INTRODUCTION

Meat and meat products are highly perishable and are susceptible to contamination by spoilage and pathogenic microorganisms. Different types of microorganisms may be introduced into sausages from various sources due to improper storage temperature and manipulation and poor hygienic condition in non industrial establishments especially in butcheries (Cordoba, Cordoba & Jordano, 1998). Some of these microorganisms can cause food poisoning and infections when they are introduced in high numbers due to direct contact with food handlers (Bryant, Javis & Gilbet, 1988). Children and elderly people are the more susceptible group to food infections (Patricia Blas & Ana, 2006). Staphylococcal food poisoning is gastrointestinal illness caused by food contaminated with Staphylococcus aureus. Staphylococcus aureus is normally found in different parts of human beings and other animals as in skin, the mucosal membrane, mouth, nose, pimples, boils, different environments, and in a wide range of food stuff (Acco, Ferreira, Henriques, & Tondo, 2003). Staphylococcus aureus is usually present in small numbers in raw meat and in food handlers. Human beings, different types of foods and environment are considered as favorable environment for Staphylococcus aureus transmission (Lateef, 2004). Angela Cheryl and Charles (2005) reported that up to 25% of healthy people have Staphylococcus aureus in their skin and in nose. Keeping of meat and meat products free from contamination with Staphylococcus aureus is a potential health hazard which indicate the high incidence of this bacterium in butcheries, processed and home-made sausages. The pH values and total Staph count are presented in Table 1. The coagulase positive Staphylococcus aureus was identified in all sausage samples that were investigated, making 51.06% of the total isolates, while the coagulase negative isolates were identified as Staphylococcus epidermidis (31.91%), Staphylococcus capitis (12.77%), Staphylococcus simulans (2.13%), and Staphylococcus hominis (2.13%). These results indicate that sausage samples are highly contaminated with Staphylococcus species particularly Staphylococcus aureus. The high incidence of this bacterium in butcheries, processed and home-made sausages is a potential health hazard which indicate improper processing procedure, handling and bad personal habits. Utilization of high quality meat for sausage production and careful handling during processing is necessary to produce sausage free of pathogens.

KEYWORDS: Sausages, Coagulase positive staphylococci, Coagulase negative staphylococci, Characterization.
mean pH values of the sausage samples ranged between 5.83 and 6.23. The highest mean pH values were recorded in samples obtained from butcheries. Cocolin et al. (2004) reported that the pH values for fresh sausages is not lower than 5.5. Results showed that the pH of most samples investigated were higher than this value. The high mean pH values for the sampled sausages revealed that these sausages were produced from low quality meat with pH values higher than 6.00, which is referred to as dark, firm and dry meat (DFD). Newton and Gill (1981) claimed that DFD meat is characterized by high ultimate pH> 6.00 and deficiencies in glucose because of exercise or stress. These factors can result in bacterial spoilage becoming evident at an earlier stage of growth of the meat flora. Newton and Gill (1981) found that the pH value is an important indicator for microbial growth and high pH resulted in high microbial count and short shelf life. The ultimate pH of meat is significant for its resistance to spoilage because most bacteria grow optimally at about pH 7.0 and not below pH 4.0 or above pH 9 (Jamilah, Abbas, and Abdul 2008). Staphylococcal mean counts ranged from 1.48x105 to 7.66x106cfu/g. Factory 2 recorded the highest count (7.66x106cfu/g), while the lowest mean count was recorded for samples obtained from factory 3 (Table 1). Similar results were obtained by Oluwafemi and Simisaye (2006) who found that the S. aureus counts ranged from 1.30x105cfu/g to 2.20x107cfu/g for sausage samples obtained from markets in Nigeria. The mean values of Staphylococcal counts of the investigated sausage samples were higher than the standard limits (5x102cells) established by the Sudanese Microbiological Standards for Foods (SSMO,2001). The number of these bacteria in sausages is usually low as obtained in Sudan by Ali (2004), who found that Staphylococcus count of sausages at zero day of storage at refrigerator temperature was1.17x102cfu/g, reached 1.19x102cfu/g after 5 days of storage and 2.8x102cfu/g at the end of 10 days of storage. Samappito, Leenanon, and Robert. (2011) recorded a lower count of staphylococci (3.3x103-2.7x106cfu/g) for “Mhmm”, a traditional meat sausage in Thailand, than that obtained in this study. The high counts of this bacteria in the sampled sausages may be attributed to cross-contamination during preparation, processing, transportation and packaging as has been observed by Abbar & Mohammed (1989). In addition, some bad habits of butchers such as wiping and dusting of displayed sausage with dirty pieces of cloth that are used for cleaning hands and tables, sneezing and snuffing play an important source of contamination. Humans are the principal source or reservoir of these organisms. Staphylococci are found in the nose, throat and skin of up to 60% of healthy humans. Staphylococcal food poisoning is a persistent cause of gastroenteritis worldwide, especially in the developing countries (Vora, Senegal, and Schaffner, 2003). Concerning public health Staphylococci are important organisms that may occur in cooked comminuted meat products. They are primarily found in processed meat and dairy products; survive in the salted medium of hams and sausages (Jay, 1996). The identified isolates of the Staphylococcus sp. are presented in Table 2. Results showed that the coagulase positive Staphylococcus aureus was identified in all sausage samples that were investigated, making 51.06% of the total isolates. Most of the isolates from Khartoum, Khartoum North and Omdurman butcheries were identified as Staphylococcus aureus (25.53%). Staphylococcus aureus is considered the third most important cause of disease in the world amongst the reported foodborne illnesses (Anonou, Maqueda, Martine, Bueno, Galvez and Valdivia, 2007). It is a saprophyte and commensal of the skin mucus membrane in both animal and humans. As a pathogen it can cause a number of diseases ranging from minor skin infection to fatal sepsis. Toxigenic strains of S. aureus are currently among the leading causes of food borne intoxication. The coagulase negative staphylococci were identified as Staphylococcus epidermidis (31.91%), S. capitis (12.77%), S. simulans (2.13%), and S. hominis (2.13%). Presence of staphylococci in Sudanese sausages is not unique as other authors identified Staphylococcus spp. in fresh sausages samples stored at 40C for 10 days (Rantiisujiacumin, Urso, Cantoni and Cocolin,2005). They found that most of the isolates were Staphylococcus xylosus (50%), strains of S. pasteuri, S. warneri, S. equeuran and S. succinus, were also identified. Cocolin Rantsisuijacumin, LUrso, Cantoni, and Comi, (2004) reported that Staphylococcus xylosus was isolated from fresh sausages stored at 40C for 10 days. The identified S epidermidis nowadays is seen as an opportunistic pathogen. It is now the most frequent cause of nosocomial infections at a rate about as high as that due to its more virulence cause S. aureus. The fact that they are extremely difficult to treat represent a serious burden for the public health system (Otto, 2009). S. capitis is part of normal flora of the skin of the human scalp, face, neck and ears and has been associated with prosthetic valve of endocarditis (D’mello Duyan, Rahman, Qu, Garland, Pearce and Deighton,2008). The identified S. simulans is frequently acquired through contact with domestic animals. It is an authentic pathogenic agent of osteoarticular infection (Mallet, Loiez, Melliez, Yazdanpanah, Senneville, Lemaire, 2011). S. huminus may occasionally cause infection in patients whose immune system are compromised for example by chemotherapy (Kloos & Schleifer, 1975). Poor hygiene practices such as negligence to wash hands after visiting the bathroom may result in up to 107 pathogens under the fingernails of the handlers (Nel Lues, Buys and Venter, 1993). The high prevalence rate of Staphylococcus aureus and the presence of coagulase negative staphylococci in the sausage samples under study indicates the poor hygiene conditions during sausages production in Sudan. Also it reflects the poor personal hygiene of people dealing with food processing. Lack of standards hygiene measures among workers in factories processing sausage may lead serious health hazards to consumers. These type of research make a critical step towards understanding the serious prevalence of staphylococci in sausage produced under poor processing conditions.

CONCLUSION

The identified S. simulans is frequently acquired through contact with domestic animals. It is an authentic pathogenic agent of osteoarticular infection (Mallet, Loiez, Melliez, Yazdanpanah, Senneville, Lemaire, 2011). S. huminus may occasionally cause infection in patients whose immune system are compromised for example by chemotherapy (Kloos & Schleifer, 1975). Poor hygiene practices such as negligence to wash hands after visiting the bathroom may result in up to 107 pathogens under the fingernails of the handlers (Nel Lues, Buys and Venter, 1993). The high prevalence rate of Staphylococcus aureus and the presence of coagulase negative staphylococci in the sausage samples under study indicates the poor hygiene conditions during sausages production in Sudan. Also it reflects the poor personal hygiene of people dealing with food processing. Lack of standards hygiene measures among workers in factories processing sausage may lead serious health hazards to consumers. These type of research make a critical step towards understanding the serious prevalence of staphylococci in sausage produced under poor processing conditions.

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