge, attitude and practices (KAP) of food handlers working in restaurants in Kuala Pilah, Malaysia. The results showed that the food handlers have excellent knowledge and attitude, and good practices toward food hygiene with mean score (SD) of 83.98(13.26), 82.8 (10.94) and 77.04 (14.98), respectively. There is significant correlation between educational level and attitude ($p=0.008$). Knowledge and attitude ($p=0.001$), knowledge and practice ($p=0.007$) and attitude and practice ($p=0.041$). Even though the result shows satisfactory KAP level of the food

handler, some aspects on hygiene measures like refreezing food item, clean working area and wearing of jewelry and watch need to be emphasized.

Literature indicates that consumer attitudes towards food safety in general differ according to demographic and socio-economic factors such as gender, age, educational level and economic status. An American multi-state survey conducted in 1995/1996 found that men were more likely to report risky practices than women (AlteKruse *et al.*, 1999). The survey results also indicated that the prevalence of risky behaviors increased with increasing socio-economic status. On the other hand, a study carried out to measure knowledge, risk perception and practices of food safety of consumers in the Caribbean-Vietnam, revealed that consumers had an acceptable awareness of appropriate safety practices; however, a considerable number of consumer did not attribute certain illnesses to being food-borne and believed that it was possibly due to their own actions (Jackson *et al.* 1989).

To be effective food hygiene training needs to target changing those behaviors most likely to result in food –borne illness. Most food hygiene training courses rely heavily on the provision of information. There is an implied assumption that such training leads to changes in behavior, based on the knowledge, attitudes and practices (KAP) model. This model has been criticized for its limitation (Ehiri *et al.*, 1997, Griffith, 2000). It is accepted knowledge alone is insufficient to trigger preventive practices and that some mechanism is needed to motivate action and generate positive attitudes (Tones *et al.*, 1994). In an evaluation of food hygiene education, the study was concluded that knowledge alone does not result in changes in food handling practices. Various studies have shown that the efficacy of training interims of changing behavior and attitudes to food safety is questionable (Mortlock *et al.*, 1999).

1.3 Food safety management system (ISO 22000-2005):

International Standard specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption. This International Standard integrates the principles of the Hazard Analysis and Critical Control Point (HACCP) system and application step developed by the Codex Alimentation Commission. The Food Safety Management System should cover organizational and technical issues address the need of the consumer and are based on the concept of continuous assessment and participation of employees working in the slaughterhouse (Jouve, 2000). By means of auditable requirements, it combines the HACCP plan with prerequisite programs (PRPs). Hazard analysis is the key to an effective food safety management system, since conducting a hazard analysis assists in organizing the knowledge required to establish an effective combination of control measures. This International Standard requires that all hazards that may be reasonably expected to occur in the food chain, including hazards that may be associated with the type of process and facilities used, are identified and assessed. Thus it provides the means to determine and document why certain identified hazards need to be controlled by a particular organization and why other need not. During hazard analysis, the organization determines the strategy to be used to ensure hazard control by combining the PRP(s), operational PRP(s) and the HACCP plan. The aim of this International Standard is to harmonize on a global level the requirements for food safety management for businesses within the food chain. It is particularly intended for application by organizations that seek a more focused, coherent and integrated food safety management system than is normally required by law. It requires an organization to meet any applicable food safety related statutory and regulatory requirements through its food safety management

system. This international standard allows an organization, such as a small and/or less developed organization (e.g. a small farm, a small packer-distributor, a small retail or food service outlet), to implement an externally developed combination of control measures.

The goal of ISO 22000 is to provide one internationally recognized standard for a food safety management system that can be applied to any organization in the food chain. The first step to developing a Food Safety Management System in slaughterhouse is to implement pre-requisite programmes, i.e. Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP)(Huss, 2003). ISO 22000 has been aligned with ISO 9001 in order to enhance the compatibility of the two standards.

HACCP has a proven track record for identifying and preventing contamination and combines sense with science to ensure safer food production. It is very complementary to Total Quality Management (TQM) and Quality Assurance (Herrera, 2004). The application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

1.4 Food- borne diseases:

Contaminated food and water have been known to be sources of illness in human. Food borne diseases are still among the most widespread health problems in the contemporary world. In rich and poor countries alike, they pose substantial health burdens, ranging in severity from mild indisposition to fatal illnesses (Tracy, 2011).

Every year, food-borne outbreaks associated with consumption of contaminated foods cause millions of cases and thousands of deaths worldwide, making food-borne illness one of the most widespread public health problems in modern society (Cagri-Mehmetoglu, 2009), for example many communicable diseases, including emerging zoonoses are transmitted

through food and many other diseases including cancers are associated with chemicals and toxins in the food supply. This existing burden will be compounded by the effects of climate change, which is likely to increase the incidence of food-borne diseases because of the faster growth rate of microorganisms in food and water at higher temperatures, potentially resulting in higher levels of toxins or pathogens in food (WHO, 2010).

Arie *et al.* (2010) said microbes can enter the food chain at different steps are highly versatile and can adapt to the environment allowing survival, growth and production of toxic compounds and therefore Cagri-Mehmetoglu (2009) recommended to decrease food-borne illness the implementation of safe food handling practices and protection from high-risk choices throughout the entire farm-to-fork continuum with the home food being the last link in this chain and ensuring washing hands with soap and water before preparing food which decreases the risk of food-borne illnesses. The FDA recommends that hands be washed with soap and warm water for at least 20 seconds before and after handling food, especially raw meat (Cagri-Mehmetoglu 2009). Critical control points preventing food-borne illness include preventing cross-contamination from the raw products to ready-to eat, using adequate times and temperatures for cooking, avoiding recontamination after cooking by surfaces previously contaminated with the raw meat and properly chilling and storing meat after cooking (Losasso *et al.*, 2012). Bruhn and Schutz (1998) Failure to fully recognize the symptoms or sources of food-borne disease prevents consumers from taking corrective action, and when consumers mishandle food during preparation, the health community, food industry, regulators and the media are ultimately responsible. Whether inappropriate temperature control, poor hygiene, or another factor, the error occurs because consumers have not been informed about how to handle food and protect them the food safety message has not been delivered effectively (Bruhan, 1997).

Although acute gastrointestinal diseases are not all food-borne and food-borne diseases do not always result in acute gastroenteritis, food does represent an important vehicle for pathogens causing acute gastroenteritis (Tracy, 2011). FAO (1991) estimated that as much as 70% of diarrheal diseases in developing countries are believed to be of food-borne origin also the World Health Organization recognized that food-borne diseases include a wide spectrum of illnesses which are a growing public health problem worldwide and are a major contributor to illness, compromised nutritional status, less resistance to disease and loss of productivity (Tracy, 2011).

1.5 Hygiene of slaughterhouse workers:

Contamination of meat carcasses has pointed to many sources including abattoir workers (Wagude, 1999). The Food Safety Management System should cover organizational and technical issues address the needs of the consumer and are based on the concept of continuous assessment and participation of all employees working in the slaughterhouse (Jouve, 2000).

The high incidence of food borne illnesses has led to an increase in global concern about food safety. Several food borne-disease outbreaks have been reported and associated with poor personal hygiene of people handling foodstuffs (Altekruse *et al.*, 1998., Bryan, 1988, Shapiro *et al.*, 1999).

Worker mishandling of food is one of the major causes of food borne disease outbreaks (WHO, 2000). Food handlers have a major responsibility in the prevention of contamination associated with food spoilage and food poisoning during the production and distribution of food and, if personal hygiene is unsatisfactory, they may cross-contaminate raw and processed foodstuffs or a symptomatic carriers of pathogenic organisms may contribute to the spread of disease (Walker *et al.*, 2003).

According to Johns (1991) personal hygiene can be defined as follows: “as clean as is reasonably practical of hands, forearms, neck, hair and any

clothing liable to come into contact with food. Personal hygiene is critical in preventing contamination of food and food borne illness, they must wash their hands properly to prevent contaminating other foods, and surfaces they touch. (Medeiros *et al.*, 2001).

Koopmans and Duizer (2004) indicated that contamination of food could occur anywhere in the "farm-to-fork" continuum, but most of food borne illnesses can be traced back to infected persons who handle food improperly. Workers at food chain may transmit pathogens to food from a contaminated surface, from another food or from hands contaminated with organisms from their gastrointestinal tract.

For many years there have been requirements regarding the clothing and personal hygiene of workers, if properly enforced, these should control contamination from workers' bodies (Restaino and Hechelmann, 1992, Kasprowiak and Wind, 1990). Facilities for personal hygiene should include: changing rooms, showers, flush toilets, hand-washing and hand-drying facilities in the appropriate locations, and separate areas for eating; and protective clothing that can be effectively cleaned and minimizes accumulation of contaminants. All areas, in which exposed meat, should be equipped with adequate facilities for washing hands that: are located convenient to work stations, have taps that are not operable by hand, Supply water at an appropriate temperature, and are fitted with dispensers for liquid soap or other hand cleansing agents; include hand drying equipment where necessary and receptacles for discarded paper towels, and have waste water ducted to drains (Brendan *et al.*, 2006).

Slaughtering and dressing of animals, and handling and inspection of meat, presents many opportunities for cross-contamination. Personal hygiene practices should prevent under general contamination, and prevent cross-contamination with human pathogens that may cause food-borne disease (CAC/RCP, 2005).

There is approved association between slaughter practice and hygienic practice of the workers (Gerats, 1990). The washing and disinfestations with hot water rarely take place, and both hygienic disposition and easy access to hygienic facilities were important for hygienic behavior in slaughterhouse (Gerats *et al.*, 1982, Stolle and Reuter 1989, Abdalla *et al.*, 2009).

Operator's knives are used to separate the skin from underlying hock and skin become heavily contaminated, as do their knives, steels and clothes. Hygienic hand disinfection, referred to the reduction of predominantly transient microorganisms with the use of germicidal agents or antiseptic detergent formulations (Sheena and Stiles 1982, Ayliffe *et al.*, 1987, Nicoletti *et al.*, 1990)

Transient organisms are of concern because they are readily transmitted by hands unless removed by the mechanical friction of washing with soap and water, or destroyed by the use of an antiseptic solution (Larson, 1995). Hands, as well as contaminated gloves, serve as vectors for transmission of transient microorganisms (Fendler *et al.*, 1998).

According to Miller (1994), transient bacteria cause great concern to the food service industry because these organisms are loosely attached to the surface of the skin and can easily contaminate food products if employees do not wash their hands adequately. Contamination can occur from the preparation of various types of foods by persons with rotavirus-contaminated hands (Ansari *et al.*, 1991).

Transmission to hands may take place through cross-contamination of foods and utensils when food workers process raw foods (Coates *et al.*, 1987).

(Powell *et al.*, 1997) emphasized the importance of training food handlers, but studies have shown that food-borne disease outbreaks still occur despite training given to food handlers' hands, arms and fingers of food employees may become contaminated with fecal microorganisms after using the toilet.

These organisms include salmonellae, E. coli, Staphylococcus aureus (Snelling, 1991).

The FDA (2009) reported that food borne illness risk factors in selected institutional foodservice, restaurant, and retail food store facility. Types, (2004) identified risk practices and behaviors that contributed to food borne illnesses: improper holding/time and temperature; poor personal hygiene; contaminated equipment /prevention of contamination. Many studies found that food safety training is positively associated with self-reported changes in food safety practices production, clean and sanitized gloves, knives, aprons as necessary during production to minimize contamination and all equipment and tables are cleaned and sanitized throughout the day (Brendan *et al.*, 2006).

Food workers play a critical role in ensuring food safety, those who do not practice proper personal hygiene, including hand washing at the appropriate times and using appropriate methods, can contaminate food (Clayton *et al.*, 2002, McElroy and Cutter, 2004).

Duration of hand washing is important for mechanical action as well as to allow sufficient contact time with antimicrobial products (Larson, 1995). Hand washing with plain soap should be sufficient to remove transient microflora from the hands of food service employees (Paulson, 1994). However, antimicrobial soap is statistically more effective in both immediate and residual properties. Increased friction by rubbing hands together or using a scrub brush allows for greater reduction of transient bacteria even with the use of plain soaps or detergents (Restaino and Wind, 1990).

In terms of food establishments, the main purpose of wearing gloves is to prevent pathogenic organisms from being transmitted to foods via hand contact from food workers. An intact vinyl or latex glove (i.e., one with no punctures, tears, or holes) will provide protection from transmission of contaminating microorganisms from hands (Paulson, 1996). The use of

gloves alone does not provide a sufficient barrier against transmission of pathogenic microorganisms from food employees to consumers. Hand washing was strongly encouraged prior to gloving (Snyder, 1997, Fendler *et al.*, 1998, Paulson, 1996) and after removal of gloves (Larson, 1995, Doebleling *et al.*, 1988, Olson *et al.*, 1993).

According to Bardell (1995), it is not uncommon for gloves to be worn for long periods of time without being changed and it is not unusual for food employees to put gloved hands to their mouths or noses without changing their gloves.

There have been requirements regarding the clothing and personal hygiene of workers. If properly enforced, these should control contamination from workers' bodies (Kasprowiak and Hetchelmann, 1992, Restaino and Wind, 1990).

Workers in the clean and dirty areas must be identifiable by different colored protective clothing so as to control the movement of personnel between these areas. This is required by the Red Meat Regulations (SA, 2004).

The hygienic condition of the dressed carcass is largely determined by the skill with which workers remove the hide and gut. Dressing can be performed equally hygienically with the carcass supported on a cradle, as in past practice (Nottingham *et al.*, 1974, Hudson *et al.*, 1983).

Upgrading dressing line facilities cannot be expected to improve dressing hygiene, unless there is a simultaneous improvement in working practices (Hudson *et al.*, 1983). Dirty hands, workers clothes and slaughterhouse equipment may act as intermediate sources of meat contamination. Accordingly, washing and sanitizing agents are effective in reducing bacterial population and the presence of pathogenic bacteria on carcasses (Thornton and Gracey, 1976, Gill, 2004). Jeffery *et al.*, (2003) Noted that the workers hands and the equipment were the sources of meat contamination. There were significant increases in total bacterial counts at skinning points

than that at washing operations, also, dirty workers hands, clothes and equipment of the slaughterhouse acted as intermediate sources of contamination of meat (Gill, 1998, Gilmour *et al.*, 2004, Abdelsadig, 2006, Abdallah *et al.*, 2009).

Gerats (1990) approved the association between slaughter practice and hygiene practice of the workers. The washing of hands and disinfestations with hot water rarely take place, and both hygienic disposition and easy access to hygienic facilities were important for hygienic behavior in slaughterhouse (Gerats *et al.*, 1982,Stolle and Reuter 1989, Abdalla *et al.*, 2009, Abdalla *et al.*, 2009).

According to Gordon-Davis (1998) one of the a major risks of food contamination originates from the working practices of food handlers and disease causing micro-organisms present in or on the food handler's body are subsequently transmitted from the food handler to the food during the handling process. Mart *et al.*, (2000) highlight the education of food handlers as a crucial line of defense in the prevention of most types of food borne illnesses. To ensure that staff members conform to personal hygiene requirements two issues must be considered: the environment within which the staff operates and the "quality" of the staff members. From food hygiene point of view the quality of the working environment depends on the facilities or equipment provided, which include toilets and protective clothing. The quality of staff depends upon their health, their hygiene and their habits (Johns, 1991).

The increasing incidence of food borne diseases has been assigned too many different factors, including population growth, changes in food preparation habits, a rise in the number of food-service establishments, increased consumption of food outside the home and a lack of food safety training and education among consumers and food handlers (Motarjemi and Kaferstein,

1999). Worker mishandling of food is one of the major causes of food borne disease outbreaks (WHO, 2000).

Because outbreaks often lead to severe economic losses, food handler training is an important business strategy for managing food safety risks. Moreover, food handler training is seen as one strategy by which food safety can be increased, offering long-term benefits for the food industry (Smith, 1994).

The human body is a reservoir for numerous microorganisms, with hands being the main agents for cross contamination within a food handling establishment (Gordon-Davis, 1998). Jay (1996) reported that the hands of food handlers generally reflect the environment and also the habits of an individual. The final step in hand-washing is drying. All the respondents indicated that they used disposable paper towels for this purpose. The usage of disposable paper towels is recommended due to its single use followed by disposal, which eliminates the possibility of cross-contamination (Hobbs and Roberts, 1993).

Van Zyl (1995) proposed that the overalls, hairnets (beard nets if applicable), hardhats, gumboots and aprons should at all times be worn by meat handlers. Because the purpose of wearing overalls is to protect both the food product and the meat handler from cross contamination, because meat handlers are probable sources of contamination from micro-organisms, it is important that all possible measures be taken to reduce or eliminate such contamination (Mortimore and Wallace, 1994)

Hobbs and Roberts (1993) emphasized the importance and advantages of having on-site health services especially in large food handling establishments, with a large work force. According to Jacob (1989) routine medical examinations of food handlers are of little value because they merely reveal the health status of the worker at a specific point in time.

Small and Lues (2003) explained that food handlers must undergo medical examinations before employment to assess the general health of the food handler. However, Jacob (1989) suggested that routine medical examinations are regarded as not being cost-effective and, in fact, unreliable.

1.6 Knowledge, attitudes and practices (KAP):

The relationship between knowledge, attitudes and practices is often explained. It has been traditionally assumed that knowledge is automatically translated into behavior (Glanz *et al.*, 2002).

Knowledge accumulates through learning processes and these may be formal or informal instruction, personal experience and experiential sharing (Tracy, 2011). Knowledge however is not insignificant and it is found to be vital in the cognitive processing of information in the attitude-behavior relationship.

Attitudes involves evaluated concepts associated with the way people think, feel and behave, it comprises a cognitive, emotional and a behavioral component implying of knowing, feeling and doing (Keller, 2007).

In health related studies, however, it has been found that knowledge is not the only factor that influences treatment seeking practice and in order to change behavior, health programs need to address a number of issues including socio-cultural, environmental, economical and structural factors (Tracy, 2011).

Behaviorists further added that a number of factors can influence one or more of the KAP variables such as self-esteem, self-efficacy and misconception.

In the world Health Organization 2006 introduced simpler, more generally applicable and essential food safety messages or principles linked to behaviors. If adopted and practiced, these messages will reduce the probability of food borne illness. The core messages of the five keys to safer

food are (1) keep clean; (2) Separate raw and cooked; (3) cook thoroughly; (4) keep food at safe temperatures; and (5) Use safe water and raw materials. On the other hands ,Byrd *et al* .,(2007)developed a food safety knowledge into five concepts or keys inspired by WHO which are cross contamination prevention/ disinfection procedures; safe times/temperatures for cooking/ storing foods ; groups at greatest risk for food-borne disease; food that increase risk of foodborne disease ; and food borne disease pathogens.

Across sectional study by Maryam *et al.*, (2010)from school of Veterinary Medicine, Shiraz University, Iran. The study evaluates the knowledge, attitudes and practices of workers in meat processing plant. The results indicate that there is an acceptable level of knowledge, excellent attitudes and poor practices towards food hygiene measures.The study also showed lack of knowledge about microbial food hazards and negative correlation between knowledge and practices, attitudes and practices.

Study done by Siow and Norrakiah (2011) from Malaysia to evaluate the level knowledge, attitudes and practices among food handlers.

The study reveals that the respondents share a good knowledge on personal hygiene and definition of food- borne diseases (93.85%) and poor knowledge on food storage and preparation temperature (28%) and they showed good attitudes in food handling.

Studies have found that food safety training is positively associated with self-reported changes in food safety practices (Clayton *et al.*, 2002) and improved attitudes (Wie and Strohbehn *et al.*, 1997).

Other studies found that training helps to improve the overall employee knowledge about food safety (Castello *et al.*, 1997, Finch and Daniel.,2005 Howes *et al.*, 1996), although others found that training is not consistently associated with improved knowledge (Luby *et al.*, 1993 and Pilling *et al.*, 2008).

Another study by (Sufen Liu *et al.*, 2015) from china evaluated the knowledge, attitudes and practices of food safety among risk factors contributing to food-borne disease out breaks. The majority of respondents did not know the maximum stored time at room temperature, they have positive attitudes about food safety and training, and there was significant variance among different food establishments, different ages and different times of training.

A recent study by Ola (2014) in Khartoum state showed that television and radio were the most important sources of information for the consumers and there is a direct relationship between the internet and the level of consumer's knowledge, also the degree of knowledge of each individual has strong link with his life style.

Other studies by Khalid (2016) in Khartoum state found there is a need for more education to the consumers about food safety and food-borne diseases.

1.7 Knowledge, Attitudes and Practices (KAP) on food Safety and Food-borne Diseases

A study to evaluate knowledge, attitudes, and behavior concerning food-borne diseases and food safety issues amongst formal food handlers conducted in Italy found that the majority of food handlers who had attended a training course had knowledge and a positive attitude toward food-borne diseases control and preventive measures (Tracy, 2011). The positive attitude was not supported when asked about self-reported behaviors and when observed during food preparation for practice of hygienic principles (Tracy, 2011). On other hand (Abdallah *et al.*, 2009) considering food handling personal play important role in ensuring food safety throughout the chain of food production and storage, although there are also many gaps in food safety knowledge and practices that may result in food-borne diseases (Eduarda *et al.*, 2007).

Food safety experts have identified the most common food-handling mistakes made by consumers at home. These mistakes include serving contaminated raw food, cooking or heating food inadequately, allowing 12 hours or more between preparations and eating, and having a colonized person handle implicated food or practice poor hygiene. The same factors were identified in mishandling associated with specific pathogens (Bruhan 1997). The authors suggested that emphasis should continue on improving knowledge and control of food-borne diseases amongst food handlers (Angelillo *et al.*, 2000), they included the perception that unsafe food is a personal health threat, the perception that one could do something about the threat (self-efficacy), and the motivation to maintain good health (Robert *et al.*, 1993). Recent survey studies pinpointing the need for training and education of food handlers in public hygiene measures and revealed a general lack of knowledge of microbiologic food hazard, refrigerator temperature ranges, cross contamination and personal hygiene (Bas *et al.*, 2006).

1.8 Impact of Education of Food Industry Personal in Hygiene Matters:

Educational materials may not be effective if they are designed without looking at the worksite social, physical, and environmental factor surrounding the target audience. Food safety education is most likely to be effective when it is designed specifically for the audience (consumers) and the particular hazard of interest (Nieto-Montenegro *et al.*, 2005) so requires a re-examination of food safety educational messages to conform epidemiological changing of food-borne illnesses and the increase in knowledge concerning emerging food-borne pathogens to ensure that the guidance given to consumers is appropriate for controlling pathogens that are prevalent in the food supply chain (Jevsnik *et al.*, 2008). Also research is needed to establish reliable and valid evaluation measures for five behavioral

constructs which are practice personal hygiene, cook foods adequately, avoid cross-contamination, keep foods at safe temperatures, and avoid food from unsafe sources. If evaluation instruments focus on these five behavior areas, the result will be more easily summarized across food safety education programs for consumers (Lydia *et al.*, 2001) because at the end of the day the best ways to manage risk of food-borne illness to promote safer handling of food at the consumer end of the food chain are communication and consumer education (Patil *et al.*, 2005). Education of food industry personal in hygiene matters is recommended for improving safer food handling practices (Tracy, 2011).

Media presentation can motivate people to listen and change behavior because consumers need to understand how to protect themselves through kitchen and personal hygiene, including thoroughness and frequency of hand washing, temperature control, and safe food choices such as foods processed by heat or energy pasteurization (Bruhn, 1997).

Educational material regarding Good Housekeeping Practice should be available to the general public from many sources. Only safety –conscious consumers can become active partners within the food safety circle (Jevsnik *et al.*, 2008).

Chapter Two

Materials and Methods

Materials and Methods

2.1 Study area:

This survey was conducted from October-November 2017 in two export slaughterhouses in Khartoum is the political capital of the Sudan.

2.2 Target population:

The target population of this study was the workers in two slaughterhouses which are used for export of meat in Khartoum state.

2.3 Study design:

Face –to-face questionnaire was used to collect information about knowledge, attitudes and practices of the target population regarding food safety.

Questionnaire was composed of 60 workers were selected randomly who directly involved in slaughtering process in the abattoir. In the knowledge part, there were close-ended questions emphasizing personal hygiene, cross contamination, microbiological food hazards and specific food-borne disease. Subsequent part of the questionnaire was dealing with the attitudes of the responder about various hygienic measures for food safety. The handlers were asked to indicate their level of agreement to the statements. Practices of food workers were assessed by their self-reported hygienic behaviors in the last part of the questionnaire.

2.4 Data Analysis:

Statistical Methods: The use of comparative analytical method using the SPSS statistical program based on descriptive statistics and comparative and association hypothesis tests (0.05 sig. level), to demonstrate the differences in food safety knowledge, attitude, and practice among worker in slaughterhouses.

The test was used for Chi-square test to study the hypothesis which states there are no significant differences in food safety knowledge, attitude,

and practice among worker in slaughterhouses with respect to their gender, age, education level and occupation.

Chapter Three

Results

Results

Table (1): Demography of workers (n=60) in export slaughterhouses in Khartoum state:

Participants		Frequency	Percentage
Gender	Male	47	78.3
	Female	13	21.7
Age	20-30 years	12	20.0
	31-40 years	29	48.3
	41-50 years	11	18.3
	More than 50 years	5	8.3
	Not determined	3	5.0
Education level	Illiterate	3	5.0
	Basic	5	8.3
	Mediate	8	13.3
	Secondary	16	26.7
	University	17	28.3
	Post-graduate	9	15.0
Occupation	Not determined	2	3.3
	Worker	26	43.3
	Technician	8	13.3
	Technologist	2	3.3
	Veterinarian	15	25.0
	Employee	4	6.7
	Other	5	8.3

Table (1) showed the distribution of gender of participants in males were 78.3%, but in females were 21.7%. Also the age between 31-40 years represented higher percentage (48.3%), while the educational level of these people was 28.3% that educated university but a few were illiterate (5.0). The number of the workers were 26 people (43.3%), whereas the veterinarians were 15 people (25.0%) and the remaining were technicians, employees (Table 1).

Table (2): Distribution of workers (n=60) in export slaughterhouses with the respect to food safety knowledge, attitudes and practices in Khartoum state:

Participants		Frequency	Percent
Food safety knowledge	True	42	70.0
	False	18	30.0
	Do not know	0	0.0
attitudes for food safety	Agree	57	95.0
	Disagree	1	1.7
	No idea	1	1.7
	Not determined	1	1.7
practice of food safety	Often	19	31.7
	Sometimes	5	8.3
	Rarely	36	60.0

As shown in table (2) the majority (70%) of the participants were aware about food safety knowledge. While most of people (95%) agreed with safety food and had idea, but 1 person had disagreed. About 36 of the people had rarely practice food safety, whereas 19 of them were applied it (table 2).

Table (3): Characters of workers (n=60) in export slaughterhouses in Khartoum state:

Food safety knowledge						Attitudes to food safety						Practice of food safety								
Participants		True		False		P-value	True		False		Do not know		P-value	Often		Sometimes		Rarely		P-value
		N	%	N	%		N	%	N	%	N	%		N	%	N	%	N	%	
		Gender	Male	30	63.8%		17	36.2%	0.047*	45	97.8%	1		2.2%	0	.0%	0.146	11	23.4%	
	Female	12	92.3%	1	7.7%	12	92.3%	0		.0%	1	7.7%	8	61.5%	2	15.4%		3	23.1%	
Age	< 20 years	0	.0%	0	.0%	0.309	0	.0%	0	.0%	0	.0%	0.248	0	.0%	0	.0%	0	.0%	0.606
	20-30 years	7	58.3%	5	41.7%		11	91.7%	1	8.3%	0	.0%		4	33.3%	0	.0%	8	66.7%	
	31-40 years	19	65.5%	10	34.5%		28	100.0%	0	.0%	0	.0%		9	31.0%	4	13.8%	16	55.2%	
	41-50 years	10	90.9%	1	9.1%		10	90.9%	0	.0%	1	9.1%		3	27.3%	0	.0%	8	72.7%	
	> 50 years	4	80.0%	1	20.0%		5	100.0%	0	.0%	0	.0%		2	40.0%	0	.0%	3	60.0%	
Education	Illiterate	1	33.3%	2	66.7%	0.105	2	100.0%	0	.0%	0	.0%	0.629	0	.0%	1	33.3%	2	66.7%	0.000*
	Basic	4	80.0%	1	20.0%		5	100.0%	0	.0%	0	.0%		0	.0%	0	.0%	5	100.0%	
	Mediate	4	50.0%	4	50.0%		8	100.0%	0	.0%	0	.0%		0	.0%	1	12.5%	7	87.5%	
	Secondary	9	56.2%	7	43.8%		15	93.8%	1	6.2%	0	.0%		1	6.2%	2	12.5%	13	81.2%	
	University	13	76.5%	4	23.5%		17	100.0%	0	.0%	0	.0%		10	58.8%	0	.0%	7	41.2%	
	Post-graduate	9	100.0%	0	.0%		8	88.9%	0	.0%	1	11.1%		8	88.9%	0	.0%	1	11.1%	
Occupation	Worker	15	57.7%	11	42.3%	0.073	24	96.0%	1	4.0%	0	.0%	0.931	2	7.7%	2	7.7%	22	84.6%	0.000*
	Technician	4	50.0%	4	50.0%		8	100.0%	0	.0%	0	.0%		2	25.0%	1	12.5%	5	62.5%	
	Technologist	2	100.0%	0	.0%		2	100.0%	0	.0%	0	.0%		1	50.0%	1	50.0%	0	.0%	
	Veterinarian	14	93.3%	1	6.7%		14	93.3%	0	.0%	1	6.7%		12	80.0%	1	6.7%	2	13.3%	
	Employee	4	100.0%	0	.0%		4	100.0%	0	.0%	0	.0%		2	50.0%	0	.0%	2	50.0%	
	Other	3	60.0%	2	40.0%		5	100.0%	0	.0%	0	.0%		0	.0%	0	.0%	5	100.0%	

In Table 3 there were no significant differences in food safety knowledge and the attitudes of the workers in slaughterhouse ($P>0.5$). But there was significantly different in practicing of food safety among the workers ($p< 0.5$).

Table (4): Food safety knowledge, attitudes and practices of workers (n=60) in export slaughterhouses in Khartoum state:

food safety knowledge in slaughterhouses		True	False	Do not know
Proper cleaning and handling of instruments reduces the risk of contamination.	N	58	1	0
	%	98.30%	1.70%	0.00%
Washing hands before work reduces the risk of contamination.	N	58	2	0
	%	96.70%	3.30%	0.00%
Using gloves during work reduces the risk of contamination.	N	57	2	1
	%	95.00%	3.30%	1.70%
All persons, including children, and adults are at equal risk for meat poisoning.	N	32	19	6
	%	56.10%	33.30%	10.50%
Eating and drinking in the work place increases the risk of contamination.	N	54	4	1
	%	91.50%	6.80%	1.70%
During infectious disease of eye, it is necessary to take leave from work.	N	58	2	0
	%	96.70%	3.30%	0.00%
During infectious disease of skin, it is necessary to take leave from work.	N	59	1	0
	%	98.30%	1.70%	0.00%
Typhoid can be transmitted by meat.	N	37	7	16
	%	61.70%	11.70%	26.70%
Hepatitis A, B virus is among the food borne pathogens.	N	45	5	9
	%	76.30%	8.50%	15.30%
Brucellosis can be transmitted by	N	30	9	21

meat.	%	50.00%	15.00%	35.00%
Staphylococcus, clostridium botulinum is among the food borne pathogen.	N	36	2	22
	%	60.00%	3.30%	36.70%
distribution towards food safety in slaughterhouses		Agree	Disagree	No idea
Using apron is important in reducing risk of contamination.	N	57	0	2
	%	96.60%	0.00%	3.40%
Using masks is important in reducing risk of contamination.	N	58	0	1
	%	98.30%	0.00%	1.70%
Using caps is important in reducing risk of contamination.	N	57	0	2
	%	96.60%	0.00%	3.40%
Using gloves is important in reducing risk of contamination.	N	55	2	1
	%	94.80%	3.40%	1.70%
One of the most important responsibilities of the food handlers is washing hands to food safety measures.	N	57	1	1
	%	96.60%	1.70%	1.70%
Should not touch meats without gloves.	N	36	21	2
	%	61.00%	35.60%	3.40%
Health status of the workers should be evaluated before employment.	N	54	2	3
	%	91.50%	3.40%	5.10%
Food hygiene training for workers is an important issue in reducing risk of contamination.	N	53	5	1
	%	89.80%	8.50%	1.70%
It is necessary to check the temperature of the refrigerator to	N	48	5	6
	%	81.40%	8.50%	10.20%

reduce risk of contamination.						
Food borne illnesses can have deleterious health and economic effects on the society.		N	56	1	2	
		%	94.90%	1.70%	3.40%	
food safety practices in slaughterhouses		Always	Often	Sometimes	Rarely	Never
Do you wear apron during work?	N	21	3	2	28	5
	%	35.60%	5.10%	3.40%	47.50%	8.50%
Do you use gloves during work?	N	25	1	10	11	13
	%	41.70%	1.70%	16.70%	18.30%	21.70%
Do you wash your hands before using gloves?	N	22	0	2	30	6
	%	36.70%	0.00%	3.30%	50.00%	10.00%
Do you use mask during work?	N	18	4	16	15	7
	%	30.00%	6.70%	26.70%	25.00%	11.70%
Do you use cap during work?	N	17	1	13	19	10
	%	28.30%	1.70%	21.70%	31.70%	16.70%
Do you wash your hands after you touch raw meat?	N	28	2	4	23	3
	%	46.70%	3.30%	6.70%	38.30%	5.00%
Do you wash your hands after rest time when	N	18	1	3	34	1
	%	31.60%	1.80%	5.30%	59.60%	1.80%

you come back to work?						
Do you eat or drink in your work?	N	2	0	5	2	50
	%	3.40%	0.00%	8.50%	3.40%	84.70%
Do you smoke in your work?	N	1	0	1	2	53
	%	1.80%	0.00%	1.80%	3.50%	93.00%
Do you use the products of your working plant?	N	3	2	8	35	10
	%	5.20%	3.40%	13.80%	60.30%	17.20%
Do you recommend the products of your working plant to other?	N	6	1	6	34	12
	%	10.20%	1.70%	10.20%	57.60%	20.30%

Most of these workers knowing proper cleaning reduced contamination (98.3%), also using of the gloves (95%) during the work reduced the risk of contamination (Table4).

About 96.7% the infection of the eye and skin causing contamination of the food, while 76.3% of them had idea of hepatitis A, B virus and brucella were diseases among the food-borne pathogen. The majority of participants (Table 4) were determined this attitude and agreed by using apron and cap (96.6%) and mask (98.3%). The participants who practicing level of food safety were 35.6%, while 47.5% of them rarely wearing apron during the work. Whereas 5.3% of them were washing their hands sometimes after rest time (table 4).And (60%) of them know Staphylococcus, Clostridium botulinum is among the food-borne pathogen but (36.7) of them don't know.

Chapter Four

Discussion, Conclusion & Recommendation

Discussion

In the present study the respondents (Table 4) have high knowledge in proper cleaning and handling of instruments (98.3%), washing hands and wearing of gloves reduce the risk of contamination (96.7%). But eating and drinking in place of work increases the risk of contamination (91.50%) and taking leave from work during infection of skin and eye it is necessary (96.7%-98.3%).

In our results, the participants showed low level of knowledge (56.10%) about meat poisoning, also they determined their knowledge about food-borne diseases, typhoid and brucellosis can be transmitted by meat (61.7%-50%) but (26.7%-35%) do not know of them, (76.30%-60%) of the respondents have good knowledge about hepatitis A, B virus, *Staphylococcus* and *Clostridium botulinum* is among the food-borne pathogen (Elhajet *et al.*, 2012; Magda *et al.*, 2012).

Using apron, masks, caps, and gloves and washing hand which reduces the risk of contamination and this leading to reduction of transmission of food-borne diseases. Our results revealed that (Table 4) the persons participated in the questionnaires food hygiene training of the workers is important in reducing food contamination, this results in agreement with the results of Hows *et al.* (1996) and Abdalla *et al.* (2009) who stated that education of abattoir workers and meat handlers is important that providing wholesome and safe meat for consumers. Also 94.90 % of them have knowledge and attitudes that food-borne illness can harm health and economic loss in the society (Jones and Angulo, 2006).

The overall attitudes of the participants our study know well food safety managements, but there is significant negative association between correct handling of food and food-borne diseases prevention. In this results (Table 4) food hygienic practice are low, which indicated that proper personal hygienic practices is not implemented. But Siham and Abdallah, (2010) who

explained that all persons working in contact with food and food products must be adhered to hygienic practices while on duty to prevent corruption of product. Also, the application of proper and systemic hygienic practices, food will be safe and a number of food-borne diseases will be eradicated (Ali, 2007).

A study to assess knowledge, attitudes, and behavior concerning food-borne diseases and food safety issues amongst formal food handlers conducted in Italy found that the majority of food handlers who had attended a training course had knowledge and positive attitude toward food-borne diseases control and preventive measure. The positive attitude was not supported when asked about self-reported behaviors and when observed during food preparation for practice of hygienic principle. This was on the basis that only 20% used gloves when touching raw, unwrapped food. Predictors of the use of gloves were educational level and attending training courses. The authors suggested that emphasis should continue on improving knowledge and control of food-borne diseases amongst food handlers (Angelillo *et al.*, 2000). In Malawi, a study on the KAP on food hygiene of caregivers also showed a poor relation between knowledge, behavioral and sanitary practices (Tracy, 2011). Also there is disagreement between Julie(1995) and our results in that respondents knew proper food handling concepts but did not put those concepts into practice. Therefore, increasing the adoption of safe food handling practices by consumers should become an important aspect for educators in food safety educational programmes (Julie, 1995).

On other research , Hind (2012) evaluation for principles of food hygiene and safety in meat plants reported, the personal hygiene in all factories not complying with the principles of food hygiene as many employees not following the instructions with regard to hand washing and personal behavior.

Conclusion and Recommendation

The present study concluded that:

In conclusion workers in abattoir as general must have better knowledge of food safety concepts and need to receive more information about food handling practices to enable them to translate knowledge in to practice, and more education about food-borne diseases.

Recommendation:

1. Training conducted should focus on an understanding of the rationale for the attitude as knowledge is not always translated in to practice or behaviors.
2. Adequate training strategies should be established, implemented and maintained to improve the knowledge and resulting attitude and practices of workers in slaughterhouses.
3. More researches and studies about food safety should be conducted.

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Appendixes

Appendix i
QUESTIONNAIRE
Sudan University of science &Technology
College of post Graduate Studies
Master of Quality Management and Excellence

*Assessment of food safety knowledge, attitudes and practices
amongslaughterhouses workers in Khartoum state*

Note:

The data will be collected for study purposes only.

Sex: male () female ()

Age:

20-30 years () 31-40 years ()

41-50 years () more than 50 years ()

Education level:

Illiterate () Basic ()

Mediate () Secondary ()

University () Post-graduate ()

Occupation:

Worker () Technician ()

Technologist () Veterinarian ()

Employee () other ()

Assessment of food safety knowledge of workers in slaughterhouses

Statements	True	False	Do not know
Proper cleaning and handling of instruments reduces the risk of contamination?			
Washing hands before work reduces the risk of contamination?			
Using gloves during work reduces the risk of contamination?			
All persons, including children, and adults are at equal risk for meat poisoning?			
Eating and drinking in the work place increases the risk of contamination?			
During infectious disease of eye, it is necessary to take leave from work?			
During infectious disease of skin, it is necessary to take leave from work?			
Typhoid can be transmitted by meat			
Hepatitis A, B virus is among the food borne pathogens			
Brucellosis can be transmitted by meat			
Staphylococcus, clostridium botulinum is among the food borne pathogen			

Assessment of food safety attitudes of workers in slaughterhouses

Statements	No idea	Disagree	Agree
Using apron is important in reducing risk of contamination?			
Using masks is important in reducing risk of contamination?			
Using caps is important in reducing risk of contamination?			
Using gloves is important in reducing risk of contamination?			
One of the most important responsibilities of the food handlers is washing hands to food safety measures?			
Should not touch meats without gloves?			
Health status of the workers should be evaluated before employment?			
Food hygiene training for workers is an important issue in reducing risk of contamination?			
It is necessary to check the temperature of the refrigerator to reduce risk of contamination?			
Food borne illnesses can have deleterious health and economic effects on the society?			

Assessment of food hygienic practices in slaughterhouses

Responses					
Statement	never	rarely	sometimes	often	always
Do you wear apron during work?					
Do you use gloves during work?					
Do you wash your hands before using gloves?					
Do you use mask during work?					
Do you use cap during work?					
Do you wash your hands after you touch raw meat?					
Do you wash your hands after rest time when you come back to work?					
Do you eat or drink in your work?					
Do you smoke in your work?					
Do you use the products of your working plant?					
Do you recommend the products of your working plant to other?					

Appendix ii

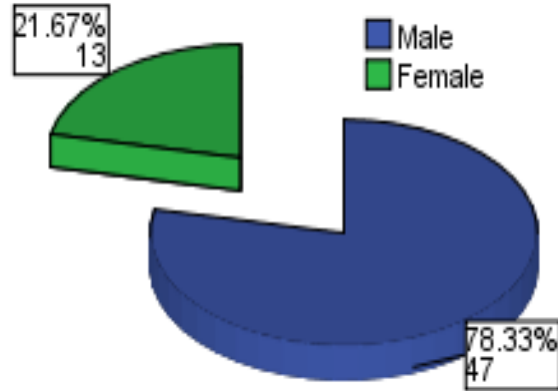


Figure (1):Participants distribution with Respect to Gender

Table (1) and Figure (1) show the distribution of gender for participants, that (78.3%) of them were male while only (21.7%) were female.

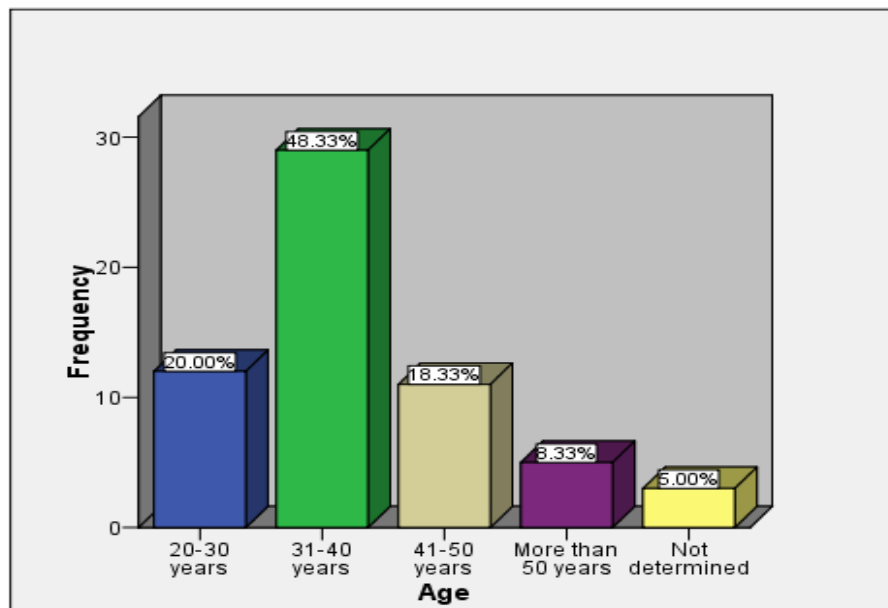


Figure (2):Participants distribution with Respect to Age

Table (2) and Figure (2) show that (20%) of participants were (20-30 years old), (48.3%) of them (31-40 years), (18.3%) of them (41-50 years), while only (8.3%) of them were more than 50 years old, since (5%) of them did not specify. Therefore, most of the participants were (31-40 years old).

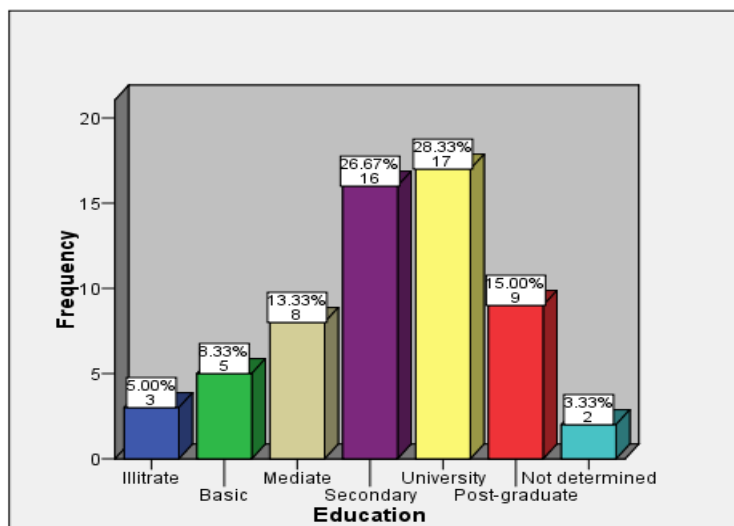


Figure (3):Participants distribution with Respect to education level

Table (3) and Figure (3) show that (5%) of sample units were illiterates, (8.3%) of them have basic school education, (13.3%) of them mediate educated, (26.7%) of them have secondary education, (28.3%) of them have university education, while (15%) of them have post graduate education. Therefore, most of the participants were (secondary or university) educated.

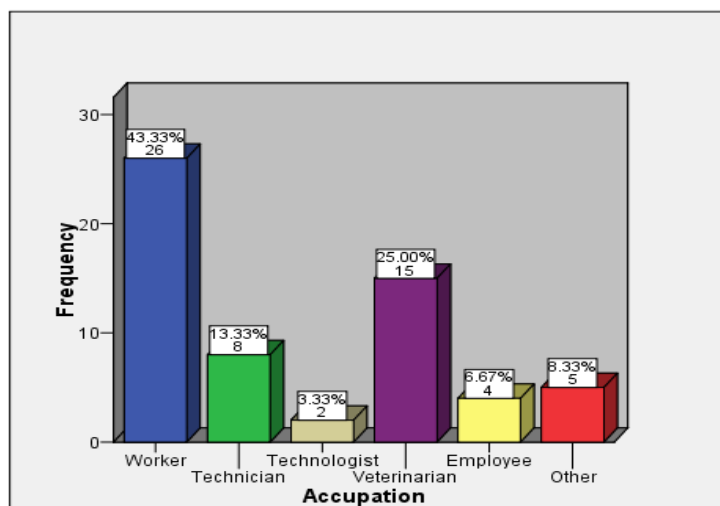


Figure (4):Participants distribution with Respect to occupation:

Table (4) and Figure (4) show that (43.3%) of participants were workers, (13.3%) of them were technicians, (3.3%) of them were technologists, (25%) of them were veterinarian, while (6.7%) of them employee, since (8.3%) of the other occupations. Therefore, most of the participants were (workers or veterinarians).

Appendix iii:ISO (22000-2005)

**Food safety management systems —
Requirements for any organization in the
food chain**

*Systemes de management de la sécurité des denrées alimentaires —
Exigences pour tout organisme appartenant à la chaîne alimentaire*



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ISO 22000:2005(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22000 was prepared by Technical Committee ISO/TC 34, *Food products*.

Introduction

Food safety is related to the presence of food-borne hazards in food at the point of consumption (intake by the consumer). As the introduction of food safety hazards can occur at any stage of the food chain, adequate control throughout the food chain is essential. Thus, food safety is ensured through the combined efforts of all the parties participating in the food chain.

Organizations within the food chain range from feed producers and primary producers through food manufacturers, transport and storage operators and subcontractors to retail and food service outlets (together with inter-related organizations such as producers of equipment, packaging material, cleaning agents, additives and ingredients). Service providers are also included.

This International Standard specifies the requirements for a food safety management system that combines the following generally recognized key elements to ensure food safety along the food chain, up to the point of final consumption:

- interactive communication;
- system management;
- prerequisite programmes;
- HACCP principles.

Communication along the food chain is essential to ensure that all relevant food safety hazards are identified and adequately controlled at each step within the food chain. This implies communication between organizations both upstream and downstream in the food chain. Communication with customers and suppliers about identified hazards and control measures will assist in clarifying customer and supplier requirements (e.g. with regard to the feasibility and need for these requirements and their impact on the end product).

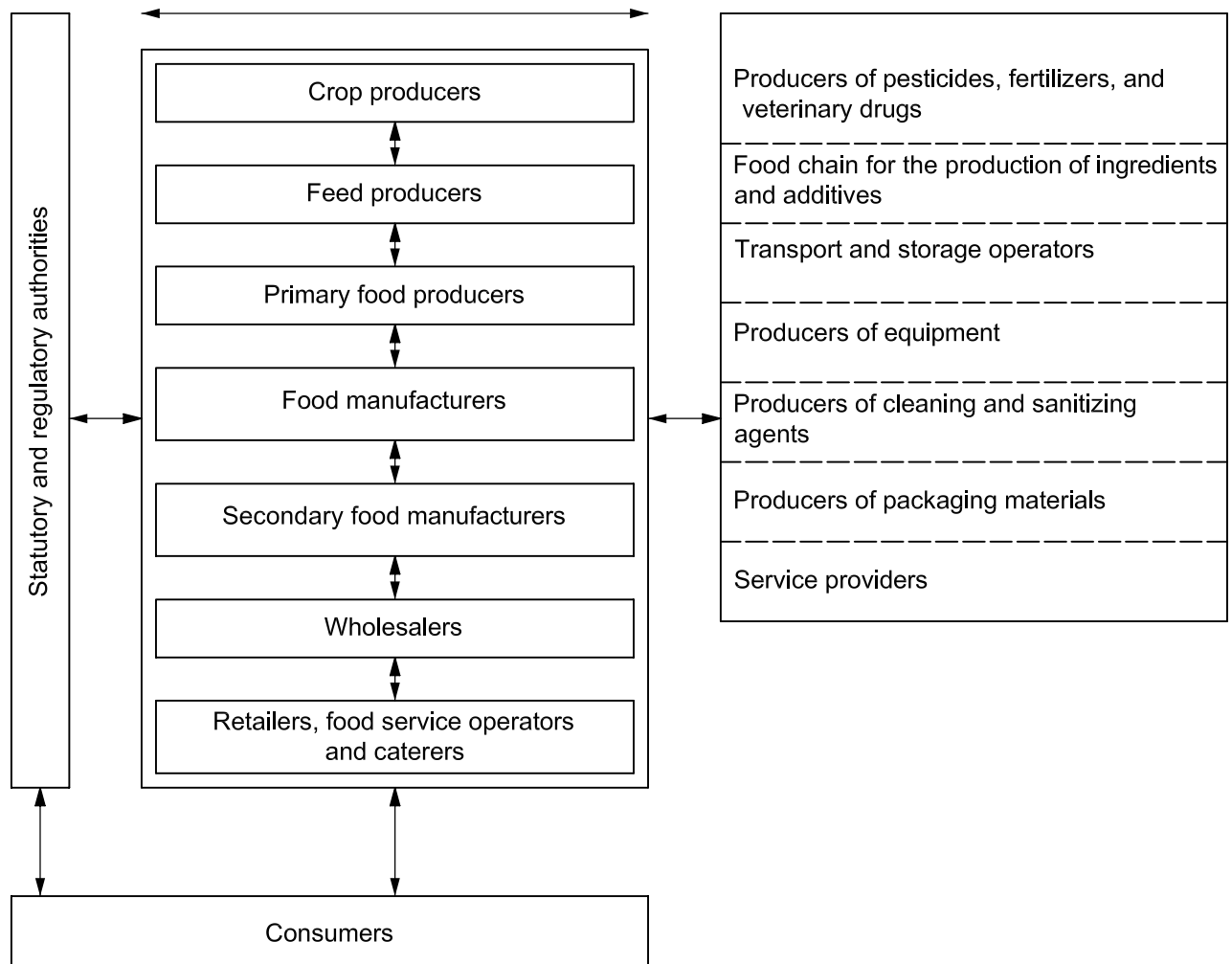
Recognition of the organization's role and position within the food chain is essential to ensure effective interactive communication throughout the chain in order to deliver safe food products to the final consumer. An example of the communication channels among interested parties of the food chain is shown in Figure 1.

The most effective food safety systems are established, operated and updated within the framework of a structured management system and incorporated into the overall management activities of the organization. This provides maximum benefit for the organization and interested parties. This International Standard has been aligned with ISO 9001 in order to enhance the compatibility of the two standards. Cross-references between this International Standard and ISO 9001 are provided in Annex A.

This International Standard can be applied independently of other management system standards. Its implementation can be aligned or integrated with existing related management system requirements, while organizations may utilize existing management system(s) to establish a food safety management system that complies with the requirements of this International Standard.

This International Standard integrates the principles of the Hazard Analysis and Critical Control Point (HACCP) system and application steps developed by the Codex Alimentarius Commission. By means of auditable requirements, it combines the HACCP plan with prerequisite programmes (PRPs). Hazard analysis is the key to an effective food safety management system, since conducting a hazard analysis assists in organizing the knowledge required to establish an effective combination of control measures. This International Standard requires that all hazards that may be reasonably expected to occur in the food chain, including hazards that may be associated with the type of process and facilities used, are identified and assessed. Thus it provides the means to determine and document why certain identified hazards need to be controlled by a particular organization and why others need not.

During hazard analysis, the organization determines the strategy to be used to ensure hazard control by combining the PRP(s), operational PRP(s) and the HACCP plan.



NOTE The figure does not show the type of interactive communications along and across the food chain that by-pass immediate suppliers and customers.

Figure 1 — Example of communication within the food chain

Cross-references between the Codex Alimentarius Commission HACCP principles and application steps (see Reference [11]) and this International Standard are provided in Annex B.

To facilitate the application of this International Standard, it has been developed as an auditable standard. However, individual organizations are free to choose the necessary methods and approaches to fulfil the requirements of this International Standard. To assist individual organizations with the implementation of this International Standard, guidance on its use is provided in ISO/TS 22004.

This International Standard is intended to address aspects of food safety concerns only. The same approach as provided by this International Standard can be used to organize and respond to other food specific aspects (e.g. ethical issues and consumer awareness).

This International Standard allows an organization (such as a small and/or less developed organization) to implement an externally developed combination of control measures.

The aim of this International Standard is to harmonize on a global level the requirements for food safety management for businesses within the food chain. It is particularly intended for application by organizations that seek a more focused, coherent and integrated food safety management system than is normally required by law. It requires an organization to meet any applicable food safety related statutory and regulatory requirements through its food safety management system.

Food safety management systems — Requirements for any organization in the food chain

1 Scope

This International Standard specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

It is applicable to all organizations, regardless of size, which are involved in any aspect of the food chain and want to implement systems that consistently provide safe products. The means of meeting any requirements of this International Standard can be accomplished through the use of internal and/or external resources.

This International Standard specifies requirements to enable an organization

- a) to plan, implement, operate, maintain and update a food safety management system aimed at providing products that, according to their intended use, are safe for the consumer,
- b) to demonstrate compliance with applicable statutory and regulatory food safety requirements,
- c) to evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety, in order to enhance customer satisfaction,
- d) to effectively communicate food safety issues to their suppliers, customers and relevant interested parties in the food chain,
- e) to ensure that the organization conforms to its stated food safety policy,
- f) to demonstrate such conformity to relevant interested parties, and
- g) to seek certification or registration of its food safety management system by an external organization, or make a self-assessment or self-declaration of conformity to this International Standard.

All requirements of this International Standard are generic and are intended to be applicable to all organizations in the food chain regardless of size and complexity. This includes organizations directly or indirectly involved in one or more steps of the food chain. Organizations that are directly involved include, but are not limited to, feed producers, harvesters, farmers, producers of ingredients, food manufacturers, retailers, food services, catering services, organizations providing cleaning and sanitation services, transportation, storage and distribution services. Other organizations that are indirectly involved include, but are not limited to, suppliers of equipment, cleaning and sanitizing agents, packaging material, and other food contact materials.

This International Standard allows an organization, such as a small and/or less developed organization (e.g. a small farm, a small packer-distributor, a small retail or food service outlet), to implement an externally developed combination of control measures.

NOTE Guidance on the application of this International Standard is given in ISO/TS 22004.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000:2000, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000 and the following apply.

For the convenience of the users of this International Standard, some of the definitions in ISO 9000 are quoted with added notes that are applicable only to this special application.

NOTE Terms are not defined where they retain their normal dictionary definition. Where bold type is used in a definition, this indicates a cross-reference to another term defined in this clause, and the number reference for the term is given in parentheses.

3.1
food safety
concept that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use

NOTE 1 Adapted from Reference [11].

NOTE 2 Food safety is related to the occurrence of **food safety hazards** (3.3) and does not include other human health aspects related to, for example, malnutrition.

3.2
food chain
sequence of the stages and operations involved in the production, processing, distribution, storage and handling of a food and its ingredients, from primary production to consumption

NOTE 1 This includes the production of feed for food-producing animals and for animals intended for food production.

NOTE 2 The food chain also includes the production of materials intended to come into contact with food or raw materials.

3.3
food safety hazard
biological, chemical or physical agent in food, or condition of food, with the potential to cause an adverse health effect

NOTE 1 Adapted from Reference [11].

NOTE 2 The term "hazard" is not to be confused with the term "risk" which, in the context of food safety, means a function of the probability of an adverse health effect (e.g. becoming diseased) and the severity of that effect (death, hospitalization, absence from work, etc.) when exposed to a specified hazard. Risk is defined in ISO/IEC Guide 51 as the combination of the probability of occurrence of harm and the severity of that harm.

NOTE 3 Food safety hazards include allergens.

NOTE 4 In the context of feed and feed ingredients, relevant food safety hazards are those that may be present in and/or on feed and feed ingredients and that may subsequently be transferred to food through animal consumption of feed and may thus have the potential to cause an adverse human health effect. In the context of operations other than those directly handling feed and food (e.g. producers of packaging materials, cleaning agents, etc.), relevant food safety hazards are those hazards that can be directly or indirectly transferred to food because of the intended use of the provided products and/or services and thus can have the potential to cause an adverse human health effect.

3.4
food safety policy
overall intentions and direction of an organization related to **food safety** (3.1) as formally expressed by top management

3.5
end product
product that will undergo no further processing or transformation by the organization

NOTE A product that undergoes further processing or transformation by another organization is an end product in the context of the first organization and a raw material or an ingredient in the context of the second organization.

3.6**flow diagram**

schematic and systematic presentation of the sequence and interactions of steps

3.7**control measure**

⟨food safety⟩ action or activity that can be used to prevent or eliminate a **food safety hazard** (3.3) or reduce it to an acceptable level

NOTE Adapted from Reference [11].

3.8**PRP****prerequisite programme**

⟨food safety⟩ basic conditions and activities that are necessary to maintain a hygienic environment throughout the **food chain** (3.2) suitable for the production, handling and provision of safe **end products** (3.5) and safe food for human consumption

NOTE The PRPs needed depend on the segment of the food chain in which the organization operates and the type of organization (see Annex C). Examples of equivalent terms are: Good Agricultural Practice (GAP), Good Veterinarian Practice (GVP), Good Manufacturing Practice (GMP), Good Hygienic Practice (GHP), Good Production Practice (GPP), Good Distribution Practice (GDP) and Good Trading Practice (GTP).

3.9**operational PRP****operational prerequisite programme**

PRP (3.8) identified by the hazard analysis as essential in order to control the likelihood of introducing **food safety hazards** (3.3) to and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment

3.10**CCP****critical control point**

⟨food safety⟩ step at which control can be applied and is essential to prevent or eliminate a **food safety hazard** (3.3) or reduce it to an acceptable level

NOTE Adapted from Reference [11].

3.11**critical limit**

criterion which separates acceptability from unacceptability

NOTE 1 Adapted from Reference [11].

NOTE 2 Critical limits are established to determine whether a **CCP** (3.10) remains in control. If a critical limit is exceeded or violated, the products affected are deemed to be potentially unsafe.

3.12**monitoring**

conducting a planned sequence of observations or measurements to assess whether **control measures** (3.7) are operating as intended

3.13**correction**

action to eliminate a detected nonconformity

[ISO 9000:2000, definition 3.6.6]

NOTE 1 For the purposes of this International Standard, a correction relates to the handling of potentially unsafe products, and can therefore be made in conjunction with a **corrective action** (3.14).

ISO 22000:2005(E)

NOTE 2 A correction may be, for example, reprocessing, further processing, and/or elimination of the adverse consequences of the nonconformity (such as disposal for other use or specific labelling).

3.14

corrective action

action to eliminate the cause of a detected nonconformity or other undesirable situation

NOTE 1 There can be more than one cause for a nonconformity.

[ISO 9000:2000, definition 3.6.5]

NOTE 2 Corrective action includes cause analysis and is taken to prevent recurrence.

3.15

validation

(food safety) obtaining evidence that the **control measures** (3.7) managed by the HACCP plan and by the **operational PRPs** (3.9) are capable of being effective

NOTE This definition is based on Reference [11] and is more suitable for the field of **food safety** (3.1) than the definition given in ISO 9000.

3.16

verification

confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[ISO 9000:2000, definition 3.8.4]

3.17

updating

immediate and/or planned activity to ensure application of the most recent information

4 Food safety management system

4.1 General requirements

The organization shall establish, document, implement and maintain an effective food safety management system and update it when necessary in accordance with the requirements of this International Standard.

The organization shall define the scope of the food safety management system. The scope shall specify the products or product categories, processes and production sites that are addressed by the food safety management system.

The organization shall

- a) ensure that food safety hazards that may be reasonably expected to occur in relation to products within the scope of the system are identified, evaluated and controlled in such a manner that the products of the organization do not, directly or indirectly, harm the consumer,
- b) communicate appropriate information throughout the food chain regarding safety issues related to its products,
- c) communicate information concerning development, implementation and updating of the food safety management system throughout the organization, to the extent necessary to ensure the food safety required by this International Standard, and
- d) evaluate periodically, and update when necessary, the food safety management system to ensure that the system reflects the organization's activities and incorporates the most recent information on the food safety hazards subject to control.

Where an organization chooses to outsource any process that may affect end product conformity, the organization shall ensure control over such processes. Control of such outsourced processes shall be identified and documented within the food safety management system.

4.2 Documentation requirements

4.2.1 General

The food safety management system documentation shall include

- a) documented statements of a food safety policy and related objectives (see 5.2),
- b) documented procedures and records required by this International Standard, and
- c) documents needed by the organization to ensure the effective development, implementation and updating of the food safety management system.

4.2.2 Control of documents

Documents required by the food safety management system shall be controlled. Records are a special type of document and shall be controlled according to the requirements given in 4.2.3.

The controls shall ensure that all proposed changes are reviewed prior to implementation to determine their effects on food safety and their impact on the food safety management system.

A documented procedure shall be established to define the controls needed

- a) to approve documents for adequacy prior to issue,
- b) to review and update documents as necessary, and re-approve documents,
- c) to ensure that changes and the current revision status of documents are identified,
- d) to ensure that relevant versions of applicable documents are available at points of use,
- e) to ensure that documents remain legible and readily identifiable,
- f) to ensure that relevant documents of external origin are identified and their distribution controlled, and
- g) to prevent the unintended use of obsolete documents, and to ensure that they are suitably identified as such if they are retained for any purpose.

4.2.3 Control of records

Records shall be established and maintained to provide evidence of conformity to requirements and evidence of the effective operation of the food safety management system. Records shall remain legible, readily identifiable and retrievable. A documented procedure shall be established to define the controls needed for the identification, storage, protection, retrieval, retention time and disposition of records.

5 Management responsibility

5.1 Management commitment

Top management shall provide evidence of its commitment to the development and implementation of the food safety management system and to continually improving its effectiveness by

- a) showing food safety is supported by the business objectives of the organization,
- b) communicating to the organization the importance of meeting the requirements of this International Standard, any statutory and regulatory requirements, as well as customer requirements relating to food safety,

- c) establishing the food safety policy,
- d) conducting management reviews, and
- e) ensuring the availability of resources.

5.2 Food safety policy

Top management shall define, document and communicate its food safety policy.

Top management shall ensure that the food safety policy

- a) is appropriate to the role of the organization in the food chain,
- b) conforms with both statutory and regulatory requirements and with mutually agreed food safety requirements of customers,
- c) is communicated, implemented and maintained at all levels of the organization,
- d) is reviewed for continued suitability (see 5.8),
- e) adequately addresses communication (see 5.6), and
- f) is supported by measurable objectives.

5.3 Food safety management system planning

Top management shall ensure that

- a) planning of the food safety management system is carried out to meet requirements given in 4.1 as well as the objectives of the organization that support food safety, and
- b) the integrity of the food safety management system is maintained when changes to the food safety management system are planned and implemented.

5.4 Responsibility and authority

Top management shall ensure that responsibilities and authorities are defined and communicated within the organization to ensure the effective operation and maintenance of the food safety management system.

All personnel shall have responsibility to report problems with the food safety management system to identified person(s). Designated personnel shall have defined responsibility and authority to initiate and record actions.

5.5 Food safety team leader

Top management shall appoint a food safety team leader who, irrespective of other responsibilities, shall have the responsibility and authority

- a) to manage a food safety team (see 7.3.2) and organize its work,
- b) to ensure relevant training and education of the food safety team members (see 6.2.1),
- c) to ensure that the food safety management system is established, implemented, maintained and updated, and
- d) to report to the organization's top management on the effectiveness and suitability of the food safety management system.

NOTE The responsibility of the food safety team leader may include liaison with external parties on matters relating to the food safety management system.

5.6 Communication

5.6.1 External communication

To ensure that sufficient information on issues concerning food safety is available throughout the food chain, the organization shall establish, implement and maintain effective arrangements for communicating with

- a) suppliers and contractors,
- b) customers or consumers, in particular in relation to product information (including instructions regarding intended use, specific storage requirements and, as appropriate, shelf life), enquiries, contracts or order-handling including amendments, and customer feedback including customer complaints,
- c) statutory and regulatory authorities, and
- d) other organizations that have an impact on, or will be affected by, the effectiveness or updating of the food safety management system.

Such communication shall provide information on food safety aspects of the organization's products that may be relevant to other organizations in the food chain. This applies especially to known food safety hazards that need to be controlled by other organizations in the food chain. Records of communications shall be maintained.

Food safety requirements from statutory and regulatory authorities and customers shall be available.

Designated personnel shall have defined responsibility and authority to communicate externally any information concerning food safety. Information obtained through external communication shall be included as input to system updating (see 8.5.2) and management review (see 5.8.2).

5.6.2 Internal communication

The organization shall establish, implement and maintain effective arrangements for communicating with personnel on issues having an impact on food safety.

In order to maintain the effectiveness of the food safety management system, the organization shall ensure that the food safety team is informed in a timely manner of changes, including but not limited to the following:

- a) products or new products;
- b) raw materials, ingredients and services;
- c) production systems and equipment;
- d) production premises, location of equipment, surrounding environment;
- e) cleaning and sanitation programmes;
- f) packaging, storage and distribution systems;
- g) personnel qualification levels and/or allocation of responsibilities and authorizations;
- h) statutory and regulatory requirements;
- i) knowledge regarding food safety hazards and control measures;
- j) customer, sector and other requirements that the organization observes;
- k) relevant enquiries from external interested parties;
- l) complaints indicating food safety hazards associated with the product;
- m) other conditions that have an impact on food safety.

The food safety team shall ensure that this information is included in the updating of the food safety management system (see 8.5.2). Top management shall ensure that relevant information is included as input to the management review (see 5.8.2).

5.7 Emergency preparedness and response

Top management shall establish, implement and maintain procedures to manage potential emergency situations and accidents that can impact food safety and which are relevant to the role of the organization in the food chain.

5.8 Management review

5.8.1 General

Top management shall review the organization's food safety management system at planned intervals to ensure its continuing suitability, adequacy and effectiveness. This review shall include assessing opportunities for improvement and the need for change to the food safety management system, including the food safety policy. Records of management reviews shall be maintained (see 4.2.3).

5.8.2 Review input

The input to management review shall include, but is not limited to, information on

- a) follow-up actions from previous management reviews,
- b) analysis of results of verification activities (see 8.4.3),
- c) changing circumstances that can affect food safety (see 5.6.2),
- d) emergency situations, accidents (see 5.7) and withdrawals (see 7.10.4),
- e) reviewing results of system-updating activities (see 8.5.2),
- f) review of communication activities, including customer feed-back (see 5.6.1), and
- g) external audits or inspections.

NOTE The term "withdrawal" includes recall.

The data shall be presented in a manner that enables top management to relate the information to stated objectives of the food safety management system.

5.8.3 Review output

The output from the management review shall include decisions and actions related to

- a) assurance of food safety (see 4.1),
- b) improvement of the effectiveness of the food safety management system (see 8.5),
- c) resource needs (see 6.1), and
- d) revisions of the organization's food safety policy and related objectives (see 5.2).

6 Resource management

6.1 Provision of resources

The organization shall provide adequate resources for the establishment, implementation, maintenance and updating of the food safety management system.

6.2 Human resources

6.2.1 General

The food safety team and the other personnel carrying out activities having an impact on food safety shall be competent and shall have appropriate education, training, skills and experience.

Where the assistance of external experts is required for the development, implementation, operation or assessment of the food safety management system, records of agreement or contracts defining the responsibility and authority of external experts shall be available.

6.2.2 Competence, awareness and training

The organization shall

- a) identify the necessary competencies for personnel whose activities have an impact on food safety,
- b) provide training or take other action to ensure personnel have the necessary competencies,
- c) ensure that personnel responsible for monitoring, corrections and corrective actions of the food safety management system are trained,
- d) evaluate the implementation and the effectiveness of a), b) and c),
- e) ensure that the personnel are aware of the relevance and importance of their individual activities in contributing to food safety,
- f) ensure that the requirement for effective communication (see 5.6) is understood by all personnel whose activities have an impact on food safety, and
- g) maintain appropriate records of training and actions described in b) and c).

6.3 Infrastructure

The organization shall provide the resources for the establishment and maintenance of the infrastructure needed to implement the requirements of this International Standard.

6.4 Work environment

The organization shall provide the resources for the establishment, management and maintenance of the work environment needed to implement the requirements of this International Standard.

7 Planning and realization of safe products

7.1 General

The organization shall plan and develop the processes needed for the realization of safe products.

The organization shall implement, operate and ensure the effectiveness of the planned activities and any changes to those activities. This includes PRP(s) as well as operational PRP(s) and/or the HACCP plan.

7.2 Prerequisite programmes (PRPs)

7.2.1 The organization shall establish, implement and maintain PRP(s) to assist in controlling

- a) the likelihood of introducing food safety hazards to the product through the work environment,
- b) biological, chemical and physical contamination of the product(s), including cross contamination between products, and
- c) food safety hazard levels in the product and product processing environment.

7.2.2 The PRP(s) shall

- a) be appropriate to the organizational needs with regard to food safety,
- b) be appropriate to the size and type of the operation and the nature of the products being manufactured and/or handled,
- c) be implemented across the entire production system, either as programmes applicable in general or as programmes applicable to a particular product or operational line, and
- d) be approved by the food safety team.

The organization shall identify statutory and regulatory requirements related to the above.

7.2.3 When selecting and/or establishing PRP(s), the organization shall consider and utilize appropriate information [e.g. statutory and regulatory requirements, customer requirements, recognized guidelines, Codex Alimentarius Commission (Codex) principles and codes of practices, national, international or sector standards].

NOTE Annex C gives a list of relevant Codex publications.

The organization shall consider the following when establishing these programmes:

- a) construction and lay-out of buildings and associated utilities;
- b) lay-out of premises, including workspace and employee facilities;
- c) supplies of air, water, energy and other utilities;
- d) supporting services, including waste and sewage disposal;
- e) the suitability of equipment and its accessibility for cleaning, maintenance and preventative maintenance;
- f) management of purchased materials (e.g. raw materials, ingredients, chemicals and packaging), supplies (e.g. water, air, steam and ice), disposals (e.g. waste and sewage) and handling of products (e.g. storage and transportation);
- g) measures for the prevention of cross contamination;
- h) cleaning and sanitizing;
- i) pest control;
- j) personnel hygiene;
- k) other aspects as appropriate.

Verification of PRP(s) shall be planned (see 7.8) and PRP(s) shall be modified as necessary (see 7.7). Records of verifications and modifications shall be maintained.

Documents should specify how activities included in the PRP(s) are managed.

7.3 Preliminary steps to enable hazard analysis

7.3.1 General

All relevant information needed to conduct the hazard analysis shall be collected, maintained, updated and documented. Records shall be maintained.

7.3.2 Food safety team

A food safety team shall be appointed.

The food safety team shall have a combination of multi-disciplinary knowledge and experience in developing and implementing the food safety management system. This includes, but need not be limited to, the organization's products, processes, equipment and food safety hazards within the scope of the food safety management system.

Records shall be maintained that demonstrate that the food safety team has the required knowledge and experience (see 6.2.2).

7.3.3 Product characteristics

7.3.3.1 Raw materials, ingredients and product-contact materials

All raw materials, ingredients and product-contact materials shall be described in documents to the extent needed to conduct the hazard analysis (see 7.4), including the following, as appropriate:

- a) biological, chemical and physical characteristics;
- b) composition of formulated ingredients, including additives and processing aids;
- c) origin;
- d) method of production;
- e) packaging and delivery methods;
- f) storage conditions and shelf life;
- g) preparation and/or handling before use or processing;
- h) food safety-related acceptance criteria or specifications of purchased materials and ingredients appropriate to their intended uses.

The organization shall identify statutory and regulatory food safety requirements related to the above.

The descriptions shall be kept up-to-date including, when required, in accordance with 7.7.

7.3.3.2 Characteristics of end products

The characteristics of end products shall be described in documents to the extent needed to conduct the hazard analysis (see 7.4), including information on the following, as appropriate:

- a) product name or similar identification;
- b) composition;
- c) biological, chemical and physical characteristics relevant for food safety;
- d) intended shelf life and storage conditions;
- e) packaging;

- f) labelling relating to food safety and/or instructions for handling, preparation and usage;
- g) method(s) of distribution.

The organization shall identify statutory and regulatory food safety requirements related to the above.

The descriptions shall be kept up-to-date including, when required, in accordance with 7.7.

7.3.4 Intended use

The intended use, the reasonably expected handling of the end product, and any unintended but reasonably expected mishandling and misuse of the end product shall be considered and shall be described in documents to the extent needed to conduct the hazard analysis (see 7.4).

Groups of users and, where appropriate, groups of consumers shall be identified for each product, and consumer groups known to be especially vulnerable to specific food safety hazards shall be considered.

The descriptions shall be kept up-to-date including, when required, in accordance with 7.7.

7.3.5 Flow diagrams, process steps and control measures

7.3.5.1 Flow diagrams

Flow diagrams shall be prepared for the products or process categories covered by the food safety management system. Flow diagrams shall provide a basis for evaluating the possible occurrence, increase or introduction of food safety hazards.

Flow diagrams shall be clear, accurate and sufficiently detailed. Flow diagrams shall, as appropriate, include the following:

- a) the sequence and interaction of all steps in the operation;
- b) any outsourced processes and subcontracted work;
- c) where raw materials, ingredients and intermediate products enter the flow;
- d) where reworking and recycling take place;
- e) where end products, intermediate products, by-products and waste are released or removed.

In accordance with 7.8, the food safety team shall verify the accuracy of the flow diagrams by on-site checking. Verified flow diagrams shall be maintained as records.

7.3.5.2 Description of process steps and control measures

The existing control measures, process parameters and/or the rigorousness with which they are applied, or procedures that may influence food safety, shall be described to the extent needed to conduct the hazard analysis (see 7.4).

External requirements (e.g. from regulatory authorities or customers) that may impact the choice and the rigorousness of the control measures shall also be described.

The descriptions shall be updated in accordance with 7.7.

7.4 Hazard analysis

7.4.1 General

The food safety team shall conduct a hazard analysis to determine which hazards need to be controlled, the degree of control required to ensure food safety, and which combination of control measures is required.

7.4.2 Hazard identification and determination of acceptable levels

7.4.2.1 All food safety hazards that are reasonably expected to occur in relation to the type of product, type of process and actual processing facilities shall be identified and recorded. The identification shall be based on

- a) the preliminary information and data collected according to 7.3,
- b) experience,
- c) external information including, to the extent possible, epidemiological and other historical data, and
- d) information from the food chain on food safety hazards that may be of relevance for the safety of the end products, intermediate products and the food at consumption.

The step(s) (from raw materials, processing and distribution) at which each food safety hazard may be introduced shall be indicated.

7.4.2.2 When identifying the hazards, consideration shall be given to

- a) the steps preceding and following the specified operation,
- b) the process equipment, utilities/services and surroundings, and
- c) the preceding and following links in the food chain.

7.4.2.3 For each of the food safety hazards identified, the acceptable level of the food safety hazard in the end product shall be determined whenever possible. The determined level shall take into account established statutory and regulatory requirements, customer food safety requirements, the intended use by the customer and other relevant data. The justification for, and the result of, the determination shall be recorded.

7.4.3 Hazard assessment

A hazard assessment shall be conducted to determine, for each food safety hazard identified (see 7.4.2), whether its elimination or reduction to acceptable levels is essential to the production of a safe food, and whether its control is needed to enable the defined acceptable levels to be met.

Each food safety hazard shall be evaluated according to the possible severity of adverse health effects and the likelihood of their occurrence. The methodology used shall be described, and the results of the food safety hazard assessment shall be recorded.

7.4.4 Selection and assessment of control measures

Based on the hazard assessment of 7.4.3, an appropriate combination of control measures shall be selected which is capable of preventing, eliminating or reducing these food safety hazards to defined acceptable levels.

In this selection, each of the control measures as described in 7.3.5.2 shall be reviewed with respect to its effectiveness against the identified food safety hazards.

The control measures selected shall be categorized as to whether they need to be managed through operational PRP(s) or by the HACCP plan.

The selection and categorization shall be carried out using a logical approach that includes assessments with regard to the following:

- a) its effect on identified food safety hazards relative to the strictness applied;
- b) its feasibility for monitoring (e.g. ability to be monitored in a timely manner to enable immediate corrections);
- c) its place within the system relative to other control measures;
- d) the likelihood of failure in the functioning of a control measure or significant processing variability;
- e) the severity of the consequence(s) in the case of failure in its functioning;
- f) whether the control measure is specifically established and applied to eliminate or significantly reduce the level of hazard(s);
- g) synergistic effects (i.e. interaction that occurs between two or more measures resulting in their combined effect being higher than the sum of their individual effects).

Control measures categorized as belonging to the HACCP plan shall be implemented in accordance with 7.6. Other control measures shall be implemented as operational PRPs according to 7.5.

The methodology and parameters used for this categorization shall be described in documents, and the results of the assessment shall be recorded.

7.5 Establishing the operational prerequisite programmes (PRPs)

The operational PRPs shall be documented and shall include the following information for each programme:

- a) food safety hazard(s) to be controlled by the programme (see 7.4.4);
- b) control measure(s) (see 7.4.4);
- c) monitoring procedures that demonstrate that the operational PRPs are implemented;
- d) corrections and corrective actions to be taken if monitoring shows that the operational PRPs are not in control (see 7.10.1 and 7.10.2, respectively);
- e) responsibilities and authorities;
- f) record(s) of monitoring.

7.6 Establishing the HACCP plan

7.6.1 HACCP plan

The HACCP plan shall be documented and shall include the following information for each identified critical control point (CCP):

- a) food safety hazard(s) to be controlled at the CCP (see 7.4.4);
- b) control measure(s) (see 7.4.4)
- c) critical limit(s) (see 7.6.3);
- d) monitoring procedure(s) (see 7.6.4);
- e) corrections and corrective action(s) to be taken if critical limits are exceeded (see 7.6.5);
- f) responsibilities and authorities;
- g) record(s) of monitoring.

7.6.2 Identification of critical control points (CCPs)

For each hazard that is to be controlled by the HACCP plan, CCP(s) shall be identified for the control measures identified (see 7.4.4).

7.6.3 Determination of critical limits for critical control points

Critical limits shall be determined for the monitoring established for each CCP.

Critical limits shall be established to ensure that the identified acceptable level of the food safety hazard in the end product (see 7.4.2) is not exceeded.

Critical limits shall be measurable.

The rationale for the chosen critical limits shall be documented.

Critical limits based on subjective data (such as visual inspection of product, process, handling, etc.) shall be supported by instructions or specifications and/or education and training.

7.6.4 System for the monitoring of critical control points

A monitoring system shall be established for each CCP to demonstrate that the CCP is in control. The system shall include all scheduled measurements or observations relative to the critical limit(s).

The monitoring system shall consist of relevant procedures, instructions and records that cover the following:

- a) measurements or observations that provide results within an adequate time frame;
- b) monitoring devices used;
- c) applicable calibration methods (see 8.3);
- d) monitoring frequency;
- e) responsibility and authority related to monitoring and evaluation of monitoring results;
- f) record requirements and methods.

The monitoring methods and frequency shall be capable of determining when the critical limits have been exceeded in time for the product to be isolated before it is used or consumed.

7.6.5 Actions when monitoring results exceed critical limits

Planned corrections and corrective actions to be taken when critical limits are exceeded shall be specified in the HACCP plan. The actions shall ensure that the cause of nonconformity is identified, that the parameter(s) controlled at the CCP is (are) brought back under control, and that recurrence is prevented (see 7.10.2).

Documented procedures shall be established and maintained for the appropriate handling of potentially unsafe products to ensure that they are not released until they have been evaluated (see 7.10.3).

7.7 Updating of preliminary information and documents specifying the PRPs and the HACCP plan

Following the establishment of operational PRP(s) (see 7.5) and/or the HACCP plan (see 7.6), the organization shall update the following information, if necessary:

- a) product characteristics (see 7.3.3);
- b) intended use (see 7.3.4);
- c) flow diagrams (see 7.3.5.1);
- d) process steps (see 7.3.5.2);
- e) control measures (see 7.3.5.2).

If necessary, the HACCP plan (see 7.6.1) and the procedures and instructions specifying the PRP(s) (see 7.2) shall be amended.

7.8 Verification planning

Verification planning shall define the purpose, methods, frequencies and responsibilities for the verification activities. The verification activities shall confirm that

- a) the PRP(s) are implemented (see 7.2),
- b) input to the hazard analysis (see 7.3) is continually updated,
- c) the operational PRP(s) (see 7.5) and the elements within the HACCP plan (see 7.6.1) are implemented and effective,
- d) hazard levels are within identified acceptable levels (see 7.4.2), and
- e) other procedures required by the organization are implemented and effective.

The output of this planning shall be in a form suitable for the organization's method of operations.

Verification results shall be recorded and shall be communicated to the food safety team. Verification results shall be provided to enable the analysis of the results of the verification activities (see 8.4.3).

If system verification is based on testing of end product samples, and where such test samples show nonconformity with the acceptable level of the food safety hazard (see 7.4.2), the affected lots of product shall be handled as potentially unsafe in accordance with 7.10.3.

7.9 Traceability system

The organization shall establish and apply a traceability system that enables the identification of product lots and their relation to batches of raw materials, processing and delivery records.

The traceability system shall be able to identify incoming material from the immediate suppliers and the initial distribution route of the end product.

Traceability records shall be maintained for a defined period for system assessment to enable the handling of potentially unsafe products and in the event of product withdrawal. Records shall be in accordance with statutory and regulatory requirements and customer requirements and may, for example, be based on the end product lot identification.

7.10 Control of nonconformity

7.10.1 Corrections

The organization shall ensure that when critical limits for CCP(s) are exceeded (see 7.6.5), or there is a loss of control of operational PRP(s), the products affected are identified and controlled with regard to their use and release.

A documented procedure shall be established and maintained defining

- a) the identification and assessment of affected end products to determine their proper handling (see 7.10.3), and
- b) a review of the corrections carried out.

Products manufactured under conditions where critical limits have been exceeded are potentially unsafe products and shall be handled in accordance with 7.10.3. Products manufactured under conditions where operational PRP(s) have not been conformed with shall be evaluated with respect to the cause(s) of the nonconformity and to the consequences thereof in terms of food safety and shall, where necessary, be handled in accordance with 7.10.3. The evaluation shall be recorded.

All corrections shall be approved by the responsible person(s), and shall be recorded together with information on the nature of the nonconformity, its cause(s) and consequence(s), including information needed for traceability purposes related to the nonconforming lots.

7.10.2 Corrective actions

Data derived from the monitoring of operational PRPs and CCPs shall be evaluated by designated person(s) with sufficient knowledge (see 6.2) and authority (see 5.4) to initiate corrective actions.

Corrective actions shall be initiated when critical limits are exceeded (see 7.6.5) or when there is a lack of conformity with operational PRP(s).

The organization shall establish and maintain documented procedures that specify appropriate actions to identify and eliminate the cause of detected nonconformities, to prevent recurrence, and to bring the process or system back into control after nonconformity is encountered. These actions include

- a) reviewing nonconformities (including customer complaints),
- b) reviewing trends in monitoring results that may indicate development towards loss of control,
- c) determining the cause(s) of nonconformities,
- d) evaluating the need for action to ensure that nonconformities do not recur,
- e) determining and implementing the actions needed,
- f) recording the results of corrective actions taken, and
- g) reviewing corrective actions taken to ensure that they are effective.

Corrective actions shall be recorded.

7.10.3 Handling of potentially unsafe products

7.10.3.1 General

The organization shall handle nonconforming products by taking action(s) to prevent the nonconforming product from entering the food chain unless it is possible to ensure that

- a) the food safety hazard(s) of concern has(ve) been reduced to the defined acceptable levels,
- b) the food safety hazard(s) of concern will be reduced to identified acceptable levels (see 7.4.2) prior to entering into the food chain, or
- c) the product still meets the defined acceptable level(s) of the food safety hazard(s) of concern despite the nonconformity.

All lots of product that may have been affected by a nonconforming situation shall be held under control of the organization until they have been evaluated.

If products that have left the control of the organization are subsequently determined to be unsafe, the organization shall notify relevant interested parties and initiate a withdrawal (see 7.10.4).

NOTE The term "withdrawal" includes recall.

The controls and related responses and authorization for dealing with potentially unsafe products shall be documented.

7.10.3.2 Evaluation for release

Each lot of product affected by the nonconformity shall only be released as safe when any of the following conditions apply:

- a) evidence other than the monitoring system demonstrates that the control measures have been effective;
- b) evidence shows that the combined effect of the control measures for that particular product complies with the performance intended (i.e. identified acceptable levels as identified in accordance with 7.4.2);
- c) the results of sampling, analysis and/or other verification activities demonstrate that the affected lot of product complies with the identified acceptable levels for the food safety hazard(s) concerned.

7.10.3.3 Disposition of nonconforming products

Following evaluation, if the lot of product is not acceptable for release it shall be handled by one of the following activities:

- a) reprocessing or further processing within or outside the organization to ensure that the food safety hazard is eliminated or reduced to acceptable levels;
- b) destruction and/or disposal as waste.

7.10.4 Withdrawals

To enable and facilitate the complete and timely withdrawal of lots of end products which have been identified as unsafe

- a) top management shall appoint personnel having the authority to initiate a withdrawal and personnel responsible for executing the withdrawal, and
- b) the organization shall establish and maintain a documented procedure for
 - 1) notification to relevant interested parties (e.g. statutory and regulatory authorities, customers and/or consumers),
 - 2) handling of withdrawn products as well as affected lots of the products still in stock, and
 - 3) the sequence of actions to be taken.

Withdrawn products shall be secured or held under supervision until they are destroyed, used for purposes other than originally intended, determined to be safe for the same (or other) intended use, or reprocessed in a manner to ensure they become safe.

The cause, extent and result of a withdrawal shall be recorded and reported to top management as input to the management review (see 5.8.2).

The organization shall verify and record the effectiveness of the withdrawal programme through the use of appropriate techniques (e.g. mock withdrawal or practice withdrawal).

8 Validation, verification and improvement of the food safety management system

8.1 General

The food safety team shall plan and implement the processes needed to validate control measures and/or control measure combinations, and to verify and improve the food safety management system.

8.2 Validation of control measure combinations

Prior to implementation of control measures to be included in operational PRP(s) and the HACCP plan and after any change therein (see 8.5.2), the organization shall validate (see 3.15) that

- a) the selected control measures are capable of achieving the intended control of the food safety hazard(s) for which they are designated, and
- b) the control measures are effective and capable of, in combination, ensuring control of the identified food safety hazard(s) to obtain end products that meet the defined acceptable levels.

If the result of the validation shows that one or both of the above elements cannot be confirmed, the control measure and/or combinations thereof shall be modified and re-assessed (see 7.4.4).

Modifications may include changes in control measures (i.e. process parameters, rigorousness and/or their combination) and/or change(s) in the raw materials, manufacturing technologies, end product characteristics, methods of distribution and/or intended use of the end product.

8.3 Control of monitoring and measuring

The organization shall provide evidence that the specified monitoring and measuring methods and equipment are adequate to ensure the performance of the monitoring and measuring procedures.

Where necessary to ensure valid results, the measuring equipment and methods used

- a) shall be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded,
- b) shall be adjusted or re-adjusted as necessary,
- c) shall be identified to enable the calibration status to be determined,
- d) shall be safeguarded from adjustments that would invalidate the measurement results, and
- e) shall be protected from damage and deterioration.

Records of the results of calibration and verification shall be maintained.

In addition, the organization shall assess the validity of the previous measurement results when the equipment or process is found not to conform to requirements. If the measuring equipment is nonconforming, the organization shall take action appropriate for the equipment and any product affected. Records of such assessment and resulting actions shall be maintained.

When used in the monitoring and measurement of specified requirements, the ability of computer software to satisfy the intended application shall be confirmed. This shall be undertaken prior to initial use and shall be reconfirmed as necessary.

8.4 Food safety management system verification

8.4.1 Internal audit

The organization shall conduct internal audits at planned intervals to determine whether the food safety management system

- a) conforms to the planned arrangements, to the food safety management system requirements established by the organization, and to the requirements of this International Standard, and
- b) is effectively implemented and updated.

An audit programme shall be planned, taking into consideration the importance of the processes and areas to be audited, as well as any updating actions resulting from previous audits (see 8.5.2 and 5.8.2). The audit

criteria, scope, frequency and methods shall be defined. Selection of auditors and the conduct of audits shall ensure the objectivity and impartiality of the audit process. Auditors shall not audit their own work.

The responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records, shall be defined in a documented procedure.

The management responsible for the area being audited shall ensure that actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities shall include the verification of the actions taken and the reporting of the verification results.

8.4.2 Evaluation of individual verification results

The food safety team shall systematically evaluate the individual results of planned verification (see 7.8).

If verification does not demonstrate conformity with the planned arrangements, the organization shall take action to achieve the required conformity. Such action shall include, but is not limited to, review of

- a) existing procedures and communication channels (see 5.6 and 7.7),
- b) the conclusions of the hazard analysis (see 7.4), the established operational PRP(s) (see 7.5) and the HACCP plan (see 7.6.1),
- c) the PRP(s) (see 7.2), and
- d) the effectiveness of human resource management and of training activities (see 6.2).

8.4.3 Analysis of results of verification activities

The food safety team shall analyse the results of verification activities, including the results of the internal audits (see 8.4.1) and external audits. The analysis shall be carried out in order

- a) to confirm that the overall performance of the system meets the planned arrangements and the food safety management system requirements established by the organization,
- b) to identify the need for updating or improving the food safety management system,
- c) to identify trends which indicate a higher incidence of potentially unsafe products,
- d) to establish information for planning of the internal audit programme concerning the status and importance of areas to be audited, and
- e) to provide evidence that any corrections and corrective actions that have been taken are effective.

The results of the analysis and the resulting activities shall be recorded and shall be reported, in an appropriate manner, to top management as input to the management review (see 5.8.2). It shall also be used as an input for updating the food safety management system (see 8.5.2).

8.5 Improvement

8.5.1 Continual improvement

Top management shall ensure that the organization continually improves the effectiveness of the food safety management system through the use of communication (see 5.6), management review (see 5.8), internal audit (see 8.4.1), evaluation of individual verification results (see 8.4.2), analysis of results of verification activities (see 8.4.3), validation of control measure combinations (see 8.2), corrective actions (see 7.10.2) and food safety management system updating (see 8.5.2).

NOTE ISO 9001 addresses continual improvement of the effectiveness of quality management systems. ISO 9004 provides guidance on continual improvement of the effectiveness and efficiency of quality management systems beyond what is addressed in ISO 9001.

8.5.2 Updating the food safety management system

Top management shall ensure that the food safety management system is continually updated.

In order to achieve this, the food safety team shall evaluate the food safety management system at planned intervals. The team shall then consider whether it is necessary to review the hazard analysis (see 7.4), the established operational PRP(s) (see 7.5) and the HACCP plan (see 7.6.1).

The evaluation and updating activities shall be based on

- a) input from communication, external as well as internal, as stated in 5.6,
- b) input from other information concerning the suitability, adequacy and effectiveness of the food safety management system,
- c) output from the analysis of results of verification activities (see 8.4.3), and
- d) output from management review (see 5.8.3).

System updating activities shall be recorded and reported, in an appropriate manner, as input to the management review (see 5.8.2).

Annex A (informative)

Cross references between ISO 22000:2005 and ISO 9001:2000

Table A.1 — Cross references between clauses of ISO 22000:2005 and clauses of ISO 9001:2000

ISO 22000:2005		ISO 9001:2000	
Introduction		0	Introduction
		01	General
		02	Process approach
		03	Relationship with ISO 9004
		04	Compatibility with other management systems
Scope	1	1	Scope
		1.1	General
		1.2	Application
Normative references	2	2	Normative reference
Terms and definitions	3	3	Terms and definitions
Food safety management system	4	4	Quality management system
General requirements	4.1	4.1	General requirements
Documentation requirements	4.2	4.2	Documentation requirements
General	4.2.1	4.2.1	General
Control of documents	4.2.2	4.2.3	Control of documents
Control of records	4.2.3	4.2.4	Control of records
Management responsibility	5	5	Management responsibility
Management commitment	5.1	5.1	Management commitment
Food safety policy	5.2	5.3	Quality policy
Food safety management system planning	5.3	5.4.2	Quality management system planning
Responsibility and authority	5.4	5.5.1	Responsibility and authority
Food safety team leader	5.5	5.5.2	Management representative
Communication	5.6	5.5	Responsibility, authority and communication
External communication	5.6.1	7.2.1	Determination of requirements related to the product
		7.2.3	Customer communication
Internal communication	5.6.2	5.5.3	Internal communication
		7.3.7	Control of design and development changes
Emergency preparedness and response	5.7	5.2	Customer focus
		8.5.3	Preventive action
Management review	5.8	5.6	Management review
General	5.8.1	5.6.1	General
Review input	5.8.2	5.6.2	Review input
Review output	5.8.3	5.6.3	Review output

Table A.1 — Cross references between clauses of ISO 22000:2005 and clauses of ISO 9001:2000 (continued)

ISO 22000:2005		ISO 9001:2000	
Resource management	6	6	Resource management
Provision of resources	6.1	6.1	Provision of resources
Human resources	6.2	6.2	Human resources
General	6.2.1	6.2.1	General
Competence, awareness and training	6.2.2	6.2.2	Competence, awareness and training
Infrastructure	6.3	6.3	Infrastructure
Work environment	6.4	6.4	Work environment
Planning and realization of safe products	7	7	Product realization
General	7.1	7.1	Planning of product realization
Prerequisite programmes (PRPs)	7.2	6.3	Infrastructure
	7.2.1	6.4	Work environment
	7.2.2	7.5.1	Control of production and service provision
	7.2.3	8.5.3	Preventive action
		7.5.5	Preservation of product
Preliminary steps to enable hazard analysis	7.3	7.3	Design and development
General	7.3.1		
Food safety team	7.3.2		
Product characteristics	7.3.3	7.4.2	Purchasing requirements
Intended use	7.3.4	7.2.1	Determination of requirements related to the product
Flow diagrams, process steps and control measures	7.3.5	7.2.1	Determination of requirements related to the product
Hazard analysis	7.4	7.3.1	Design and development planning
General	7.4.1		
Hazard identification and determination of acceptable levels	7.4.2		
Hazard assessment	7.4.3		
Selection and assessment of control measures	7.4.4		
Establishing the operational prerequisite programmes (PRPs)	7.5	7.3.2	Design and development inputs
Establishing the HACCP plan	7.6	7.3.3	Design and development outputs
HACCP plan	7.6.1	7.5.1	Control of production and service provision
Identification of critical control points (CCPs)	7.6.2		
Determination of critical limits for critical control points	7.6.3		
System for the monitoring of critical control points	7.6.4	8.2.3	Monitoring and measurement of processes
Actions when monitoring results exceed critical limits	7.6.5	8.3	Control of nonconforming product
Updating of preliminary information and documents specifying the PRPs and the HACCP plan	7.7	4.2.3	Control of documents
Verification planning	7.8	7.3.5	Design and development verification
Traceability system	7.9	7.5.3	Identification and traceability

Table A.1 — Cross references between clauses of ISO 22000:2005 and clauses of ISO 9001:2000 (continued)

ISO 22000:2005		ISO 9001:2000	
Control of nonconformity	7.10	8.3	Control of nonconforming product
Corrections	7.10.1	8.3	Control of nonconforming product
Corrective actions	7.10.2	8.5.2	Corrective action
Handling of potentially unsafe products	7.10.3	8.3	Control of nonconforming product
Withdrawals	7.10.4	8.3	Control of nonconforming product
Validation, verification and improvement of the food safety management system	8	8	Measurement, analysis and improvement
General	8.1	8.1	General
Validation of control measure combinations	8.2	8.4 7.3.6 7.5.2	Analysis of data Design and development validation Validation of processes for production and service provision
Control of monitoring and measuring	8.3	7.6	Control of monitoring and measuring devices
Food safety management system verification	8.4	8.2	Monitoring and measurement
Internal audit	8.4.1	8.2.2	Internal audit
Evaluation of individual verification results	8.4.2	7.3.4 8.2.3	Design and development review Monitoring and measurement of processes
Analysis of results of verification activities	8.4.3	8.4	Analysis of data
Improvement	8.5	8.5	Improvement
Continual improvement	8.5.1	8.5.1	Continual improvement
Updating the food safety management system	8.5.2	7.3.4	Design and development review

Table A.2 — Cross references between clauses of ISO 9001:2000 and clauses of ISO 22000:2005

ISO 9001:2000		ISO 22000:2005	
Introduction			Introduction
General	0.1		
Process approach	0.2		
Relationship with ISO 9004	0.3		
Compatibility with other management systems	0.4		
Scope	1	1	Scope
General	1.1		
Application	1.2		
Normative reference	2	2	Normative references
Terms and definitions	3	3	Terms and definitions
Quality management system	4	4	Food safety management system
General requirements	4.1	4.1	General requirements
Documentation requirements	4.2	4.2	Documentation requirements
General	4.2.1	4.2.1	General
Quality manual	4.2.2		
Control of documents	4.2.3	4.2.2 7.7	Control of documents Updating of preliminary information and documents specifying the PRPs and the HACCP plan
Control of records	4.2.4	4.2.3	Control of records

Table A.2 — Cross references between clauses of ISO 9001:2000 and clauses of ISO 22000:2005 (continued)

ISO 9001:2000		ISO 22000:2005	
Management responsibility	5	5	Management responsibility
Management commitment	5.1	5.1	Management commitment
Customer focus	5.2	5.7	Emergency preparedness and response
Quality policy	5.3	5.2	Food safety policy
Planning	5.4		
Quality objectives	5.4.1		
Quality management planning	5.4.2	5.3 8.5.2	Food safety management system planning Updating the food safety management system
Responsibility, authority and communication	5.5	5.6	Communication
Responsibility and authority	5.5.1	5.4	Responsibility and authority
Management representative	5.5.2	5.5	Food safety team leader
Internal communication	5.5.3	5.6.2	Internal communication
Management review	5.6	5.8	Management review
General	5.6.1	5.8.1	General
Review input	5.6.2	5.8.2	Review input
Review output	5.6.3	5.8.3	Review output
Resource management	6	6	Resource management
Provision of resources	6.1	6.1	Provision of resources
Human resources	6.2	6.2	Human resources
General	6.2.1	6.2.1	General
Competence, awareness and training	6.2.2	6.2.2	Competence, awareness and training
Infrastructure	6.3	6.3 7.2	Infrastructure Prerequisite programmes (PRPs)
Work environment	6.4	6.4 7.2	Work environment Prerequisite programmes (PRPs)
Product realization	7	7	Planning and realization of safe products
Planning of product realization	7.1	7.1	General
Customer-related processes	7.2		
Determination of requirements related to the product	7.2.1	7.3.4 7.3.5 5.6.1	Intended use Flow diagrams, process steps and control measures External communication
Review of requirements related to the product	7.2.2		
Customer communication	7.2.3	5.6.1	External communication
Design and development	7.3	7.3	Preliminary steps to enable hazard analysis
Design and development planning	7.3.1	7.4	Hazard analysis
Design and development inputs	7.3.2	7.5	Establishing the operational prerequisite programmes (PRPs)
Design and development outputs	7.3.3	7.6	Establishing the HACCP plan
Design and development review	7.3.4	8.4.2 8.5.2	Evaluation of individual verification results Updating the food safety management system
Design and development verification	7.3.5	7.8	Verification planning
Design and development validation	7.3.6	8.2	Validation of control measure combinations
Control of design and development changes	7.3.7	5.6.2	Internal communication

Table A.2 — Cross references between clauses of ISO 9001:2000 and clauses of ISO 22000:2005 (continued)

ISO 9001:2000		ISO 22000:2005	
Purchasing	7.4		
Purchasing process	7.4.1		
Purchasing information	7.4.2	7.3.3	Product characteristics
Verification of purchased product	7.4.3		
Production and service provision	7.5		
Control of production and service provision	7.5.1	7.2	Prerequisite programmes (PRPs)
		7.6.1	HACCP plan
Validation of production and service provision	7.5.2	8.2	Validation of control measure combinations
Identification and traceability	7.5.3	7.9	Traceability system
Customer property	7.5.4		
Preservation of product	7.5.5	7.2	Prerequisite programmes (PRPs)
Control of monitoring and measuring devices	7.6	8.3	Control of monitoring and measuring
Measurement, analysis and improvement	8	8	Validation, verification and improvement of the food safety management system
General	8.1	8.1	General
Monitoring and measurement	8.2	8.4	Food safety management system verification
Customer satisfaction	8.2.1		
Internal audit	8.2.2	8.4.1	Internal audit
Monitoring and measurement of processes	8.2.3	7.6.4	System for the monitoring of critical control points
		8.4.2	Evaluation of individual verification results
Monitoring and measurement of product	8.2.4		
Control of nonconforming product	8.3	7.6.5	Actions when monitoring results exceed critical limits
		7.10	Control of nonconformity
Analysis of data	8.4	8.2	Validation of control measure combinations
		8.4.3	Analysis of results of verification activities
Improvement	8.5	8.5	Improvement
Continual improvement	8.5.1	8.5.1	Continual improvement
Corrective action	8.5.2	7.10.2	Corrective actions
Preventive action	8.5.3	5.7	Emergency preparedness and response
		7.2	Prerequisite programmes (PRPs)

Annex B (informative)

Cross references between HACCP and ISO 22000:2005

Table B.1 — Cross references between the HACCP principles and application steps and clauses of ISO 22000:2005

HACCP Principles	HACCP application steps ^a		ISO 22000:2005	
	Assemble HACCP team	Step 1	7.3.2	Food safety team
	Describe product	Step 2	7.3.3 7.3.5.2	Product characteristics Description of process steps and control measures
	Identify intended use	Step 3	7.3.4	Intended use
	Construct flow diagram	Step 4	7.3.5.1	Flow diagrams
	On-site confirmation of flow diagram	Step 5		
Principle 1 Conduct a hazard analysis.	List all potential hazards Conduct a hazard analysis Consider control measures	Step 6	7.4 7.4.2 7.4.3 7.4.4	Hazard analysis Hazard identification and determination of acceptable levels Hazard assessment Selection and assessment of control measures
Principle 2 Determine the critical control points (CCPs).	Determine CCPs	Step 7	7.6.2	Identification of critical control points (CCPs)
Principle 3 Establish critical limit(s).	Establish critical limits for each CCP	Step 8	7.6.3	Determination of critical limits for critical control points
Principle 4 Establish a system to monitor control of the CCP.	Establish a monitoring system for each CCP	Step 9	7.6.4	System for the monitoring of critical control points
Principle 5 Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.	Establish corrective actions	Step 10	7.6.5	Actions when monitoring results exceed critical limits
Principle 6 Establish procedures for verification to confirm that the HACCP system is working effectively.	Establish verification procedures	Step 11	7.8	Verification planning
Principle 7 Establish documentation concerning all procedures and records appropriate to these principles and their application.	Establish documentation and record keeping	Step 12	4.2 7.7	Documentation requirements Updating of preliminary information and documents specifying the PRPs and the HACCP plan

^a Published in Reference [11].

Annex C (informative)

Codex references providing examples of control measures, including prerequisite programmes and guidance for their selection and use

C.1 Codes and Guidelines¹⁾

C.1.1 General

CAC/RCP 1-1969 (Rev.4-2003), Recommended International Code of Practice — General Principles of Food Hygiene; incorporates Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application

Guidelines for the Validation of Food Hygiene Control Measures²⁾

Principles for the Application of Traceability/Product Tracing with respect to Food Inspection and Certification²⁾

Commodity Specific Codes and Guidelines

C.1.2 Feed

CAC/RCP 45-1997, Code of Practice for the Reduction of Aflatoxin B₁ in Raw Materials and Supplemental Feeding stuffs for Milk Producing Animals

CAC/RCP 54-2004, Code of Practice for Good Animal Feeding

C.1.3 Foods for special intended uses

CAC/RCP 21-1979, Code of Hygienic Practice for Foods For Infants and Children³⁾

CAC/GL 08-1991, Guidelines on Formulated Supplementary Foods for Older Infants and Young Children

C.1.4 Specifically processed foods

CAC/RCP 8-1976 (Rev. 2-1983), Code of Hygienic Practice for the Processing and Handling of Quick Frozen Foods

CAC/RCP 23-1979 (Rev. 2-1993), Recommended International Code of Hygienic Practice for Low and Acidified LowAcid Canned Foods

CAC/RCP 46-1999, Code of Hygienic Practice for Refrigerated Packaged Foods with Extended Shelf Life

1) These documents, as well as updates thereof, can be downloaded from the web-page of *Codex Alimentarius*: <http://www.codexalimentarius.net>.

2) Under development.

3) Under revision.

C.1.5 Ingredients for foods

CAC/RCP 42-1995, Code of Hygienic Practice for Spices and Dried Aromatic Plants

C.1.6 Fruits and vegetables

CAC/RCP 22-1979, Code of Hygienic Practice for Groundnuts (Peanuts)

CAC/RCP 2-1969, Code of Hygienic Practice for Canned Fruit and Vegetable Products

CAC/RCP 3-1969, Code of Hygienic Practice for Dried Fruit

CAC/RCP 4-1971, Code of Hygienic Practice for Desiccated Coconut

CAC/RCP 5-1971, Code of Hygienic Practice for Dehydrated Fruits and Vegetables, including Edible Fungi

CAC/RCP 6-1972, Code of Hygienic Practice for Tree Nuts

CAC/RCP 53-2003, Code of Hygienic Practice For Fresh Fruits and Vegetables

C.1.7 Meat and meat products

CAC/RCP 41-1993, Code for Ante-mortem and Post-mortem Inspection of Slaughter Animals and for Ante-mortem and Post-mortem Judgement of Slaughter Animals and Meat

CAC/RCP 32-1983, Code of Practice for the Production, Storage and Composition of Mechanically Separated Meat and Poultry for Further Processing

CAC/RCP 29-1983, Rev. 1 (1993), Code of Hygienic Practice for Game

CAC/RCP 30-1983, Code of Hygienic Practice for the Processing of Frog Legs

CAC/RCP 11-1976, Rev. 1 (1993), Code of Hygienic Practice for Fresh Meat

CAC/RCP 13-1976, Rev. 1 (1985), Code of Hygienic Practice for Processed Meat and Poultry Products

CAC/RCP 14-1976, Code of Hygienic Practice for Poultry Processing

CAC/GL 52-2003, General Principles of Meat Hygiene

Code of Hygienic Practice for Meat²⁾

C.1.8 Milk and milk products

CAC/RCP 57-2004, Code of Hygienic Practice for Milk and Milk Products

Revision of the Guidelines for the Establishment of a Regulatory Programme for the Control of Veterinary Drug Residues in Foods Prevention and Control of Drug Residues in Milk and Milk Products (including milk and milk products)²⁾

C.1.9 Egg and egg products

CAC/RCP 15-1976, Code of Hygienic Practice for Egg Products (amended 1978, 1985)

Revision of the Code of Hygienic Practice for Egg Products²⁾

C.1.10 Fish and fishery products

CAC/RCP 37-1989, Code of Practice for Cephalopods

CAC/RCP 35-1985, Code of Practice for Frozen Battered and/or Breaded Fishery products

CAC/RCP 28-1983, Code of Practice for Crabs

CAC/RCP 24-1979, Code of Practice for Lobsters

CAC/RCP 25-1979, Code of Practice for Smoked Fish

CAC/RCP 26-1979, Code of Practice for Salted Fish

CAC/RCP 17-1978, Code of Practice for Shrimps or Prawns

CAC/RCP 18-1978, Code of Hygienic Practice for Molluscan Shellfish

CAC/RCP 52-2003, Code of Practice for Fish and Fishery Products

Code of Practice for Fish and Fishery Products (aquaculture)²⁾

C.1.11 Waters

CAC/RCP 33-1985, Code of Hygienic Practice for the Collection, Processing and Marketing of Natural Mineral Waters

CAC/RCP 48-2001, Code of Hygienic Practice for Bottled/Packaged Drinking Waters (Other than Natural Mineral Waters)

C.1.12 Transportation

CAC/RCP 47-2001, Code of Hygienic Practice for the Transport of Food in Bulk and Semi-packed Food

CAC/RCP 36-1987 (Rev. 1-1999), Code of Practice for the Storage and Transport of Edible Oils and Fats in Bulk

CAC/RCP 44-1995, Code of Practice for Packaging and Transport of Tropical Fresh Fruit and Vegetables

C.1.13 Retail

CAC/RCP 43-1997 (Rev. 1-2001), Code of Hygienic Practice for the Preparation and Sale of Street Foods (Regional Code — Latin America and the Caribbean)

CAC/RCP 39-1993, Code of Hygienic Practice for Precooked and Cooked Foods in Mass Catering

CAC/GL 22-1997 (Rev. 1-1999), Guidelines for the Design of Control Measures for Street-Vended Foods in Africa

C.2 Food safety hazard specific codes and guidelines¹⁾

CAC/RCP 38-1993, Code of Practice for Control of the Use of Veterinary Drugs

CAC/RCP 50-2003, Code of Practice for the Prevention of Patulin Contamination in Apple Juice and Apple Juice Ingredients in Other Beverages

CAC/RCP 51-2003, Code of Practice for the Prevention of Mycotoxin Contamination in Cereals, including Annexes on Ochratoxin A, Zearalenone, Fumonisin and Tricothecenes

CAC/RCP 55-2004, Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts

CAC/RCP 56-2004, Code of Practice for the Prevention and Reduction of Lead Contamination in Foods

Guidelines for the Control of *Listeria monocytogenes* in Foods²⁾

Code of Practice for the Prevention and Reduction of Inorganic Tin Contamination in Canned Foods²⁾

Code of Practice to Minimize and Contain Antimicrobial Resistance²⁾

Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Treenuts²⁾

C.3 Control measure-specific codes and guidelines¹⁾

CAC/RCP 19-1979 (Rev. 1-1983), Code of Practice for the Operation of Irradiation Facilities Used for the Treatment of Foods

CAC/RCP 40-1993, Code of Hygienic Practice for Aseptically Processed and Packaged Low-acid Foods

CAC/RCP 49-2001, Code of Practice for Source Directed Measures to Reduce Contamination of Food with Chemicals

CAC/GL 13-1991, Guidelines for the Preservation of Raw Milk by Use of the Lactoperoxidase System

CAC/STAN 106-1983 (Rev. 1-2003), General Standard for Irradiated Foods

Bibliography

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- [2] ISO 9004:2000, *Quality management systems — Guidelines for performance improvements*
- [3] ISO 10012:2003, *Measurement management systems — Requirements for measurement processes and measuring equipment*
- [4] ISO 14159:2002, *Safety of machinery — Hygiene requirements for the design of machinery*
- [5] ISO 15161:2001, *Guidelines on the application of ISO 9001:2000 for the food and drink industry*
- [6] ISO 19011:2002, *Guidelines for quality and/or environmental management systems auditing*
- [7] ISO/TS 22004:—⁴⁾, *Food safety management systems — Guidance on the application of ISO 22000:2005*
- [8] ISO 22005:—⁵⁾, *Traceability in the feed and food chain — General principles and guidance for system design and development*
- [9] ISO/IEC Guide 51:1999, *Safety aspects — Guidelines for their inclusion in standards*
- [10] ISO/IEC Guide 62:1996, *General requirements for bodies operating assessment and certification/registration of quality systems*
- [11] *Codex Alimentarius Food Hygiene Basic Texts*. Food and Agricultural Organization of the United Nations, World Health Organization, Rome, 2001
- [12] Reference websites: <http://www.iso.org>; <http://www.codexalimentarius.net>

4) To be published.

5) To be published.