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MICROBIOLOGICAL ASSESSMENT OF MUTTON INTENDED FOR EXPORT FROM ElKADARO EXPORT SlAUGHTER HOUSE, SUDAN

التقييم الميكروبي للحوم الضان المعدة للتصدير من مسلخ الكدرو، السودان

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المستخلص

خططت هذه الدراسة لتقييم مستوى ضبط الجودة للحوم الضان المعدة للتصدير بمسلخ الكدرو اعتمادا على التلوث السطحي البكتيري . تم جمع 75 عينة باستخدام المسحات خلال خمسة زيارات (15 عينة لكل زيارة: 5 عينات لكل من صالة الذبيح و الثلاجات وعربات النقل المبردة بعد التفريغ في المطار). أظهرت نتيجة العد البكتيري ارتفاع طفيف (يتراوح بين CFU/ cm^2 $10^3\times 1$الى $10^6\times 6$) ولكن بدون الوصول إلى مستوى التلوث الحرج اعتمادا على النقطة الحرجة للحوم الطازجة (10^6 CFU/ cm^2) واللحوم المبردة (10^7 CFU/ cm^2) .

Abstract

The study is planned to evaluate the hygienic quality of mutton intended for export from Elkadaro Slaughter House on basis of surface bacterial contamination. Seventy five samples (swabs) were collected during five visits, 15 samples in each visit (five samples for each: slaughter hall, slaughter house chiller and the refrigerated vehicle at Airport after unloading). The results of the bacterial counts revealed relatively high counts which(ranged between 1×10^3 - 6×10^6 CFU/ cm^2), but without critical contamination levels according to the cut-off (critical) point for fresh meat (10^6 CFU/ cm^2) and chilled meat (10^7 CFU/ cm^2) .

Key words: Mutton, Slaughter house, Export, Sudan

Introduction

Sudan is the most spacious country in Africa and the first regarding animal resources. Animal resources in the Sudan comprise sheep, goat, cattle, camel, poultry and wild-game. Most of the animals in the Sudan are raised on natural pastures by nomadic tribes. In irrigated projects and the areas of mechanized farming, animals feed on crops byproducts. So animals in sudan are almost free from feed additives, hormonal and chemical residues, which give special preference to their products. Live sheep and mutton represent an important component of the Sudanese exports (table 1).

Establishing a hygienic program for exported mutton is required in order to enable Sudan fulfill the international trade parameters. This entails a vital need to improve the slaughter houses and to impose strict hygienic measures to provide healthy and wholesome meat to fulfill the international requirements. The present study is aimed to evaluate the hygienic quality of mutton intended for export from Elkadaro Export Slaughter House.

Table (1): Estimation of sheep population, exported live sheep and exported mutton

Year	Sheep population head	Exported live sheep	Exported mutton (ton)
2000	46,095,000	731,242	6157.8
2001	47,043,000	15,417	4855.2
2002	48,136,000	1,602,638	7113.8
2003	48,440,000	1,315,399	7837.11
2004	48,910,000	1,7035,62	5570.9

Source: Animal Resources Economics Administration, Ministry of Animal Resources and Fisheries, Information and Statistics Unit (2005)

Materials and Methods

The Study site

The study was carried out in Elkadaro Export Slaughter House in Khartoum State, the most important export slaughter house in the Sudan.

Collection of informative data

a. Data on number of animals entering in the slaughter house, the number of animals rejected, and the reasons for rejection, the number of animals passed for slaughter, and animal breeds were taken from Ante-morteum records of the slaughter house.

b. Temperature and hygienic conditions and weight of animal carcass were recorded.

c. The chilled carcase temperature and duration of chilling were recorded.

d. The same in data b and c as well as the hygienic conditions of the refrigerated truck were taken while un loading the refrigerated vehicle at the airport.

Samples collection

Five visits were conducted, a total of 75 swabs (15 swabs in each visit: 5 samples for each: the fresh carcases, the chilled carcases and after unloading the carcases from the refrigerated vehicle at the air port) were collected to detect muscle surface contamination of the carcasses. Five carcasses were selected and identified by label fixation as such: A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area). A hand-made right angled metallic triangle with an area of 10 cm^2 was used as a template and disinfected by using 70% alcohol (ethanol). Swabs were placed in ice box (0C°) and were transferred as soon as possible to the laboratory. Swabs were stored in deep freezer in laboratory at -20 °C till processing.

Bacterial count

Pour plate method was used for bacterial colony counts as described by Quinn, et al (2000). The swabs were taken from the deep freezer and immersed in test tubes containing 10 ml sterile normal saline and ten fold dilutions were prepared from the normal saline (10^{-2}, 10^{-3}, 10^{4}, and 10^{-5}). A total of 100 µ (0.1 ml) was taken from the final dilution and pared in sterile Petri-dishes and then (15-20 ml) of sterile nutrient agar solution (N.A) were added to the peteri-dishes contents. Mixing was done by shaking the Petri-dishes. The contents were left to solidify before being incubated at 37°C for 24-48 hours for colony count. The average value

from each duplicate from the same dilution was taken. The colo nies were calculated using the following formula:

Colony count = average value × dilution factor CFU/cm^2

CFU/cm^2 refer to colony forming unit per square centimeter

• **Cut-off (critical) point:** fresh meat (10^6 CFU/ cm^2), chilled meat (10^7 CFU/ cm^2) (Gracey et al., 1999)

Results

The salient features of the ante-mortem record were: average number of the animals entering the slaughter house was 417, while average number of the accepted animals was 406; average number of rejected animals was 3. The major causes for rejection in the ante-mortem were lameness, tick infestation swelling of the lymph nodes, sheep pox and emaciation. (Hamari, Kabashi, Butana)Most are the popular breeds of sheep in the Sudan brought to the slaughter house. After the post- mortem examination the average number of carcases accepted was 402, while average number of unaccepted carcasses was 4. The causes of unacceptance were Jaundice, hydatidoses, bruises, lymph nodes infection, haematomas and abscessations. The hygiene condition was good and average temperature in the slaughter hall was 34°C. The chiller showed good hygiene, and average temperature was -0.9, and average chilling time was 13 hours. The average holding time in the refrigerated vehicle was 5 hours, while the average carcases temperature was 0.02 °C. The hygiene condition in the vehicle was good since neither rancidity nor dripping was observed (Table 2).

Table (2): Cold storage and cold transportation records

	Temp.	Duration of Chilling (Hrs.)	Hygiene condition	Temp. of vehicle	Average carcase temp.	Time in the vehicle	Hygiene condition
First	-2°C	11	good	-2°C	0.8°C	4 hours	good
Second	- 0.3	15	good	(2 vehicles) -0.7, -5 °C	-2 °C	4 hours	good
Third	0.5°C	13	good	(2 vehicles) -2, 0 °C	0 °C	2 hours	good
Fourth	0.5°C	14	good	(2 vehicles) -2 °C, -0.2	-0 °C	10 hours	good
Fifth	-1.4°C	12	good	2.5°C	1.4°C	6 hours	good

Bacterial counts of the first visit revealed no contamination level. In slaughter hall relatively low counts were observed for the third and fifth carcase (9×10^3 and 1×10^3 10^6 CFU/ cm^2, respectively). Low counts were also recorded at the air port for first, second, third and fourth carcasse (8×10^3, 1×10^3, 8×10^3 and 7×10^3 CFU/ cm^2, respectively). All the counts of the second visit were below the contamination level, : the slaughter hall showed relatively high counts for the first and fourth carcases (2×10^5 and 5×10^5 CFU/ cm^2, respectively). In the chiller similar readings were recorded for the first, second, fourth and fifth carcases (4×10^5, 5×10^5, 5×10^5 and 9×10^5 CFU/ cm^2, respectively). There was no contamination level in the five carcases in the three different stages of the third visit. Similarly, there was no significant contamination level during different stages of the fourth visit: for the slaughter-hall high bacterial counts were recorded for the first, second, and fifth carcase (2×10^4 CFU/ cm^2 for each). At the air-port relatively higher bacterial counts were recorded for

the first, third and the fifth carcase (3×10^4, 2×10^4 and 1×10^4 CFU/cm^2 respectively). The results of bacterial counts of the fifth visit revealed no contamination level in the three different stages. Bacterial counts of all visits showed no critical contamination levels according to the cut-off point for fresh meat (10^6 CFU/ cm^2) and chilled meat (10^7 CFU/ cm^2) as described by Gracey et al. (1999). All results are summarized in Table 3,4,5,6 and 7.

Table (3): Bacterial count of the first visit

Carcase	**Sample site**	**Bacterial count CFU/cm^2**		
		Fresh caracase in slaughter-hall (temp. 37°C)	**Chilled carcase in the slaughter house (temp. 0.2°C)**	**Chilled meat at the air-port (temp. -2°C)**
First	A	2×10^4	1×10^5	8×10^3
Second	B	2×10^4	1×10^5	1×10^3
Third	C	9×10^3	1×10^5	8×10^3
Fourth	D	2×10^4	1×10^4	7×10^3
Fifth	E	1×10^3	1×10^5	1×10^4

A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area)
Duration of time: in the chiller 11 hours & refrigerated vehicle 4 hours
Cut-off (critical) point: fresh meat **(10^6 CFU/ cm^2)** & chilled meat **(10^7 CFU/ cm^2)**, (Gracey et al., 1999)

Table (4): Bacterial count of the second visit

Carcase	Sample Site	Bacterial count CFU/cm^2		
		Fresh caracase in slaughter-hall temp. 33°C	**Chilled carcase in the slaughter house temp. -0.3°C**	**Chilled carcase at the air-port temp. -2°C**
First	A	2×10^5	4×10^5	8×10^5
Second	B	No growth	5×10^5	1×10^5
Third	C	5×10^5	3×10^6	3×10^5
Fourth	D	5×10^5	5×10^5	4×10^5
Fifth	E	5×10^4	9×10^5	8×10^5

A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area)

Duration of time: in the chiller 14 hours & refrigerated vehicle 7 hours

Cut-off (critical) point: fresh meat **(10^6 CFU/ cm^2)** & chilled meat **(10^7 CFU/ cm^2)** (Gracey et al., 1999)

Table (5): Bacterial counts of the third visit

Carcase	Sample site	Bacterial count CFU/cm^2		
		Fresh caracase in slaughter-hall temp.32°C	**Chilled carcase in the slaughter house temp. 0.5°C**	**Chilled carcase at the air port temp. -2°C**
First	A	7×10^3	1×10^5	7×10^4
Second	B	1×10^4	1×10^5	1×10^5
Third	C	2×10^4	2×10^5	2×10^5
Fourth	D	3×10^3	8×10^4	2×10^5
Fifth	E	3×10^3	2×10^5	6×10^4

A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area)
Duration of time: in the chiller 13 hours & refrigerated vehicle 16 hours
Cut-off (critical) point: fresh meat **(10^6 CFU / cm^2)** & chilled meat **(10^7 CFU/ cm^2)** (Gracey et al., 1999)

Table (6): Bacterial count of the fourth visit

carcase	Sample Site	Bacterial count CFU/cm^2		
		Fresh caracase in slaughter-hall temp.32°C	**Chilled carcase in the slaughter house temp. 0.5°C**	**Chilled carcase at the air-port temp. -2°C**
First	A	2×10^4	1×10^4	3×10^4
Second	B	2×10^4	9×10^4	5×10^3
Third	C	5×10^3	3×10^3	2×10^4
Fourth	D	1×10^3	8×10^3	1×10^3
Fifth	E	2×10^4	8×10^3	1×10^4

A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area)
Duration of time: in the chiller 14 hours & refrigerated vehicle 14 hours
Cut-off (critical) point: fresh meat **(10^6 CFU / cm^2)** & chilled meat **(10^7 CFU/ cm^2)** (Gracey et al., 1999)

Table (7): Bacterial count of the fifth visit

Carcase	Sample site	Bacterial count CFU/Cm^2		
		Fresh caracase in slaughter-hall temp.36°C	**Chilled carcase in the slaughter house temp. -1.4°C**	**Chilled meat at the air-port temp. -2°C**
First	A	2×10^6	Temp. (-14°C) 9×10^6	5×10^4
Second	B	8×10^5	6×10^5	6×10^5
Third	C	2×10^6	8×10^5	8×10^4
Fourth	D	2×10^6	1×10^6	5×10^4
Fifth	E	6×10^5	1×10^6	1×10^5

A (thigh muscles), B (external abdominal muscles), C (chest area), D (shoulder muscles) and E (vertebral area)

Duration of time: in the chiller 12 and 24 hours & refrigerated vehicle 3 and 6 hours

Cut-off (critical) point: fresh meat **(10^6 CFU/ cm^2)** & chilled meat **(10^7 CFU/ cm^2)** (Gracey et al., 1999)

Discussion

The study is planned to evaluate hygienic quality of mutton intended for export from Elkadaro Export Slaughter House. Strict ante-mortem and post-mortem inspection as well as good hygiene were observed in the slaughtering process during five visits at Elkadaro Export Slaughter House. The temperature of the chiller and the refrigerated vehicles were acceptable and the duration of chilling was satisfactory. Similarly, good hygiene condition in slaughter hall was observed. The results of the bacterial counts were less than the critical contamination levels which (ranges between 1×10^3 and 6×10^6 CFU/ cm^2) Graceyetal 1999. The surface bacterial load on the sheep carcase surface is essential in mutton grading, in order to cope with the international standards. Acceptability of meat must account for the following: abattoir hygiene, and the perfection of meat inspection in ante-mortem and post- mortem. Anti-mortem must consider the animal condition, animal handling, and other aspects of the slaughter animal welfare. While, post- mortem must consider the Islamic slaughter, the perfection of bleeding, meat preservation, meat transportation and meat packaging. In Elkadaro Slaughter House animals were rested for more than twelve hours before slaughtering, animal transportation is carried in a proper way so no stress take place, perfect bleeding is eminent and Islamic slaughter is strictly practiced. The major bacterial contaminants previously found on the carcase surface were *Corynebacterium, Lisleria , Staphylococcus spp., Micrococcus spp., Bacillus spp, Actinomycetes, Actinobacillus spp. , Chromobacterium* and *Enterobacteria spp*, (Suliman, 2004). Elamin, (2002) isolated Staphylococcal, Micrococcus, Corynebacteria, Kurthia, Entero-bacteria and Pseudomonia. (Sary Eldin, 1972) reported the contamination of meat with staphylococcus coagulase positive.

Gracy, *et al* (1999) considered that microbial count of 10^5 CFU/cm^2 was satisfactory for fresh meat, while count of 10^6CFU/cm^2 was considered unsatisfactory. Bacterial count of 10^6 CFU/cm^2 for chilled meat was considered satisfactory, but count of 10^7 CFU/cm^2 was considered unsatisfactory. Furthermore, ICMSF (1980) reported that if meat is

prepared under unhygienic conditions, the initial count was higher (exceeding 10^6 CFU/cm^2). The results of our study are similar to Frank and Mallion (1980) who recognized that a recent slaughtered and dressed carcase will be contaminated with bacteria count of 10^2 -10^6 CFU /cm^2. In contrast, the findings of this study disagree with study by Elamin (2002) in Slaughter House in Omdurman, where the bacterial counts exceedied 10^7 CFU/cm^2. This disagreement is attributed to that hygienic standard of Slaughter House in Omdurman was far below that applied in Elkadaro Slaughter House as well as there was no demarcation between the areas of clean and dirty operations.

Attaining high standards of hygiene and providing high quality meat for export is a matter of a paramount importance, by so doing our meat and meat products can cope with the international standards of trade and can compete in the international market. Strict hygienic measures must be applied in all production stages with regard to Hazard Analysis Critical Control Point (HACCP) system.

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