



Sudan University Of science and Technology
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**Assessment of Food Safety Knowledge, Attitudes and Practices
among Abattoir and Butcher Shops Workers in Alfasher City,
North Darfur State, Sudan**

تقييم المعرفة والسلوك والممارسات بين العاملين بالمسالخ والجزارات
في مدينة الفاشر - ولاية شمال دارفور - السودان

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By:

Osman Adam Idris Sulieman

B.V.S, (2006) faculty of Veterinary science

University of Nyala

Supervisor:

Professor Mohamed Abdelsalam Abdalha

**Department of Preventive Veterinary Medicine and Public
Health, College of Veterinary Medicine, Sudan University of
Science and Technology**

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الإستهلال Initiation

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(وَمَا مِنْ دَابَّةٍ فِي الْأَرْضِ وَلَا طَائِرٍ يَطِيرُ بِجَنَاحَيْهِ إِلَّا أُمَمٌ أَمْثَلُكُمْ ۗ مَا فَرَّطْنَا فِي الْكِتَابِ مِنْ شَيْءٍ ۗ ثُمَّ إِلَىٰ رَبِّهِمْ يُحْشَرُونَ).

صدق الله العظيم

سورة الانعام الاية (٣٨)

Dedication

Every challenging work needs self-efforts as well as guidance of elders especially those who were very close to our heart.

My humble effort I dedicate this thesis to my sweet and loving father and mother, whose affection, love, encouragement and prays of days and night make me able to get such success and honor, along with all hard working and respected teachers.

My beloved brothers and sisters; particularly my dearest brothers, Dr. Suleiman and Dr. Mustafa whose stands by me when things look bleak and supported me in all steps.

My dearest wife, who leads me through the valley of darkness with light of hope and support.

My beloved kids: Hazim, Hatim, Mohamed, Adam and Alzahara, whom I can't force myself to stop loving. To all my family, the symbol of love and giving.

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In the name of Alha, the most merciful, the most compassionate all praise be to Alha, the lord of the world; and prayers and peace be upon Mohamed His messenger.

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Abstract

A cross-sectional survey design was conducted among Al flasher abattoir and butcher shops in Al flasher city, North Darfur state, Sudan, and this assessment survey was carried out from January to March 2021 to assess current overall hygienic conditions in abattoir and butcher shops and to evaluate food safety knowledge of workers of abattoir and butcher shops.

A structured questionnaire was adopted from previous published research articles in order to meet the objective of this study. One hundred and twenty of workers (n=120) were interviewed by using structured questionnaire with 100% response rate.

Through which results were illustrated that more than 69% of the sample of the study (n=120) was below secondary level, indicating that they were not recognized by proper health behavior, applying and its importance in meat quality in abattoir and butchers shops.

Abattoir and butcher shops workers 81.7% were trained on food and meat hygiene during their work time, and 41.7% of the respondents who work in the Alfaher slaughterhouse known other zoonotic disease like Tuberculosis, Hyatidosis etc. than those mentioned in the questionnaire such as Brucellosis and Anthrax. As revealed in the result of knowledge data analysis using multiple comparisons test in ANOVA, the findings apparent that there is a significant differences between the answers of the Illiteracy and the secondary only based on the level of significant (0.024), which less than 5% (p-value). Recommended that future research should focus on the determination of KAP and the level of compliance with slaughterhouse and butcher shops laws in both licensed and unlicensed abattoir across the State.

In conclusion, abattoir and butcher shops workers had unsatisfactory knowledge mainly on foodborne diseases, time temperature control.

ملخص الدراسة

تم إجراء تصميم مسح متقاطع في المسالخ ومحلات الجزارات في مدينة الفاشر، ولاية شمال دارفور، السودان، لتقييم الظروف الصحية العامة الحالية في المسالخ والجزارات وتقييم معرفة سلامة الأغذية بين العاملين بالمسالخ والجزارات. وتمت إجراء هذه التقييم من يناير إلى مارس ٢٠٢١. تم اعتماد إستبيان منظم من مقالات البحث المنشورة السابقة من أجل تلبية هدف هذه الدراسة. تمت مقابلة مائة وعشرون (١٢٠) من العاملين من خلال إستبيان منظم مع معدل استجابة بنسبة ١٠٠٪.

من خلال نتائج المستوى التعليمي يتضح أن أكثر ٦٩% من عينة الدراسة (١٢٠) كانوا دون الثانوي، مما يشير إلى أنهم لا يعرفون عن السلوك وممارسات الصحة المناسبة، تطبيقها وأهميتها في جودة اللحوم في المسالخ والجزارات. من العاملين بالمسالخ ومحلات الجزارات، (٨١.٧%) تتدربوا على سلامة الغذاء وصحة اللحوم من خلال العمل. (٤١.٧%) يعرفون بعض الأمراض المشتركة الأخرى أكثر من التي كانت في الإستبيان مثل البروسيلا والجمرة الخبيثة. كما هو موضح في نتيجة تحليل بيانات المعرفة باستخدام إجراءات مقارنات متعددة، فإن النتائج الواضحة أن هناك اختلافات كبيرة بين إجابات الأمية والثانوية فقط بناءً على مستوى ٠.٠٢٤ الهامة، والتي أقل من قيمة المستوى المعنوية 5%. أوصت الدراسة بأن تركز البحوث المستقبلية على تحديد المعرفة والسلوك والممارسات ومستوى الإمتثال لقوانين محلات المسالخ والجزارين في كل من المسالخ و الجزارات المرخصة وغير المرخصة في جميع أنحاء الولاية.

في الختام، كان لدى عمال المسالخ الجزارات المعرفة غير المرضية بشكل رئيسي في الأمراض التي تنقلها الأغذية، ومراقبة درجة الحرارة الزمنية التي تؤثر على جودة اللحوم.

1. INTRODUCTION

Livestock is an important component of the food supply of rural and urban areas and contributes to family nutrition, supplying animal protein. Meat is an important source of animal protein and a valuable product in resource-poor communities in many developing countries like Bangladesh. A slaughterhouse is a facility where animals are slaughtered for consumption as human food. The noticeable reform of slaughterhouses was visible in the nineteenth century. This reform was a part of the rapid transition of industrial society from an agricultural society based on urbanization, technological development, and growing concern about public hygiene (Brandt *et al*; 2005). An anthropologist Noelle Vialles pointed out, “animal slaughtering tends to be a somewhat unpopular subject: no one wants to know about it” (Vialles, 1994). Philosopher Nancy Williams argued, there was an unwillingness among the public to think about how their meat was produced, and that this had important ethical implications (Williams, 2008). The slaughterhouse is a location from which one can view economic and geographic changes in the production of food, cultural attitudes towards killing, social changes in small communities, and the changing sensibilities and relations between humans and animals.

In developing countries, facilities of large scale slaughterhouse or meat processing plant situated in the city area differ from that of rural areas with small scale slaughterhouses (Clottey, 1985). This difference between meat processing plants with modern facilities and small slaughterhouses in the meat industry is due to insufficient investment from the private sector and limited regulation of the trade (Mann *et al.*, 1983). Slaughtering facilities and unsatisfactory slaughtering techniques often contaminates meat and is hazardous to human health. Food safety is the foundation for the future success of this industry. Currently there are growing concerns in critical areas such as biosecurity, good animal husbandry, feeding practices, quality

assurance programs at farm levels, good hygiene practices in food establishments like abattoir and meat selling centres are essential for consumer protection and the control of public health risks. This is because the hygiene of food workers can contribute significantly to the outbreak and transmission of foodborne illness. All workers in a food handling area are therefore expected to maintain a high degree of cleanliness of their body and clothing, wear suitable and protective clothing to ensure food safety and public health (Assefa *et al.*, 2015). The traditional management system of abattoir and meat selling centres were not sufficient to supply quality meat for human consumption. Slaughterhouses facilities such as the water supply, concrete floor, drainage system and ventilation system were not sufficient. Workers' hands and clothes were found to be dirty. The crows were found in the slaughter place waiting for thrown by-products and no restriction of dog and cat entering the slaughterhouses. No rules of the Government related to slaughterhouses were executed in the abattoir (Alam *et al.*, 2009). These two studies were conducted a decade ago and meanwhile a new law about slaughtering animal and meat quality control named "Slaughterhouses Act-2011" was implemented by Bangladesh Government to improve meat safety by the modernization of facilities. However, food safety cannot be attained solely through the modernization of facilities. It is also necessary to address the behaviour of people working at slaughterhouses and meat selling centres. The behaviour of workers is connected to various socio-economic factors such as educational background, social status and workers' enthusiasm (connected to their income and social status). On-the-job training of workers is also important for the improvement of food safety.

1.1 Objectives

The present study was designed:-

- To assess current overall hygienic conditions in abattoir and butcher shops.
- To evaluate food safety knowledge of workers of abattoir and butcher shops considering socio-economic background.

CHAPTER ONE

LITERATURE REVIEW

2.1 Food safety

Food safety is a significant public health concern in the world. Foodborne diseases due to microbiological agents, including pathogens and biotoxins, and chemical contaminants in food represent serious threats to the health of thousands of millions of people (FAO and WHO, 2003). According to WHO, contaminated food contributed to 1.5 billion cases of diarrhea in children each year, resulting in more than 3 million premature deaths (DeWaal and Robert, 2008). In South East Asian Region, foodborne diseases are common in the region. Contamination of food and water are major causes of deaths and illnesses due to diarrhea. Approximately 1 million children under 5 years old die each year from diarrheal diseases. In Thailand, approximately a million cases of acute diarrhea were reported each year, with more than 120,000 are related to foodborne poisoning cases. Diarrheal diseases are usually occurrence among those living in poor environmental sanitation and those with poor personal hygiene. The high rate of disease incidence in children under five years of age was also reported in Thailand. The microbiological contaminated food are usually found that originated from gastrointestinal tracts of food animals. Considering the food chain from farm to fork, foodborne illness is caused by many factors. The most common reported contributing factors are insanitary food handling procedures and contamination of potentially hazardous foods with pathogens, foods from unsafe sources, leaving food at room temperatures for an extended period of time and insufficient time and/or temperature during initial cooking or reheating and contaminated equipment (Kassa *et al.*, 2010). Strict maintenance of good practices of slaughterhouse hygiene in meat production is an important role for the prevention of microbial carcass contamination (Zweifel *et al.*, 2005). Food handlers participate in the final stage of the

prevention of foodborne diseases (Abdullah Sani and Siow, O.N.2014). The hands of food handlers can be vectors for the spread of foodborne diseases because of poor personal hygiene or cross-contamination (Baş *et al.*, 2006). They must take significant steps to minimize the pathogen contamination to the minimum level in food (Medeiros *et al.*, 2004). Food handlers should have excellent hygiene practice to ensure cross contamination is reduced, thus protecting the consumers from foodborne diseases (Abdul-Mutalib *et al.*, 2012). To ensure that food handlers have the awareness, knowledge and practice related to the correct way of handling food, training and education are essential parts of their job (Martins *et al.*, 2012). Numerous studies indicated that training may increase knowledge but does not always result in behavior change (Powell *et al.*, 1997). Incentive factors and hindering factors should be considered for change practice. In contrast to food hygiene training, meat handler training represents one of the most effective strategies to maintain and mitigate food safety risks (Jianu and Goleţ, 2014). Effective food safety training from organizations as well as adequate resources will strengthen food handling and workplace safety practice. KAP studies can be conducted by quantify and measure an incident through the use of questionnaires and statistical processing of the information collected. KAP assessment can generate the level of knowledge and the awareness of personal workers in food production. Thus, the KAP information should be transferred to educational training programs in order to address the lack of knowledge and increase the awareness of personal incentive roles.

2.2 Personal hygiene

Personal hygiene and health of food handlers is of the utmost importance when an effort is made to deliver a safe product of high quality to the consumer. Workers should be medically examined before employment in order to determine if they are physically fit to perform the work and also if they do not suffer from transmissible diseases, which can be transmitted through the food they handle to the consumer. They must also undergo daily fitness checks for different signs of illness. Workers must be issued daily with clean clothes in a good condition in order to protect the food from contamination and also to protect the workers against potential dangers.

Each worker can contribute to good personal hygiene standards.

According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases. The term "food hygiene" is used to describe the preservation and preparation of foods in a manner that ensures the food is safe for human consumption, and to prevent – as far as possible – the contamination of food. Personal hygiene of food handlers pertains to the hygiene practices that prevent contamination food with mixing chemicals, spreading from people, pets, and pests. Personal hygiene is performed by an individual to care for one's bodily health and wellbeing, through cleanliness. Motivations for personal hygiene practice include reduction of personal illness, healing from personal illness, optimal health, social acceptance and prevention of spread of illness to others. Other practices that are generally considered proper hygiene include washing hands regularly and especially before handling food, washing scalp hair, wearing clean clothing, cutting finger nails. Moreover, it is an important factor to be aware of dangers of cross contamination between raw and cooked food by separate raw and cooked food. Temperature and length of time should appropriate for cooking. Food handlers store food at the proper temperature.

2.3 Foodborne illnesses

Foodborne illnesses are prevalent in all parts of the world. It is defined by the World Health Organisation as disease usually either infectious or toxic in nature caused by agents that enter the body through the ingestion of food. WHO estimated that more than 2.2 million people worldwide die each year from foodborne and waterborne diseases (Food Standard Agency, 2011). In addition, CDC reported that foodborne diseases caused approximately 76 million cases, resulting in 325,000 hospitalizations and 5,000 deaths each year in the United States of America alone (Mead *et al.*, 1999). Consequently, the economic losses due to foodborne diseases has been estimated \$77 billion annually (Scharff, 2012). Foodborne illnesses can be caused by microorganisms such as viruses, bacteria, parasites, and prions, and chemical contaminants such as food additives, pesticides. Most foodborne cases are associated with acute gastroenteritis defined as diarrhea and vomiting (Lucado *et al.*, 2013), but affected individuals can also experience abdominal cramps, fever and bloody stool (Daniels *et al.*, 2002). Furthermore, more serious complications such as colitis, bloodstream infection, meningitis, joint infection, kidney failure, paralysis, miscarriage and other problems can be developed in some healthy persons and especially in vulnerable people who are susceptibility than others (King *et al.*, 2013). In fact, approximately half of the reported foodborne illnesses occur in children, with the majority of these cases among children under 15 years old. Young children are the most susceptible to foodborne illnesses due to their lower bodyweight and immature immune systems (Tan *et al.*, 2013). In Thailand, diarrheal diseases have been a major public health problem for many years. Bureau of Epidemiology reported that the consumption of microbial contaminated drinking water and food is the major cause of the diseases in Thailand. Contributing risk factors of diarrheal diseases are usually found among those living in poor environmental sanitation and those with poor personal hygiene. Inappropriate consumption behaviors among people in some areas, who

always consume raw or undercooked food, are one of the major causes of diarrheal diseases in Thailand (FAO and WHO, 2004).

2.4 The Nature and Extent of Foodborne Disease

Foodborne disease (also referred to as foodborne illness or food poisoning) is any illness that results from the consumption of contaminated food, contaminated with pathogenic bacteria, viruses, or parasites. The economic costs associated with foodborne disease can be severe on people, food companies, and country reputation. Foodborne disease globally is still not under control and outbreaks can cause health and economic losses. The causes are unhygienic practices in food production, harvesting, and preparation. There are 31 main foodborne pathogens causing diseases; the significant ones such as *Salmonella* nontyphoidal, *Campylobacter*, *Listeria*, and Shiga toxin-producing *Escherichia coli* are monitored by national authorities, and outbreaks are assessed in depth to assess trends and determine the steps necessary to combat future outbreaks. Foodborne diseases can be mild with recovery in days, or severe resulting in hospitalization and death in certain patients (Adely and Ryan (2016).

2.5 Sources of Foodborne Hazards

Though the magnitudes of different foodborne risks are difficult to measure, their general sources are better understood. They include: (1) contaminated, diseased, or otherwise harmful materials that are not detected and excluded or cleansed; (2) inadequate storage, handling, or processing, which fails to detect and exclude harmful food materials or contaminants of food materials; and (3) purposeful introduction in to the food supply of potentially harmful materials (including pesticides, fertilizers, animal drugs, packaging materials, and food ingredients). Many risks stem from bacteria and parasites that live on or near animals or contact crops during food production, processing, or storage. Because there is a tendency for bacteria to contaminate entire flocks or herds, one contaminant can incubate in a farm or processing plant and eventually contaminate food across wide areas. The effective methods of reducing bacterial risk include basic sanitation (both on the farm and in processing), use of antibacterial agents, application of radiation (for meat and poultry), and pasteurization(Ames and Bruce, 1987). The sources of non-bacterial risk are similarly diverse. Pesticides can contaminate food through agricultural run-off into the water supply and by forming residues on raw agricultural commodities and in prepared foods. Drugs administered to livestock can leave residues in human food. Insect and rodent pests can infect foods in processing and storage plants. Natural contaminants, such as aflatoxin, occur naturally in some foods and may pose risks greater than any chemicals that require regulatory safety approval (Fabio levi, 1998). Food allergens are ubiquitous and some pose serious risks to sensitive consumers. More recently, federal agencies have become concerned about possible bioterrorist attacks on the food supply. The dietary choices that consumers make can also affect their risk of disease. Certain foods, such as red meat, are correlated with higher incidence of certain cancers, while others, such as fruits and vegetables, are believed to be linked to lower cancer risks (Janet E.coolinss, 1997). As Americans have come to rely more heavily on restaurants and processed

foods, they have relinquished control over risks inherent in food preparation and storage. Because consumer demand for fresh agricultural commodities has surpassed domestic supply, supermarkets are now stocked with imported fresh foods on a year-round basis. Imported foods may present greater risks than domestically-produced foods because of less rigorous food safety controls or production factors, such as spoilage through shipping.

2. Bacteria most frequently associated with food borne diseases

According to the CDC, bacterial pathogens such as *Campylobacter*, *Salmonella*, and *E. coli* 0157:H7 are the most common causes of foodborne morbidity and mortality in the United States (Mead *et al.*, 1998). Many of the largest outbreaks of bacterial foodborne disease have been caused by consumption of undercooked animal-based foods or foods prepared under unsanitary conditions, meat and poultry are believed to be the most common sources of these pathogens. Because food preparation conditions play so significant a role in the spread of bacterial foodborne pathogens, increasing consumer reliance on commercially prepared foods is likely to take on special importance in the battle against foodborne illness. The Department of Agriculture's Economic Research Service (ERS) has estimated that illnesses caused by the seven most common foodborne pathogens result in \$6.5 billion to \$13.3 billion of lost wages and health costs annually. (Janes and Buzby 1988-1992).

2.7 Knowledge, Attitudes and Practices (KAP)

The relationship between knowledge, attitudes and practices is often explained through the (KAP). It has been traditionally assumed that knowledge is automatically translated into behavior (Glanz *et al.*, 2002). A KAP survey is a quantitative type method by interviewing through the use of a structured, standardized questionnaire and statistical method for collected information. It serves as an educational diagnosis of the community. A KAP survey is widely used to gather information through various types of cross-sectional surveys that plan public health programs. The public health programs are implemented to improve the health of poor people across the world that depends upon adequate understanding of the socio-cultural and economic aspects of the context in countries (Launiala, 2009). KAP studies show that food handlers who have never been trained in food safety-related knowledge of food-borne illness. It is a significant positive correlation between the level of knowledge, attitudes and practices of meat handlers. Food handlers should practice all the skills and ongoing training to get more knowledge in hygiene and food safety (Powell *et al.*, 1997). 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 involve evaluated concepts associated with what people think, feel and behave, it comprises a cognitive, emotional and behavioral component (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 sociocultural, environmental, economical and structural factors (Tracy, 2011). Behaviorists further add that a number of factors can influence one or more of the (KAP) variables such as self-esteem, self-efficacy and misconception. World Health Organization (WHO, 2010)

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
- (5) Use safe water and raw materials.

On the other hands (Byr *et al.*,2007) developed a food safety knowledge in to five concepts or keys inspired by WHO, (2010) 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 food borne disease ; and food borne disease pathogens.

Across sectional study by Maryam *et al.*, (2010) from school of veterinary medicine, Shiraz University, Iran the evaluated the knowledge, attitudes and practices of workers in meat processing plant. The results indicated that there was 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) in Malaysia to evaluate the level knowledge, attitudes and practices among food handlers. The study revealed that the respondents share a good knowledge on personal hygiene and definition of foodborne 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). Other studies found that training helps to improve the overall employee knowledge about food safety (Castello *et al.*, 1997). Another study

(Sufen *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 (Ola, 2014) in Khartoum state showed that television and radio are the most important sources of information for the consumers and there was 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. Also other study (Khalid, 2016) in Khartoum state found that there was a need for more education to the consumers about food safety and food borne diseases.

2.7.1. 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 handler conducted in Italy found that the majority of food handlers who had attended a training course had knowledge and appositive 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 Abdalla *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 according to (Eduarda *et al.*, 2007). Food safety experts have identified the most common foodhandling 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), so the authors suggested that emphasis should continue on improving knowledge and control of foodborne diseases amongst food handlers (Angelillo *et al.*, 2000), these 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), so 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).

2.8 HACCP

A HACCP plan is a form of process and risk control (Buchanan and Whiting, 1998). Traditional HACCP plans do not quantify the influence of multiple control points and their variations or attempt to link a critical control point to a measurable impact on public health. Each critical control point is usually evaluated separately from the other processing steps and critical control points. The risk assessment provides the underlying support for a HACCP plan by quantitatively determining the degree of control an entire process and each individual process operation contributes to the safety of the food (Serra et al., 1999). Establishing an acceptable or tolerable level of risk for a food is a social and value decision, not a scientific decision. The tolerable level of risk is not necessarily constant for different pathogens or foods. The severity of disease (*Listeria* vs. *Salmonella*), the susceptibility of various subpopulations (children for *E. coli* O157:H7), and established customs (raw oysters, sunny-side up fried eggs) affect the level of risk that is acceptable to the consumer. The dose-response relationship can establish the amount and frequency of pathogen consumption that achieves a tolerable level of risk (ICMSF, 1998). This amount and frequency is termed the *food safety objective*. The risk assessment, in consultation with risk management, will evaluate the entire process from raw ingredients to consumption and establish a series of process steps that meet the food safety objective. The risk managers will then select the specific process to be used, also taking into consideration quality, cost, and feasibility (Morales and McDowell, 1998). The HACCP system is a preventative approach to managing hazards during food handling and processing and is effective if correctly implemented (Brashears and Butler, 2016).

2.8.1 Principles of HACCP plan

For the practical application of the HACCP concept according to Codex Alimentarius [6], 7 rules have to be followed which are laid down in 7 main principles of a HACCP plan:-

- **Principle 1:** Perform a hazard analysis. The objective of this step is to obtain a comprehensive list of all biological, chemical and physical agents or conditions which have the potential to cause harm, the assessment and the severity of the risk associated with these hazards as well as the possible control measures for each hazard.

- **Principle 2:** Determine the Critical Control Points (CCPs): Codex describes a CCP as: “A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. The intent of the HACCP system is to focus control at CCPs”.

- **Principle 3:** Establish one or several critical limit(s)

- **Principle 4:** Establish a CCP monitoring system

- **Principle 5:** Establish corrective action to be taken if monitoring indicates that a specific CCP is no longer under control.

- **Principle 6:** Establish procedures of verification to confirm a successful working of the HACCP system

- **Principle 7:** Introduce a documentation system taking into account all processes and records in accordance with the principles and their application (Damikouka et al; 2007).

CHAPTER TWO

MATERIALS AND METHODS

3.1 Study area

The assessment survey was carried out from January to March 2021 in Elfasher abattoir and butcher shops in north darfur state, Sudan where cattles, sheeps, goats and camels are brought from different states and localities for slaughter in order to evaluate food Hygiene knowledge, attitudes and practices of abattoir. Elfasher is the capital of the North Darfur state, Sudan. It's a large town in the Darfur region north western Sudan, 195 km (121 miles) northeast of Nyala, Sudan and it is 1,030 km away from Khartoum, Sudan, latitude 13.619° N and longitude 25.3549° E. It is located at an elevation of about 700 meters above sea. The town serves as an agricultural marketing point for the cereals and fruits grown and majority of population depends on livestock production in their life. The population estimated to be 263,243 census (Eric Danies, 2005). Al fasher has a hot arid climate with three distinct seasons.

3.2 Study design and sample collection

A cross-sectional survey design was conducted among Alfasher abattoir and butcher shops in Alfasher town, north Darfur state, Sudan. One hundred and twenty workers were interviewed by using structured questionnaire with 100% response rate. All (n =120) workers involved in meat processing in the abattoir and butchery shops of the town were included in the study and the respondents were interviewed face-to face on an one-off basis during working hours with out prior notice of interview. Explanation of the purpose of the study was given before and the respondents were assured about the confidentiality of their status. The questionnaire was read and completed by an interviewer in individual

interviews. The respondents were given sufficient time (15 min) to answer the questionnaire.

3.3 Questionnaire

A structured questionnaire was adopted from previous published research articles in order to meet the objective of this study. The questionnaire structured into four distinct parts including demographic information such as respondent's age, sex, years of experience, responsibility, income and attending food safety training.

The second section of the questionnaire is about food safety knowledge, questions on knowledge referred to their personal hygiene, cross-contamination, causes and symptoms of food borne diseases and time temperature control. It contains (7) close-ended questions and each question has three optional answers (“Yes”, “No”, “I don't know”).

The third part of the questionnaire was about food safety attitudes of abattoir and butchery shop workers. It comprise (11) questions about hand washing, cross-contamination, how to deal with injuries when you work in meat processing area, storage etc. In this section the respondents answers were (“agree”, “disagree”, “uncertain”).

The last section dealt with food hygiene practices. The questions comprises the issues of personal hygiene, hand washing practices, practice against food borne diseases and cross-contamination. This section had (10) questions with four possible responses (“Usually”, “sometimes”, “Never, ” Don't use).

3.4 Statistical analysis

The statistical analysis of the data were performed by using SPSS (Statistical package for the social sciences) software version 20. Descriptive statistics such as frequency (%) for categorical, mean and standard deviation (SD) for numerical data were used to sum up the data. Chi square(χ^2) was also used to find the relationship between attitudes with knowledge and practice score. P-value less than 0.05 was considered statistically significant.

CHAPTER THREE

Results

1.1 Socio-demographic characteristics of workers interviewed in the Alfasher abattoir.

All workers in abattoir and butcher shops were male and 120 of workers who responded, a majority were old-aged (more than 40 years) representing 30% of workers, followed by youngers (20-25 years) group 29.2% as showed in (Table 3.1). Through which results are illustrated that more than 69% of the sample of the study (n=120) was below secondary level, indicating that they are not recognized by proper health behavior, applying and its importance in meat quality in abattoirs and butchers shops, and therefore, recommended that veterinary and health authorities should establish essential skills to help improve them Continuous and the quality of meat, which is reflected in consumer health and environment (Table 3.2).

Table.3.1 Age (yr) of the workers {n=120} in Alfasher- North Darfur State.

	Age	Frequency	Percent
Valid	< 20	11	9.2
	20-25	35	29.2
	30-35	16	13.3
	35- 40	22	18.3
	More 40	36	30.0
	Total		120

Table.3.2 Percentages of Educational levels of workers {n= 120} in Alfasher- North Darfur State.

Educational level	Frequency	Percent
Illiteracy	18	15.0
Primary	65	54.2
Secondary	37	30.8
Total	120	100.0

Table 3.3: Percentages of food hygiene training taken by workers {n=120} in Alfasher- North Darfur State.

Do you have Food hygiene training	Percent
Yes	81.7
No	16.7
Don't know	1.7

Table 3.4: Percentages of most common zoonotic diseases known by workers{n=120} in Alfasher-North Darfur state

Most common zoonotic diseases	Percent
Brucellosis	21.7
Hemorrhagic fever	12.5
Anthrax	4.2
Others	41.7

About 81.7% of abattoir and butcher shops workers were trained on food and meat hygiene during their work time (Table 3.3), with 41.7% of personnel who work in Alfasher abattoir knows other zoonotic disease like Tuberculosis, Hyatidosis etc. than those mentioned in the questionnaire such as Brucellosis and Anthrax and Hemorrhagic fever (Table 3.4).

Table 3.5: Percentages practices of workers {n= 120} in Alfasher-North Darfur State

What you do when wash your hands?	Percent
Wash my hands with soap and water	83.3
Wash my hands with water only	10
Don't care about	6.7

The respondents whom using water and soap when washing their hands before and after working were 83.5% (Table 3.5).

Table 3.6: Percentages of cross-contamination known by the workers {n=120} in Alfasher-North Darfur State.

Do know cross-contamination	Percent
Yes	72.5
No	22.5
Don't know	4.2

Table 3.7: Percentages of signs of spoilages known by the works {n=120} in Alfasher-North Darfur State.

Known of meat spoilages	Percent
Yes	94.2
Nos	2.5
Don't know	1.7

Regarding to the abattoir workers knowledge, 72.5% of respondents were known cross-contamination (Table 3.6) and 94.2% of abattoir workers were known signs of meat spoilage, so they able to differentiate if the meat spoiled or not (Table 3.7).

Table 3.8: Mean value of attitudes among abattoir workers {n=120} in Afasher- North Darfur state

Sentences	Measure	Agree	Disagree	Uncertain	Ean	SD	
Information meat hygiene	Freq	119	1	0	1.008	0.091	Agree
	Percent	99.2	0.8	0			
Sterilization of equipment's	Freq	112	6	2	1.08	0.33	Agree
	percent	93.3	5	1.7			
Cooling the meat reduces bacterial growth	Freq	115	4	1	1.05	0.25	Agree
	percent	95.8	3.3	0.8			
Role of insects on meat contamination	Freq	110	9	1	1.09	0.32	Agree
	percent	91.7	7.5	0.8			
Training on meat hygiene	Freq	107	11	2	1.12	0.38	Agree
	percent	89.2	9.2	1.7			
Using protective clothes reduce the risk of meat contamination	Freq	117	1	3	1.04	0.27	Agree
	percent	97.5	0.8	1.7			
Washing hands practices	Freq	120	0	0	1	0	Agree
	percent	100	0	0			
Carcasses should be separated	Freq	113	5	2	1.07	0.32	Agree
	percent	94.2	4.2	1.7			
Storage of meat can be a hazard to health	Freq	106	13	1	1.13	0.36	Agree
	percent	88.3	10.8	0.8			
Butchers with cuts should not touch carcasses	Freq	103	13	4	1.17	0.46	Agree
	Percent	85.8	10.8	3.3			
Result of Attitudes	Freq	1112	63	15	1.07	0.278	Agree
	Percent	93.5	6.3	1.5			

According to table 3.8 most of workers in abattoir and butchery shops were answered the questions with agree option and explained their responsibilities to maintain hygiene and safety of meat by applying good manufacture practices (GMP) and positive attitudes. And statement not agreed with actual practices of abattoir and butcher shops workers.

Table 3.9: Association between Attitude and knowledge of workers {n=120} In Alfasher-North Darfur State

Chi-Square Test (X2)			
	Value	Df	A sump.Sig. (2-sided)
Pearson Chi-Square	83.259 ^a	66	.074
Likelihood Ratio	65.379	66	.498
Linear-by-Linear Association	9.987	1	.002
N of Valid Cases	120		
a. 76 cells (90.5%) have expected count less than 5. The minimum expected count is .01.			

Regards to the value of the level of significance in the chi-square. In table 3.9 Chi-squared test found that the probability of the significance of taking a value of 0.07 which was greater than 0.05% and therefore accepted the hypothesis that there were no significant differences the mean of the answers between knowledge and attitude, that means the knowledge has no statistical significance with regard to behavior. But the respondents were not practicing this behavior.

Table 3. 10: Comparisons Knowledge Attitudes, and Practices of workers{n=120} in Alfasher-North Darfur State.

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
ATTITUDES	Between Groups	.023	2	.012	.674	.512
	Within Groups	2.001	117	.017		
	Total	2.024	119			
PRACTICES	Between Groups	.080	2	.040	.930	.398
	Within Groups	5.032	117	.043		
	Total	5.112	119			
KNOWLEDGE	Between Groups	.393	2	.197	2.782	.066
	Within Groups	8.274	117	.071		
	Total	8.668	119			

As showed in the Table 3.10 the probability of significance taking the values (0.512-0.398- 0.066) were larger than 5%, and therefore the null hypothesis was accepted, there were no significant differences between the averages of answers according to the educational level.

Table 3.11: Knowledge of abattoir workers {n=120} in Alfasher-North Darfur State.

Multiple Comparisons							
LSD							
/;Dependent Variable	(I) Educational level	(J) Educational level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
ATTITUDES	Illiteracy	Primary	.03726	.03483	.287	-.0317	.1062
		Secondary	.04084	.03758	.279	-.0336	.1153
	Primary	Illiteracy	-.03726	.03483	.287	-.1062	.0317
		Secondary	.00358	.02693	.895	-.0498	.0569
	Secondary	Illiteracy	-.04084	.03758	.279	-.1153	.0336
		Primary	-.00358	.02693	.895	-.0569	.0498
KNOWLEDGE	Illiteracy	Primary	.09100	.07083	.201	-.0493	.2313
		Secondary	.17525*	.07642	.024	.0239	.3266
	Primary	Illiteracy	-.09100	.07083	.201	-.2313	.0493
		Secondary	.08425	.05477	.127	-.0242	.1927
	Secondary	Illiteracy	-.17525*	.07642	.024	-.3266	-.0239
		Primary	-.08425	.05477	.127	-.1927	.0242
PRACTICES	Illiteracy	Primary	.03257	.05523	.557	-.0768	.1420
		Secondary	.07591	.05960	.205	-.0421	.1939
	Primary	Illiteracy	-.03257	.05523	.557	-.1420	.0768
		Secondary	.04334	.04271	.312	-.0412	.1279
	Secondary	Illiteracy	-.07591	.05960	.205	-.1939	.0421
		Primary	-.04334	.04271	.312	-.1279	.0412

*. The mean difference is significant at the 0.05 level.

As revealed in the result of knowledge data analysis using multiple comparisons test in ANOVA (Table 3.11), the findings becomes apparent that there is a significant differences between the answers of the Illiteracy and the secondary only based on the level of significant (0.024), which less than 5% (p-vau), and therefore the null hypothesis was rejected and there were no significant differences according to educational levels.

CHAPTER FOUR

DISCUSSION

This study had attempted to evaluate food hygiene knowledge, attitudes and practices of abattoir and butcher shops personal in Al-fasher locality, North Darfur state, Sudan January 2021. Maintenance of proper hygienic practices is at the top of the agenda in food and drinking establishments, while handling is essential to provide fresh and healthy meat for public consumption. Socio-economic conditions of the food handling also considered because of their vital importance for food hygiene practices.

As reflected by the study (Table 3.1,3.2,3.3) the majority of workers were olders in the abattoir attributed to their experiences. The level of educated workers in this study is low because the workers who leave primary school represented 54.2% and food hygiene trained respondents were represented 81.7%, this finding in accordance with finding of Soultis *et al.*(2015).

In this result (Table 3.4) the respondents known other zoonotic common diseases (41.7%) like Tuberculosis, Hydatidiosis, Brucellosis and Anthrax. The current study revealed (Table 3.5) there was no particular place for washing hands in abattoir and butchery shops, majority of the workers were washed their hands at home, and those were use water and soap when they washing hands represented (83.5%). Reports indicated that simple act of washing hands with soap and water reduces the incidence of diarrhea caused by *Shigella* and other causative agent by up to 35% (WHO, (1999). Because meat handlers are probable sources of contamination for microorganisms, It is important that all possible measures should be taken to reduce or eliminate such contamination by applying good manufacture practices, also the respondents unaware of the correct refrigerator temperatures for food storage.

(Muinde and kuria, 2005).

In this study (Tables 3.6,3.7) workers had well knowledge about cross-contamination, how meat become contaminated with pathogenic agents and workers were known signs of meat spoilage, so they able to differentiate if the meat spoiled or not, actually the workers did not use personal protective equipments (PPE). This study in accordance to the previous studies of the same field which revealed that the purpose of wearing overalls is to protect both the food products and the meat handlers from cross contamination (Nel *et al.*, 2004). In addition to public health effect, abattoir risks include the potential of pollution of air, soil, surface water and the ground water, (Alkinro *et al.*, 2009).

In this study (Socio-demographic characteristics) unlike other food processing, all abattoir and butchery shops personal involved in meat processing were males {100%}, from this study reflected our personal observation that meat handlers were manned by women. This findings were similar with other study was conducted in Brazil (Hanashiro *et al.*, 2005). Also this results in accordance with previous study s conducted in Guhana by Akabanda *et al.* (2017) which revealed that most abattoir and butchery shops were males.

In this study (Tables 3.8,3.9,3.10) most workers in the abattoir and butchery shops explained their responsibilities to maintain hygiene and safety of meat by applying GMP and positive attitudes, also there was no significant differences between knowledge and attitude. Moreover, in comparison between knowledge and attitude the result revealed the probability of significance taking the values (0.512,0.398,0.066) were larger than 5% and therefore the null hypothesis was accepted. This findings is in agreement with the findings by Baş *et al.* (2006) who said that many of the respondents unaware of the correct refrigerator temperatures for food storage.

In this study (Table 3.11) knowledge using multiple comparison test revealed that there is a significant differences between answers of the Illiteracy and the

secondary only based on the level of p-value (0.024) which was less than 5%, and therefore the null hypothesis was rejected because there were no a significant differences according to educational levels. Moreover, workers knowledge, attitude and personal hygiene practices plays vital role to ensure safety of food and safeguard the consumer from food borne infection and intoxication, also gastrointestinal tract contents of abattoir were disposed in to the gully and during the rainy season these contaminates the environments of the city. This result is in contrast with the finding by Soares *et al.* (2012) and findings by Adesokan and Raji (2014) who reported in knowledge, attitude and practices of respondents.

CONCLUSION AND RECOMMENDATION

CONCLUSION

In conclusion, slaughterhouse and butcher shops workers had unsatisfactory knowledge mainly on foodborne diseases, time temperature control. It may be due to high proportion of illiteracy and primary school leaver abattoir personals in the study area. Furthermore no abattoir or butcher shops workers had taken official food safety training, except during working time. Though most of abattoir and butchery shops workers have basic understanding and good attitude about personal hygiene, they didn't translate in to the strict food hygiene practices. Therefore continuous food safety education and training for meat handlers should be given that can enhance good safety practices through better understanding and positive attitude. Apart from training programs should be provided, there is a need to better understanding about cross contamination problem in meat production chain and government should realize the real problem and cooperate with stakeholders to find the techniques or solve problems together.

Recommendation

- I. Proper training, monitoring and educating slaughter personnel will help to assure that the workers are provided with good quality wholesome meat all the times.
- II. Routine inspections by responsible authorities are also advisable to assess compliance with the standards and requirements according to the rules and regulations for safer meat processing in abattoirs and butcher shops.
- III. Based on the outcome of this study, public education and enlightenment regarding the risk associated with noncompliance with abattoir and meat selling centers laws, particularly to the abattoir workers, should be routinely practiced through mass media.
- IV. Similarly, future educational programs in the mode of the spread of pathogens, zoonotic diseases, and personnel to carry out meat inspection should be properly taken in to account for an effective compliance with slaughterhouse and butcher shops laws.
- V. Moreover, a proper motivation of the workers toward maintaining a positive attitude and good practices regarding compliance with abattoir and butcher shops laws as well as enforcing all the existing laws governing the abattoir operation in the country should be encouraged.
- VI. It is also recommended that future research should focus on the determination of KAP and the level of compliance with slaughterhouse and meat selling centers laws in both licensed and unlicensed slaughterhouses across the State.
- VII. Anew abattoirs should be established in the city to fulfilling the hygienic requirements as per regional or international standards.

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Appendix

A. Abbreviations

- **KAP:** Knowledge, Attitude and Practices
- **PPE:** Personal protective equipment
- **HACCP:** Hazard analysis and critical control point
- **CCP:** critical control point
- **FAO:** Food and agriculture Organization
- **WHO:** World health Organization
- **SPSS:** Statistical package for the social sciences
- **ANOVA:** Analysis of variance
- **ERS:** Economic Research services
- **SOPS:** Standard operating procedure
- **HMPS:** Hygiene management programmes
- **HMS:** Hygiene management system
- **GMPS:** Good manufacturing practices
- **SD:** Standard deviation

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College of graduate Studies

B. Questionnaires to determine the knowledge's, attitudes, and practices of abattoir and butchery shops workers in Alfasher, North Darfur state towards food hygiene and food safety 2021.

Interviewee name/...../.....

Residence: City State

Language used for interview: () English () Arabic

Gender: () Male () Female

PART (A): Demographic characteristics:

1. Age (yr.): () < 20 () 20 - 25 () 30 - 35 () 35 - 40 () > 40
2. Nationality : () Sudanese () Foreigner
3. Educational level: () Illiteracy () Primary () Secondary () Higher
4. Duration of work (Yr): () < 1 () 1 – 3 () 3 – 5 () 5 – 10 () > 10
5. Monthly salary (SDG/Hundred): () < 6 () 6 – 7 () 7 - 8 () > 8
6. Working duration(hr): () 8 () 9 () 10 () > 10
7. Places of residence : () Inside of premise () Outside of premise

PART (B)

KNOWLEDGE:-

1. Do you have basic food hygiene and safety training

YES NO DON' T KNOW

2. I there any relationship between the works in the slaughter house and Zoonotic diseases:

YES NO DON' T KNOW

3. If yes,

A. what are the most common zoonotic diseases in the slaughterhouses due to your on knowledge: Brucellosis Hemorrhagic fever Anthrax others

B. Is there any relationship between the works in slaughterhouses and food poisoning? Cholera Typhoid Food poisoning worm Dysentery others

4. Do you know cross-contamination? YES NO DON'T KNOW

5. Do you know how meat becomes contaminated?

YES NO DON'T'T KNOW

6. Do you know the optimum temperature for bacterial growth?

YES NO DON'T KNOW

7. Is necessary to separate people who work outside the hall from people who working inside the hall? YES NO DON'T' KNOW

8. Do you know the optimum temperature of meat storage? YES NO DON'T KNOW

9. Do you know the signs of meat spoilages? YES
NO DON'T KNOW

10. How long have you worked at this abattoir?
Years Months

11. How many days per week do you work at this abattoir?
 Once a week At least three times a week Daily

PART (C)

ATTITUDES:

12. Meat hygiene is an important part of your job responsibilities:
 Agree Disagree Uncertain No

13. Sterilizing the equipment's used for operations after use:
 Agree Disagree Uncertain No

14. Cooling the meat reduces bacterial growth:
Agree Disagree Uncertain No

15. Pest and pets play strong role on meat contamination: Agree
 Disagree Uncertain No

16. Training and learning about meat hygiene is an important to me:
Agree Disagree Uncertain No

17. Using hairnet, facemasks, protective gloves and adequate clothing reduce
the risk of meat contamination: Agree Disagree
Uncertain No

18. Washing and disinfecting hands prevents Meat contamination:
 Agree Disagree Uncertain No

19. Carcasses should be separated: Agree Disagree
Uncertain No

20. Improper storage of meat can be a hazard to health: () Agree () Disagree () Uncertain () No

21. Butchers with abrasion or cuts should not touch carcasses:
() Agree () Disagree () Uncertain () No

PART (D)

PRACTICES:

22. Where do you change your clothes?

() In my residence () Inside slaughterhouse () in locker rooms
() don't change

23. What do you do when you washing your hands?

() Wash my hand with soap and water () Wash my hand with water only
() don't care about / don't remember () don't know

24. Name the occasion when you wash your hands: () Before starting my job

() after using the Toilet () before and after equipment's and body () don't remember

25.* Do you smoke? () YES () NO

* Do you use snuff? () YES () NO

26. If yes, where? () In

my residence only () after I finish my duty () on my break between duty
() during my duty

26. Do you use the same knife for removing skin and evisceration?

() Usually () Sometimes () Never () don't use

27. Do you use the same cleaning equipment for outdoor and indoor (Hall)

cleaning? () Usually () Sometimes () Never () don't use

28. Do you touch the carcasses together during washing?

() Usually () Sometimes () Never () don't use

29 .If you got injured, what do you do?

See a doctor

Dressing

Ignore and continue my work

don't care