Bacterial Quality of Ostrich Meat and Edible Offal

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Abstract

The present study was designed to determine the microbiological quality and prevalence of foodborne pathogens on retail ostrich meat and edible offal in Egypt. A total of 80 samples of frozen ostrich meat, liver, heart and gizzard (20 of each) from local retail supermarkets in Egypt were collected for bacteriological examination. Aerobic plate counts were recovered from all samples with a mean count of 3.88, 4.38, 4.23 and 4.11 log10 cfu/g for meat, liver, heart, and gizzard samples respectively. Aerobic plate counts showed differences (P <0.01) between meat, liver, heart, and gizzard samples. Anaerobic plate counts were slightly lower than aerobic plate counts of the same frozen samples with a mean counts of 3.28, 4.02, 3.94 and 3.81 log10 cfu/g for meat, liver, heart and gizzard samples respectively. Significant differeces (P <0.01) between meat samples and the others, but not significant (P > 0.01) among liver, heart and gizzard samples were observed. The enterobacteriaceae were found in relatively high numbers. The log mean numbers of enterobacteriaceae counts were 2.01, 2.44, 3.84, and 3.06 log10 cfu/g for meat, liver, heart, and gizzard samples respectively. The evolution of counts of enterobacteriaceae was similar (P > 0.01) for meat, liver, and gizzard samples. On the second axis, *Salmonella typhimurium* were detected on 5%of both ostrich meat and gizzard, while *Salmonella* spp. were not isolated from liver and heart samples. *E. coli* was the most prevalent foodborne pathogenic bacteria investigated, it was detected in 5%, 15% and 15% of frozen ostrich meat, liver and gizzard. Moreover, *Clostridium perfringens* were only isolated from one sample (5%) of frozen ostrich gizzard. Neither *Listeria monocytogenes* nor *Staphylococcus aureus* were detected in all frozen ostrich samples. In conclusion, the recovery of foodborne pathogens from the ostrich carcasses indicates that the same considerations must be taken as with other raw foods of animal origin. Temperature abuse, underprocessing and cross-contamination from raw to cooked products can make such foods vehicles for foodborne illness. Proper precautions must be taken in the food processing and food service environment as well as in the home.

Introducction

Ostriches are native to Africa and the Middle East, but are now extinct in the latter region. They have been farmed since the middle of the nineteenth century, first in South Africa and subsequently in other countries for the principle purpose of producing feathers, skins and meat **(37 and 19)**.

Ostrich is one of the more popular non-traditional protein sources in Western societies because it is marketed and perceived as a healthy alternative to other red meats due to its favourable nutritional properties (low cholesterol and intramuscular fat contents and generally high omega-3 polyunsaturated fatty acids) **(16; 1 and 8).**

The consumption of ostrich meat is increasing; therefore improvements to the hygienic safety of this foodstuff and the extension of its shelf-life are crucial for marketing the product, both for local consumption and export. Even though the nutritional value of ostrich meat is well documented, very little information is available worldwide on the microbiological aspects and keeping quality of this foodstuff. The microbiological conditions of ostrich meat will depend upon the types of microorganisms carried by this specie, on the hide, in the gastrointestinal tract, or in the muscle tissue itself; the circumstances in which the bird is slaughtered; and the conditions under which the carcass is dressed and butchered. The microflora that develops during storage will depend upon the storage conditions and intrinsic biochemical qualities of the meat.

Microbiological contamination is one of the main risk conditions that affect meat quality and consumers health, because their importance to human health such as: *Salmonella* spp., *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, and *Clostridium perfringens*, which are object of public health certification because of the potential risk they represent in diseases transmitted by food **(35)**. In Egypt, the government through the Ministry of Agriculture has promoted regulations regarding production, transformation and commercialization in the product-ostrich system for good production and manufacturing practices. On the other hand, health regulations applicable to ostrich meat production systems are not specific,

due to the absence of regulations regarding quality and product safety, in which microbiological conditions should be specified. This situation could compromise the quality and food safety of ostrich meat.

Taking into account the progressive increase of the production and consumption of this meat type and the lack of information in the scientific literature, the present study was designed to determine the microbiological quality and prevalence of foodborne pathogens on retail ostrich meat and edible offal in Egypt.

Materials and Methods

Sample collection

A total of 80 random samples of frozen ostrich meat, liver, heart and gizzard (20 of each) were collected from local retail supermarkets in Egypt. Each sample was packed in plastic bag and transferred immediately to the laboratory in an ice box for bacteriological examination.

Sample preparation for microbiological analysis

Defrosting of frozen samples was started in a refrigerator at 5^0C before the sample preparation. The sample were prepared and examined according to the technique recommended by **(27)** as follows: 25 gm meats were removed aseptically from each sample and transferred to a sterile polyethylene bag. Then, 225 ml of 1% sterile peptone water were aseptically added to the content of the bag and homogenized at 200 rpm for 1-2 minutes to prepare the initial 1/10 dilution which was used for the preparation of other serial dilutions.

Bacterial counts

The spread plate technique was used to prepare duplicate plates for determination of aerobic plate counts (APC), anaerobic plate (AnPC) **(22)** and Enterobacteriaceae counts **(3)**. After incubation, duplicate agar plates between 30 and 300 colonies were counted, and then mean counts were calculated.

Isolation and identification of pathogenic bacteria

- *Salmonella* spp. were isolated and identified according to **(26)**.
- *E. coli* were isolated and identified according to **(13)**.
- *Closteridium perfringens* were isolated and identified according to **(27)**
- *Listeria monocytogenes* were isolated and identified according to **(25)**
- *Staphylococcus aureus* were isolated and identified according to **(7)** and confirmed by the coagulase test as described by **(10)**.

Results and Discussion

Table (1): Aerobic plate counts (log CFU/g) of frozen ostrich meat and edible offal (N=20).

sample	min	max	mean	se	sd	median
meat	2.60	4.39	3.88 d	0.13	0.59	3.56
liver	2.90	4.87	4.38 a	0.16	0.72	3.95
heart	2.95	4.67	4.23 b	0.10	0.49	4.04
gizzard	3.07	4.56	4.11 c	0.12	0.56	3.47

[a-d] Values in the same column bearing different letters are significantly different (P<0.01).

Table (2): Anaerobic plate counts (log CFU/g) of frozen ostrich meat and edible offal (N=20).

sample	min	max	mean	se	sd	median
meat	2.00	3.77	3.28 b	0.11	0.51	3.02
liver	2.30	4.43	4.02 a	0.17	0.78	3.30
heart	2.90	4.23	3.94 a	0.08	0.38	3.95
gizzard	2.04	4.25	3.81 ab	0.16	0.73	3.34

[a-d] Values in the same column bearing different letters are significantly different (P<0.01).

Table (3): Enterobacteriaceae counts (log CFU/g) of frozen ostrich meat and edible offal (N=20).

sample	min	max	mean	se	sd	median
meat	1.00	2.47	2.01 b	0.09	0.42	1.95
liver	1.47	2.84	2.44 b	0.10	0.45	2.00
heart	1.30	4.50	3.84 a	0.25	1.12	2.57
gizard	1.77	3.77	3.06 b	0.13	0.58	2.77

[a-d] Values in the same column bearing different letters are significantly different (P<0.01).

Table (4): Prevalence of bacterial food-borne pathogens of frozen ostrich meat, liver, heart, and gizzard samples (n= 20).

Sample	*Salmonella*		*E.coli*		*Clostridium perfringens*		*Listeria Mono-cytogenes*		*aureus*	
	No	%	No	%	No	%	No	%	No	%
meat	1	5	1	5	0	0	0	0	0	0
liver	0	0	3	15	0	0	0	0	0	0
heart	0	0	0	0	0	0	0	0	0	0
Gizzard	1	5	3	15	1	5	0	0	0	0

Very few data are available in the literature concerning the microbiological quality of ostrich carcasses and meat, making it difficult to compare these results with others. **(31)** and **(17)** refer only to pathogenic bacteria; **(34)**, **(36)**, **(8)** and **(14)** examined the effect of packaging and storage conditions; and other authors **such as 23; 40 and 20** have considered different sampling sites and/or adopted different methods than those chosen in this study.

In the present study, aerobic plate counts were recovered from all samples from ostrich carcasses. The log mean counts of total aerobes estimated for previously frozen ostrich meat, liver, heart, and gizzard samples were 3.88, 4.38, 4.23 and 4.11 log10 cfu/g, respectively. Aerobic plate counts showed differences ($P < 0.01$) between meat, liver, heart, and gizzard samples (Table 1). Moreover, edible offal samples showed higher ($P < 0.01$) aerobic plate counts than ostrich meat samples. These microbial counts were similar to previously reported counts on ostrich carcasses **(23 and 14)** and higher than those reported by **(20)** who recorded aerobic plate

counts 2.98 log cfu/cm2 in ostrich carcasses, and **(34)** who obtained low initial APC (2 log cfu/cm2) for intact previously frozen ostrich meat steaks, then reached 7.2 log cfu/cm2 by day 28 of refrigerated storage. Meanwhile, higher values of aerobic loads than that of the present study have been found by **(2), (1), (9) and (8)** who observed total aerobic counts as high as 8.30, 7.32, 7.92 and 4.9–5.4 log10 cfu/g in refrigerated vacuum-packed ostrich steaks, respectively.

According to **E.O.S.Q.C. (12)** total aerobic count of frozen meat and edible offal must be $<10^6$ and $<10^5$ cfu/g., respectively, therefore, all investigated ostrich samples consider acceptable. On the other hand, **(20)** and **(9)** concluded that the microbiological counts in ostrich meat and carcasses were higher than those from other species, necessitating the implementation of measures to improve the microbiological quality of this product. Sanitation and temperature were stated as being the most critical factors affecting the shelf-life of most meat products with or without modified atmosphere packaging conditions **(6)**.

The results of this study revealed that anaerobic plate counts were detected from all tested samples and were slightly lower than aerobic plate counts of the same frozen samples. The log mean numbers of total anaerobes estimated for these samples were 3.28, 4.02, 3.94, and 3.81 log10 cfu/g for meat, liver, heart, and gizzard samples, respectively. Anaerobic plate counts were different ($P < 0.01$) between meat samples and the others, but not ($P > 0.01$) among liver, heart and gizzard samples. Ostrich meat samples showed lower ($P < 0.01$) anaerobic plate counts than the other edible offal samples (Table 2). **(1)** observed that lactic acid bacteria were the most abundant bacterial group in the ostrich samples analysed. Studies on refrigerated vacuum-packed meat products carried out by other authors have demonstrated a similar dominance of this microbial group **(30; 4 and 15)**. According to **(18)** mainly LAB and also Enterobacteriaceae, Brochothrix thermosphacta and Shewanella putrefaciens, which are capable of growing on anaerobic atmospheres, are responsible for spoilage in vacuum-packed meat and meat products.

The enterobacteriaceae were found in all examined samples and in relatively high numbers. The log mean numbers of enterobacteriaceae counts were 2.01, 2.44, 3.84, and 3.06 log10 cfu/g for meat, liver, heart, and gizzard samples respectively. The evolution of counts of enterobacteriaceae was similar ($P > 0.01$) for meat, liver, and gizzard samples. However, heart samples showed higher ($P < 0.01$) enterobacteriaceae counts than all other examined samples (Table 3). Enterobacteriaceae counts in the present study were similar to previously reported on ostrich carcasses by **(28), (8), (36) and (14)**; and lower than those of **(2), (1) and (9)** who found an average of 6.78, 5.29, 4.55 log10 cfu/g respectively, in refrigerated vacuum-packed ostrich steaks. However, the examined samples in the present work with enterobacteriaceae counts > 10^2 cfu/g consider unacceptable according to **E.O.S.Q.C. (12)**.

On the second axis, the present study indicated also the prevalence of bacterial foodborne pathogens on frozen ostrich meat and edible offal. Identifying bacterial pathogens in natural hosts is important because they constitute potential reservoirs for zoonotic transmission **(24)**. The reported prevalence of pathogens such as *Salmonella* and *E. coli* in raw meat varies considerably, depending on the meat species as well as on its processing and origin **(32)**.

Salmonella remains a major cause of foodborne disease in humans world wide **(11)**. This study detected *Salmonella typhimurium* on one sample of both ostrich meat (prevalence, 5%) and gizzard (prevalence, 5%), while *Salmonella* spp. were not isolated from liver and heart samples (Table 4). Similar results were obtained in the gizzard, liver and heart of ostrich carcasses by **(21)**. Salmonella were previously recovered from >20% of carcasses at one abattoir and detected in >30% of wash waters from carcasses at a second abattoir, but no Salmonella were detected in samples of meat from carcasses at the second facility **(21 and 28)**. Samples from >100 carcasses from eight US abattoirs yielded only one Salmonella **(31)**. These data suggest that contamination of ostrich meat with Salmonella may be rare. However, recent publication indicated that the ostrich liver had salmonella prevalence of 12.9% **(17)**.

The present study indicated that *E. coli* was the most prevalent foodborne pathogenic bacteria investigated, it was detected on one sample (5%) of frozn ostrich meat, 3 samples (15%) of the liver and also 3 samples (15%) of the gizzard (Table 4). The extent to which ostrich meat may be contaminated with enteric pathogens is uncertain. E. coli strains were previously isolated from18.8% and 22% of the ostrich carcasses (**28 and 33**). The majority of the samples testing positive for *E. coli* were collected after evisceration. The mean number of generic E. coli on dressed carcasses at one abattoir were about 1/100 cm2 while at another the mean number was about $10^2/cm^2$ (**20 and 28**). That suggests that faecal contamination of carcasses may be far more common at some than at other abattoirs (**19**). On the other hand, the present study revealed also that six E. coli strains were isolated from 7 ostrich samples. The isolated strains were O2:K1 from 1 meat sample; O78:K50, O113:K75, O128:K67 from 3 liver samples; and O2:K1, O9: K30, O112:K68 from 3 gizzards, while *E. coli* O157 was not detected from any examind sample. Although results of previous publications demonstrated no *E. coli* 0157:H7 from the carcasses sampled (**31 and 5**), *E. coli* strains were previously isolated from four samples, corresponding to 22% of the 18 ostriches. All the ostrich *E. coli* isolates belonged to serogroup O15:H8 (**35**). Moreover, 8 *E. coli* strains were isolated from ostriches with respiratory disease, serogrouping showed that four isolates belonged to serogroup O2, two to serogroup O78, one to serogroup O9, and one to serogroup O21 (**29**). Nevertheless, the results in this work are too preliminaries to confirm if the E. coli strains, found in these ostrich samples, were initially transmitted from humans, cattle or birds.

This study has confirmed that *Clostridium perfringens* could be a contaminant of frozen ostrich meat and other edible offal. *Clostridium perfringens* were only isolated from one sample (5%) of frozen ostrich gizzard (Table 4). Enteritis due to *Clostridium perfringens* were common findings in neonatal ostrich chicks and ratites of all ages (**39 and 38**).

Listeria monocytogenes were not detected in the present study from the analyzed ostrich samples (Table 4). Similar finding was also recorded by (5). Limited studies have been conducted to determine the prevalence of *listeria* spp. and *Listeria monocytogenes* in ostrich carcasses. *Listeria innocua* was recovered form the three carcasses (23). *L. innocua* is non-pathogenic, and its presence indicates the potential for the presence of pathogenic *Listeria* species. Given the wide distribution of *Listeria spp.* throughout the environment, however some level of the organisms would be expected on the ostrich carcasses or any other foods that have not undergone a heat treatment.

Furthermore, *Staphylococcus aureus* strains were not detected in this study. This observation was in a complete compliance with the result of (5) and (1), meanwhile this finding does not agree with that of (2), who report more than 3 log10 cfu *Staphylococcus aureus*/g in retail refrigerated ostrich steaks in Spain.

The recovery of foodborne pathogens from the ostrich carcasses indicates that the same considerations must be taken as with other raw foods of animal origin. Temperature abuse, underprocessing and cross-contamination from raw to cooked products can make such foods vehicles for foodborne illness. Proper precautions must be taken in the food processing and food service environment as well as in the home.

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الجودة البكتيرية للحوم وأعضاء النعام الداخليةالتى تؤكل

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** قسم البكتريولوجى والمناعة والفطريات- كلية الطب البيطرى بمشتهر -جامعة بنها

الملخص العربى

أجريت هذه الدراسة لتحديد جودة وسلامة لحوم النعام وأعضائه الداخليةالتى تؤكل من الناحية الميكروبيولوجية وكذلك تقيم مدى تواجدالبكتريا الممرضة به, حيث تم تجميع عدد ٨٠ عينة مجمدة من اللحوم, الكبد, القلب والقونصة لعشرين نعامة مختلفة (بواقع ٢٠ عينة لكل منهم) من محلات السوبرماركت المختلفة بمصرونلك للفحص البكتريولوجى. وقد أوضحت النتائج أن متوسط العد الكلى للبكتيريا الهوائية هو٣,٨٨ , ٤,٣٨ , ٤,٢٣ و٤,١١ لوج خلية /الجرام لكل من عينات اللحوم, الكبد, القلب والقونصة المجمدة على الترتيب. كما أظهر التحليل الاحصائى عن وجود إختلافات جوهرية فى العد الكلى للبكتيريا الهوائية بين العينات المجمدة لكل من اللحوم, الكبد, القلب والقونصة. بينما كان العد الكلى للبكتيريا اللاهوائية أقل قليلا من العد الكلى للبكتيريا الهوائية لنفس العينات المفحوصة وذلك بمتوسط عد كلى ٣,٢٨ , ٤,٠٢ , ٣,٩٤ و٣,٨١ لوج خلية /الجرام لكل من العينات المجمدة من اللحوم, الكبد, القلب والقونصة على الترتيب. كما أظهرت التحليلات الاحصائية إختلافات جوهرية بين عينات اللحوم المجمدة و عينات الأعضاء الأخرى، بينما لم يظهر أى إختلافات بين عينات الكبد, القلب والقونصة. وقد لوحظ أن متوسط العد الكلى للبكتيريا المعوية هو٢,٠١, ٢,٤٤, , ٣,٨٤و٣,٠٦ لوج خلية /الجرام لكل من العينات المجمدة من اللحوم, الكبد, القلب والقونصة على الترتيب. ، بينما لم يظهر أى إختلافات جوهرية بين عينات الكبد, القلب والقونصة. وعلى المحور الآخر فقد تم عزل ميكروب السالمونيلا تيفميوريوم من ٥% من عينات كل من اللحوم والقونصة، بينما لم يتم عزل ميكروب السالمونيلا من الكبد و القلب. وقد أثبتت الدراسة إلى أن ميكروبات إى كولاى كانت الأكثر شيوعا حيث تم عزلها من ١٥،١٥،٥ % من عينات اللحوم و الكبد والقونصة المجمدة.كما تم عزل ميكروب كلوستريديوم برفرينجينز من عينة واحدة (٥ %) من القونصة المجمدة. بينما لم يتم عزل ميكروب ليستريا مونوسيتوجين أو ميكروب العنقودى الذهبى من جميع العينات المفحوصة. وقد خلصت الدراسة إلى أن إكتشاف البكتريا الممرضة فى ذبائح النعام يشكل خطورة ميكروبية على صحة المستهلك, لذلك يجب إتباع نفس الإحتياطات التى تتبع مع لحوم الحيوانات والطيور الأخرى, حيث أن سوء التبريد والتجهيزممكن أن يجعل هذه اللحوم مصدرا للعدوى بالبكتريا الممرضة, و لذلك يجب الإهتمام الصحى بعمليات تجهيز وتقديم الطعام سواء فى أماكن تناول الطعام خارج المنزل أو فى داخله.