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Seasonal impact on the microbiological quality of some poultry meat products

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ABSTRACT

This research was designed to study the seasonal impact on the microbiological quality of some poultry meat products. A total of 270 samples of raw chilled drumstick samples of chicken, quail, and duck (30 of each), were collected from different butchers in Qalyubia governorate, Egypt in different seasons (winter, spring, and summer) in 2021 following the standard methods for microbiological examination in meat products. The obtained aerobic plate count (log_{10} CFU/g) results during winter, spring, and summer seasons were 4.25, 4.51, and 4.77 in chicken; 3.51, 4.24, and 4.74 in quail and 5.06, 5.44, and 5.85 in duck samples, respectively. However, *E. coli* and *S. aureus* were detected in all the examined samples at an acceptable limit in reference to the Egyptian standards (< 2 log CFU/g) during the winter and spring seasons, 100% and 10.0% of chicken and duck samples exceeded *E. coli* limits; and 16.7, 13.4 and 100 % exceeded the permissible limit of *S. aureus* counts during summer season. In general, results revealed significant variations in the microbiological quality of the examined samples in relation to the season as significant increases in the microbial counts were recorded in the summer season. Furthermore, duck drumstick samples recorded the highest microbial contamination during the period of the study. Application of strict hygienic measures during processing and cold storage of raw poultry meat cuts, especially in the summer season, to avoid the enhancement of hot and humid climate on microbial growth

1. INTRODUCTION

Many of the recent environmental changes were not prevalent during the first decades of the 20th century (IPCC, 2013). It has become commonly known that there have been extensive changes to the environment on a worldwide scale, including variations in temperature and precipitation measures (Lucette *et al.*, 2018).

Because of the high nutritional value of the poultry meat, the microbiological effects of climate change on poultry meat products are significant (Abioja and Abiona, 2021). Poultry is the most widely available source of easily assimilated protein, fat, vital amino acids, minerals, vitamins, and other nutrients that significantly contribute to the dietary balance of a meal. However, due to its high moisture content, high proportion of nitrogenous compounds, abundant supply of minerals, some fermentable carbohydrates (glycogen), and favorable media for the majority of microorganisms, chicken meat is regarded as an ideal culture medium for the growth of many organisms (Edris *et al.*, 2012).

The chicken industry has received recognition on a global scale as a highly important and necessary source of animal protein in the daily diet of a typical l household (Salawu *et al.*, 2014).

Growing the poultry business, which is a quick and more affordable source of proteins, can help Egypt tackle its serious challenge of rising demand for animal proteins. Egypt lacks red meat, hence chicken meat is regarded as a substantial source of protein in Egypt due to the lack of red meat production (Hussein *et al.*, 2018).

Numerous earlier studies emphasized the primary points of contact between contaminated chicken meat and consumers, from the point of slaughter to the ready-to-eat meat meal (Rouger et al., 2017). High levels of cross-contamination are primarily caused by water used to dress poultry (Mpundu *et al.*, 2019).

When food is contaminated with pathogenic microorganisms due to a lack of suitable sanitary conditions, hygiene practices, correct storage, and mistreatment, there are significant underlying food safety issues that need to be addressed (WHO, 2020).

According to Smith *et al.* (2014), the biggest hazards to human health from climate change are those linked to food safety, food security, and food system issues. Given that many foodborne infectious diseases are caused by climate-sensitive pathogens, researchers anticipated a relationship between foodborne illness and climate change known to be influenced by climate and weather variables (Lake, 2017).

Therefore, the present investigation focused on the seasonal impact on the microbiological quality of drumstick samples of chicken, quail and duck in different seasons of the year.

2. MATERIAL AND METHODS

1. Collection of samples

A total of 270 random samples of fresh, raw chicken, quail, and duck drumsticks (30 of each) were collected from

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different poultry butchers located in the Qalyubia government during the winter, spring, and summer seasons of 2021 (30 of each). Each samples weighted about 100, 70 and 150 g for chicken, quail and duck, respectively. Each sample was kept individually in a separate plastic bag and transferred, as soon as possible, to the laboratory in an insulated ice box under complete aseptic conditions without undue delay. All collected samples were examined bacteriologically for detection of their bacteriological quality as follow:

1.1. Preparation of samples (ISO 6887-1: 2017):

Ten-fold serial dilutions were prepared on sterile peptone water (0.1%); from which the following parameters were examined.

1.2. Aerobic plate count "APC" according to ISO 4833-1 (2013) on APC agar (OXOID) and incubated at 30±1 °C for 72 hrs.

1.3. *Escherichia coli* counts, according to ISO 16649-2 (2001) on TBX agar (OXOID) and incubated at 44±1 °C for 24 hrs.

1.4. *Staphylococcus aureus* count (ISO 6888-1, 2003):

It was applied using Baird Parker agar (OXOID) supplemented with egg yolk tellurite and incubated at 35±2 °C for 24 hrs.

1.5. *Determination of total yeast and mold* count (ISO, 2008):

0.1 ml of each serial dilution was spread over Dicloran Rose-Bengal agar (Lab M) and incubated at 25±1 °C for 3-5 days aerobically according to ISO 21527-1 (2008). Mold and yeast colonies were counted and recorded.

3. Statistical analysis

The obtained data of APC, *E. coli, S. aureus* and total fungal counts were subjected to two-way ANOVA (relation between microbiological counts and season and species among the examined samples) using SPSS software (version 18) according to IBM (2009).

3. RESULTS

Referring to the recorded aerobic plate counts (APC, log_{10} CFU/g) results in fig. (1), the examined samples during summer showed a significantly higher APC than those recorded in the spring and winter seasons. Moreover, duck drumstick was higher in APC than those recorded in quail and chicken samples with mean values of 5.06, 5.44, and 5.85 during winter, spring, and summer seasons, respectively. Regarding with their acceptability for human consumption (Tables 1-3) according to the legislated Egyptian standards (No. 1651/2019), all (100%) of the examined chicken and quail samples were accepted; while 70% of duck samples were acceptable during summer season (Table, 3) (<5 log_{10} CFU/g, during the three seasons.

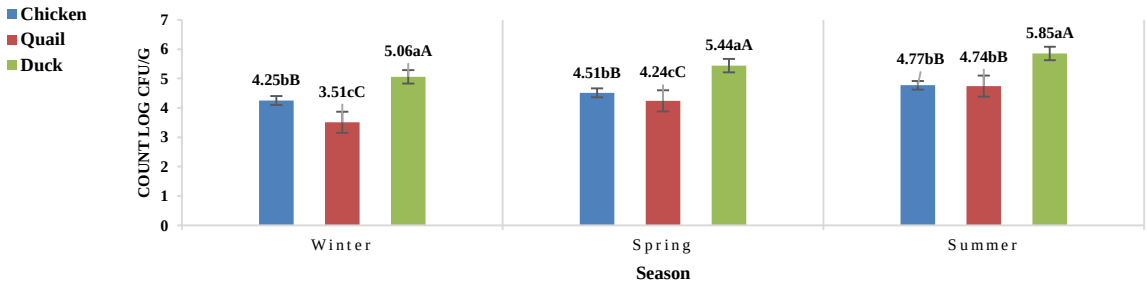

Fig. 1 Aerobic Plate counts (log_{10} CFU/g) in the examined fresh drumstick samples. ^{abc} values with different superscript letters within the same season were significantly different at ($P \leq 0.05$). ^{ABC} values with different superscript letters within species were significantly different at ($P \leq 0.05$).

Regarding the incidence of the detected pathogenic microorganisms in the examined samples, *E. coli, S. aureus*, and fungal contamination were detected in all of the examined samples regardless of the seasons of collection. Results in tables (1-3) and Figs. (2-4) showed that *E. coli, S. aureus*, and fungal counts in duck samples were the highest, followed by chicken and quail samples in all seasons, respectively. These counts were higher in samples examined in the summer season than those of spring and winter ones, with mean values of 2.01, 1.94, and 1,98; 1.96 2.04, and 1.74; 1.82, and 2.04 and in chicken, quail, and duck drumstick samples during the summer season, respectively. Regarding their acceptability according to the legislated Egyptian standards (No. 1651/2019), *E. coli* counts in all examined samples during the summer and spring seasons were acceptable, while 100% and 10% of chicken and duck samples were unacceptable where they exceeded the permissible limit (<2 log10 CFU/g) in winter. In addition, *S. aureus* counts in all the examined samples during the summer and spring seasons were acceptable while 16.6, 13.3 and 100% of the examined chicken, quail, and duck samples were unacceptable during the winter season exceeded the PL (<2 log_{10} CFU/g). Furthermore, fungal counts in all examined samples during the investigation seasons were unacceptable for human consumption.

Table 1 Acceptable drumstick samples (%) in winter according to the Egyptian standards (2019) (n=30).

	APC		*E. coli*		*S. aureus*		Mold and yeast	
	No.	%	No.	%	No.	%	No.	%
Chicken	30	100	30	100	30	100	0	0
Quail	30	100	30	100	30	100	0	0
Duck	29	96.7	30	100	30	100	0	0

Table 2 Acceptable drumstick samples (%) in spring according to the Egyptian standards (2019) (n=30).

	APC		*E. coli*		*S. aureus*		Mold and yeast	
	No.	%	No.	%	No.	%	No.	%
Chicken	30	100	30	100	30	100	0	0
Quail	30	100	30	100	30	100	0	0
Duck	27	90	30	100	30	100	0	0

Table 3 Acceptable drumstick samples (%) in summer according to the Egyptian standards (2019) (n=30).

	APC		*E. coli*		*S. aureus*		Mold and yeast	
	No.	%	No.	%	No.	%	No.	%
Chicken	30	100	0	0	25	83.3	0	0
Quail	30	100	30	100	26	86.6	0	0
Duck	21	70.0	27	90	0	0	0	0

In reference to EOS (2019)

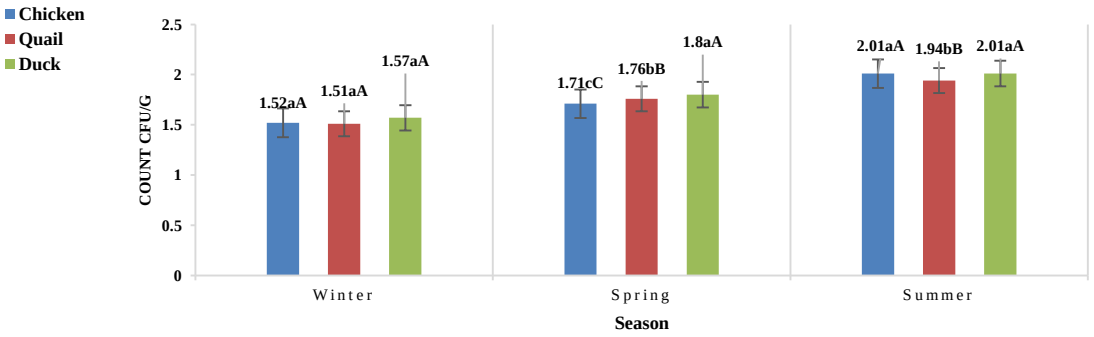

Fig. 2 *E. coli* counts (log_{10} CFU/g) in the examined fresh drumstick samples. ^{abc} values within a column with different superscript letters were significantly different at ($P \leq 0.05$). ^{ABC} values with different superscript letters within species were significantly different at ($P \leq 0.05$).

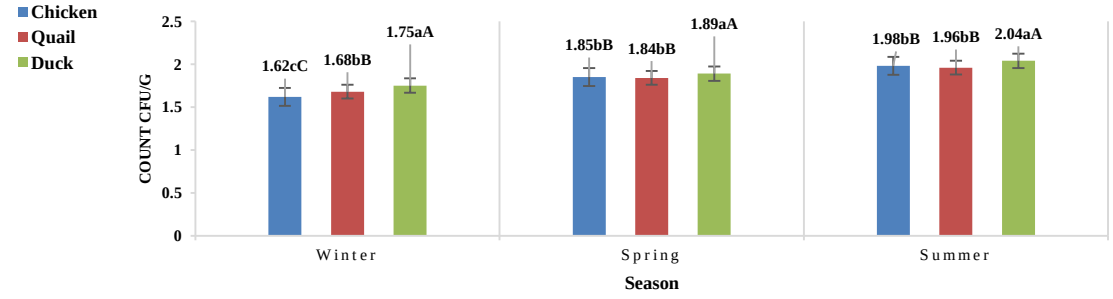

Fig. 3 *S. aureus* counts (log_{10} CFU/g) in the examined fresh drumstick samples. ^{abc} values within a column with different superscript letters were significantly different at ($P \leq 0.05$). ^{ABC} values with different superscript letters within species were significantly different at ($P \leq 0.05$).

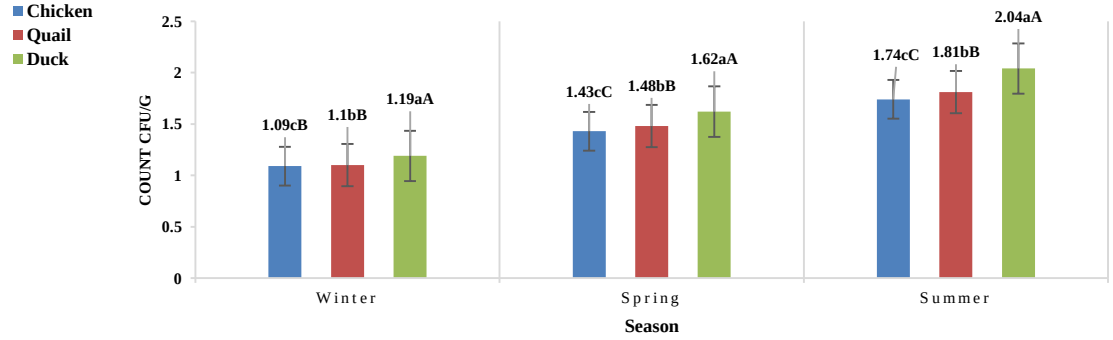

Fig. 4 Fungal counts (log_{10} CFU/g) in the examined fresh drumstick samples. ^{abc} values within each season with different superscript letters were significantly different at ($P \leq 0.05$). ^{ABC} values with different superscript letters within species were significantly different at ($P \leq 0.05$).

4. DISCUSSION

Climate change has drawn more attention in recent years as a result of the severe threat it poses to both human cultures and the ecosystems on our planet. According to FAO, climate changes may have an impact on things like environmental pathogen survival and growth, sources and modes of transmission, food, and ultimately human health (FAO, 2008). As a result, the epidemiologic triad perspective which considers interactions among agent, environment, and host—is used to portray climate-related alterations.

Referring to the recorded results of the microbiological quality of the examined chicken, quail, and duck drumstick samples, the recorded results by Edris *et al.* (2005), and Ahmed (2021), who recorded that the APC (log CFU/g) of the examined chicken and quail meat samples were 5.9 and 5.8, respectively came higher than the currently obtained results. Moreover, Abdallaha *et al.* (2014) and Naeem *et al.* (2018) recorded that the APC of the examined duck and quail samples were 4.9 and 3.01, respectively which came lower than the current recorded results.

The state regulation for food safety may require aerobic plate count, a microbiological indicator that is widely employed in the food sector. The APC test is a general indicator test for bacteria, where a lot of the bacteria in the sample could be found (Knutson, 2020).

Escherichia coli is a pathogen that can be used as an indicator because it shows fecal contamination and

suggests that there may be other pathogens of fecal origin as well as poor sanitation during the handling of meat by infected food handlers and during slaughtering, evisceration, dressing, and transportation (Saad *et al.*, 2018).

The currently obtained results of *E. coli* incidence can be compared with those recorded by Abdallaha *et al.* (2014), Ahmed (2021), and Ahmed *et al.* (2022), who detected *E. coli* in 15, 12, and 8% of the examined duck, chicken, and quail samples, respectively.

Staphylococcus aureus contamination in poultry meat and its byproducts is indicative of both poor personal hygiene and insufficient sterilization of used equipment. According to Zogg *et al.* (2016), *Staphylococcus aureus* can grow while maintaining the desirable flavor and odor of food products while secreting heat-resistant enterotoxins that cause food intoxication and the rapid onset of symptoms in 3–8 hours after consumption, including nausea, vomiting, abdominal cramps, severe diarrhea, and gastroenteritis in consumers.

The obtained results of *S. aureus* came lower than those recorded by Hassanin *et al.* (2020) (3.1 $\log_{10}$ CFU/g in chicken meat samples), while came in agreement with those recorded by Al-Dughaym and Al-Tabari (2009) (<2 $\log_{10}$ CFU/g in chicken thigh sample), while higher results were recorded by Edris *et al.* (2005) (3.9 $\log_{10}$ CFU/g in quail meat samples).

Fungal organisms are quite common and can survive as saprophytes in the environment by using different propagules, such as conidia. Fungal agents can cause contamination of meat and meat byproducts at any step of production, transit, storage, and processing. Mycotoxicosis and infrequently invasive fungal infections can result from eating tainted meat (Nair *et al.*, 2020). According to Lorenzo *et al.* (2018), fungal deterioration, especially in poor developing countries, is a serious source of food spoilage that results in different organoleptic changes in flavor, color, texture, and odor. This is because there aren't enough hygienic controls in place during processing and handling. The term "mold in foods" refers to the fungal spores, which are prevalent in the environment and can easily enter the food chain through dust, water, people, and equipment. As these fungi may be linked to the production of mycotoxins, their presence in food samples raises serious public health concerns (Benedict *et al.*, 2016).

Referring to the obtained results of fungi counts, higher results were recorded by Eldaly *et al.* (2002) (3.36 $\log_{10}$ CFU/g in broiler chicken cuts), while nearly similar results were reported by Shaltout *et al.* (2016) (4.11 $\log_{10}$ CFU/g in chicken carcasses), Hassan (2019) (2.2 $\log_{10}$ CFU/g in chicken meat) and Shaltout *et al.* (2022) (2.01 $\log_{10}$ CFU/g in chicken thigh samples). Variations between different authors can be referred to as differences in the hygienic quality of the examined samples, localities of collection, season of collection, and the examined meat cuts.

According to Shaltout *et al.* (2014) and Smith *et al.* (2014), the most serious climate change-related concerns to human health are those linked to food safety issues. Since the pathogens that cause many foodborne infectious diseases are known to be influenced by seasonal variables, researchers expected a link to exist between climate change and foodborne illness (Lake, 2017).

Regarding seasonal variation, the results showed that there were higher contamination rates in the samples that were collected during the summer. This may be attributed to the clear connection between foodborne infections and environmental change, as foodborne microbe contamination and growth rates have been shown to be higher during warm and humid weather patterns (Smith and Fazil, 2019). Moreover, the higher microbial loads in duck samples than in chicken and quail ones may be attributed to the type of duck meat and its biochemical structure with the differences in the intestinal microbiota (Zhu et al., 2020).

5. CONCLUSIONS

Duck drumstick samples revealed the highest contamination levels followed by chicken and quail samples, respectively. The collected samples during the summer season showed higher microbial contamination than those in the spring and winter seasons, respectively. So, it is concluded that the susceptibility of microbial contamination and proliferation in food items is higher in the hot and humid climate of the summer season, the application of strict hygienic measures during processing and cold storage of raw poultry meat cuts is very important to avoid the enhancement of microbial growth.

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