# IMPACT OF PROCESSING LINES AND PLANT-PROCESSING ENVIRONMENT ON FUNGAL CONTAMINATION OF POULTRY CARCASSESIN A COMMERCIAL POULTRY SLAUGHTERHOUSE

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***Abstract***

The impact of different locations of processing lines and plant-processing environment on the fungal quality of poultry carcasses was determined in a commercial poultry slaughterhouse atGharbia governorate, Egypt. Swabs were obtained from skin of broiler carcasses at different points on the processing lines of the plant during 5 sampling days. At the same time, environmental swabs were also collected from different areas of plant processing units during the same previous periods for mycotic examination. The statistical analysis of the results from the microbiological analysis, showed significant increase in total yeast and mould count ($P < 0.05$) of broiler carcasses after bleeding, defeathering, and evisceration. Meanwhile, scalding and spray washing operations significantly reduced fungal populations on the carcasses. The numbers of total yeast and mould on the carcasses were apparently not substantially affected by the water chilling process. The findings indicated that the only substantial changes in the numbers of fungi on carcasses after processing were reduction in the numbers of yeast and mould (2.87 log cfu/cm2) as a result of the freezing operation and increase in their numbers (4.89 log cfu/cm2) as well as a result of the cutting and deboning processes.

Regarding to the spread and persistence of mycotic flora on carcasses and critical points of the processing lines or the processing environment of different plant units; it was shown that some species were positive for both carcasses and points of processing operations or environmental surfaces at the same facility. The predominant species recovered from these carcasses were Aspergillusniger, Aspergillusflavus, Cladosporium sp., Pencillium sp., Alternaria sp., Fusarium sp. and Candida albicans.

The present study concluded that, although the levels of fungi on broiler carcass end products are reduced during modern poultry processing, the carcass portions had a significantly higher mould and yeast counts. Furthermore, carcass cross-contamination by mould and yeast, such as Aspergillusniger and Aspergillusflavus, are widespread and occurs continuously during processing. Methods for reducing carcass contamination during the processing operations deserve further study.

## INTRODUCTION

To ensure food safety within a poultry processing plant, the correct control systems must be in place. These control systems help reduce the risk of microbial contamination of meat. This is achieved by reducing the interaction between the meat and the source of microbial contamination. However, broilers entering slaughter processing are highly contaminated by microorganisms, and these pathogens tend to be disseminated in the processing plant during processing (Mead et al., 1994; Kotula and Pandya, 1995). Although it is impossible to ensure the complete absence of pathogens from broilers, the risk of foodborne disease can be reduced substantially by minimizing their numbers.

Microorganisms found in slaughtered poultry, originate from two main sources: the environment of the slaughterhouse (live poultry, equipment, staff) and the digestive track of the animals (Surak, 2002). Poultry meat process includes the following common stages: slaughtering, bleeding, scalding, defeathering, evisceration, washing, chilling and classification. The whole process is divided into two main zones: (a) the "unclean zone", where the procedures of slaughtering, bleeding, scalding, defeathering and evisceration take place and (b) the "clean zone" where all procedures are carried out at low temperatures and under strict hygiene controls ( Donos, 1975, Escudero-Gilete et al., 2007, ICMSF, 1988 and Simonsen et al., 1987).Mead (1989) considered that there was extensive aerial dissemination of microorganisms near to chicken plucking machines but suggested that the transfer of bacteria via equipment was the more important route of cross-contamination in evisceration rooms. Allen et al. (2003) identified the airborne route as the principal means of cross-contamination during defeathering. Moreover, the feathers of birds brought to the plants for slaughter are typically infestedin·festtr.v. in·fest·ed, in·fest·ing,in·fests

1. To inhabit or overrun in numbers or quantities large enough to be harmful, threatening,orobnoxious:

..... withbacterial and fungal pathogens. The findings of several studies indicate that airborne transmission of microorganisms to carcasses in evisceration rooms may contribute to carcass contamination but no quantification of the effect has been made (Ellerbroek, 1997, Saleha et al., 1998 and Whyte et al., 2001).Carcasscarcass, carcase

1.the body of an animal killed for meat. The head, the legs below the knees and hocks, the tail, the skin and most of the viscera are removed. The kidneys are left in

and in most instances the body is split down the middle through the sternum and the vertebral contamination is supposed to be the lowest as the birds leave the chiller.chill·ern.

1.One that chills.

2. A frightening story, especially one involving violence, evil, or the supernatural; a thriller.chiller

However, recontamination of the carcass surface can potentially occur by deposition of large pathogen-carrying solid or liquid particles (Burge 1995).

Hygiene plays an important role during processing in the prevention of initial contamination of meat and poultry (Smulders 1987 and NarasimhaRao et al. 1998). It was reemphasized that there is a need for improvements in hygiene during processing of poultry from the point of the application of HACCP principles (Davies and Board, 1998).In previous studies, researchers have generally measured the numbers of organisms on carcasses and in the various positions along the processing line. However, the numbers of yeasts and molds in the major processing areasand the significant correlations between the numbers of these pathogens on carcass surfaces and in the poultry slaughtering plants were not fully demonstrated.

The present study has been carried out to determine the impact of different locations of processing lines and plant-processing environment, in a commercial poultry slaughterhouse, on the fungal quality of poultry carcasses; and to aid the local industry to enhance the quality and safety of their products.

## MATERIALS AND METHODS

### 2.1. Description of the broiler processing plant.

The slaughter plant used in the current study was part of an integrated broiler operation and processed on average 60 000 birds per day. It is subdivided into six units: unit 1 (area of live birds), unit 2 (area of slaughtering, bleeding and defeathering), unit 3 (area of evisceration), unit 4 (area of chilling), unit 5 (area of portioning and packing) and unit 6 (area of freezing). After birds are hung on the shackle line, all the operations except slaughtering are performed mechanically. The blood allowed to drain out into a trough. The slaughtered birds were scalded at 58-60C for 1 min in a scalding tank. The temperature of the scald water was maintained by a thermostat. The scalded birds were defeathered using a picker with rotating rubber fingers. The defeathered birds were hung on overhead rails, eviscerated automatically and cooled by immersion in cold water. About half the carcasses (each weigh between 1.3 and 1.6 kg) are packed for dispatch from the plant after further

freezing. The remaining carcasses are mechanically divided into skin-on portions, most of which are packed in bulk. However, most breast portions are mechanically skinned and deboned.

**2.2. Collection of samples**

**Sampling criteria**

Sampling was carried out at the processing lines on 5 separate visits to the plant. Samples were collected each day from carcasses within the same flock at each sampling point on the processing lines. The sampling points used for the current study were: (I) live birds, (II) immediately after bleeding, (III) after scalding, (IV) after defeathering, (V) after evisceration, (VI) after washing, (VII) after chilling, (VIII) after packing (IX) after cutting and deboning (X) after exiting the blast freezing tunnel.

**Sampling sites**

Samples were taken at different sites and stages of processing on the same facility. The following sampling points were establishing: poxes; hocks; chickens' feathers; the bleeding knife; the carcasses surfaces after bleeding; scalding water; the carcasses surfaces after scalding; the rubber fingers from the mechanical pucker; the carcasses surfaces after defeathering; washing water; post-evisceration external carcasses surfaces; post-evisceration internal carcasses surfaces; post-evisceration carcasses surfaces after washing; the carcasses surfaces after chilling; the tables surfaces after cutting and deboning; plastic bags before packing; and the carcasses surfaces after freezing.

**Environmental sampling**

On five different sampling dates, the following surfaces of six units of the plant were swabbed using a cotton swab. The surfaces of tools, floors, walls and chicken carcasses at each processing unit were sampled. These surfaces and additional tables' surfaces of units 4 &5 were tested for mould and yeast.

**2.3. Microbiological Analysis**

Sampling of carcass surfaces was done with a swab at the breast with a total surface area of 10 cm2. Scald water for analysis was collected in sterile bottles. The samples were subjected to fungal analysis according to standard procedures (APHA 1992), yeast and mold counts was performed usingSabouraud's dextrose agar supplemented with chloramphenicol (20 lg/ml) (25°C, 7 days). Isolation of fungi was performed on Glucose- Czapek's supplemented with chloramphenicol (20 lg/ml).

### 2.4. Statistical analysis

All microbial counts obtained from samples were transformed to log10 values for subsequent data analysis. Differences in microbial counts were examined for significance by analysis of variance. A significance level of $P<0.05$ was set for the separations of means. Those calculations were accomplished by Duncan's multiple range test using the software SPSS for windows (SPSS Inc. 1992).

## RESULTS AND DISCUSSION

TABLE 1. Mean counts for fungi isolated from skin samples of chicken carcasses at different stages of processing under commercial conditions[1]

| Unit | 1 | 2 | | | 3 | | 4 | 5 | 6 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Process | Live birds | After bleeding | After scalding | After defeathering | After evisceration | After washing | After chilling | After packing | After freezing | After cutting |
| Mean | $3.22^{cd}$ | $3.40^{bc}$ | $3.11^{de}$ | $3.61^{bc}$ | $3.79^{b}$ | $3.46^{bc}$ | $3.38^{bc}$ | $3.74^{b}$ | $2.87^{e}$ | $4.89^{a}$ |
| SD | 0.05 | 0.14 | 0.13 | 0.24 | 0.14 | 0.12 | 0.63 | 0.51 | 0.33 | 0.33 |

1Data are expressed as mean log colony-forming units per cm2 (± SD). Each mean represents n = 5 measurements.

Table (1) shows the mean counts of fungi on the skin of broiler carcasses obtained from different points on the processing lines of the plant during 5 sampling days. The statistical analysis of the results from the microbiological analysis, showed that the difference in the numbers for total yeast and mouldcount, at all stages of processing lines is statistically significant ($P < 0.05$). Live birds carried a particularly high microbial load, total yeast and mould count was 3.22 log cfu/cm2. Feathers and skin of broilers entering a processing plant may have high numbers of human pathogens (Mead et al., 1993; Abu Rwaida et al., 1994; Kotula and Pandya, 1995; Geornaras et al., 1997). Physical separation of live bird areas from the processing area has been suggested as one of the means of minimizing the transfer of microorganisms from live birds to processed carcasses (Patterson 1971; Mead 1976).

The mean total yeast and mould count obtained from chicken carcasses after bleeding was 3.40 log cfu/cm2. The data presented here showed that the initial microflora of birds arriving at the slaughterhouse increased immediately after slaughtering process. However, the numbers of total yeast and mould reduced to 3.11 log cfu/ cm2 after scalding. Scalding significantly reduced fungal populations on the carcasses, by 0.39 log cycle (Table 1). Similar observations were reported by Lillard (1990), Mead et al. (1993), Geornaras et al. (1997), Yashoda et al. (2001),

and Go¨ksoy et al. (2004). Abu-Rwaida et al. (1994) found increased numbers of bacteria following scalding and defeathering. When birds are immersed in the scalding tank, dirt, fecal material, and other surface contaminants are removed. Therefore, the washing effect of scalding water may reduce bacterial numbers on the surface of chicken carcasses if the water of scalding tank is continuously replaced with fresh water. Scalding partially eliminates the initial flora on poultry skin and tends to be selective for heat-resistant mesophiles and spore-forming organisms, but subsequent recontamination takes place mostly by Gram negative organisms (Barnes 1976; McNamara, 1997; Genigeorgis et al., 1986; Oosterom et al., 1983).

The microbiological load of carcasses after the defeathering stage, showed a statistically significant increase of total yeast and mould to 3.61 log cfu/ cm2. Similar increase in total yeast and mould count were observed by Yashoda et al. (2001). On contrary, previous studies reported that defeathering tends to reduce bacterial numbers on chicken carcasses (Lillard, 1990; Mead et al., 1993; Go¨ksoy et al., 2004). Defeathering has been identified as a major site of cross-contamination (Notermans et al., 1980; Clouser et al., 1995). During defeathering there can be considerable spread of microorganisms from carcass to carcass and from the defeathering equipment itself (Mulder et al. 1978; Bryan 1980; Mead 1992). It is interesting to note that in the present study the defeathering operation contributed significantly towards microbial build up on carcasses. However, frequent washing of defeathering fingers is necessary as it was demonstrated that the microbiological load on plucker fingers builds up during progress of the operation (Whittemore and Lyon 1994; Bolder 1998). The process of defeathering also appears to equalize the microbial population among carcasses as the operation progresses (Shackelford et al. 1993). This suggests that even though in the present study defeathering resulted in a significant increase in microbial counts, it would be advisable that even in small-scale processing units, where batch type defeathering machines are used, frequent washing of plucker fingers is necessary.

The evisceration process resulted in a marginal ($P < 0.05$) increase in total yeast and mould count (3.79 log cfu/cm2). Significant increase in total yeast and mould count were observed on chicken carcasses after the evisceration stage (Yashoda et al. 2001). Meanwhile, no significant reductions in bacterial counts following evisceration were detected on chicken carcasses (Lahallec et al., 1973; Notermans et al., 1977; Lillard, 1989; Mead et al., 1993; Go¨ksoy et al., 2004).

However, following automatic evisceration, the numbers of Enterobacteriaceae increased in some studies due to the breakage in the intestines (Nottermans et al., 1980; Mead et al., 1993; Abu-Rwaida et al., 1994). This indicates that care during evisceration to avoid fecal contamination of carcasses is necessary.

It has been reported that spray washing may reduce microbial numbers when applied immediately after contamination, e.g., fecal contamination after intestinal breakages (Mulder and Veerkamp, 1974; Notermans et al., 1980). The present study recorded that spray washing following evisceration, reduced the mean total yeast and mould count by 0.33 log cycle (Table 1). Significant reductions were found in the numbers of fungi (Yashoda et al. 2001) or bacteria (Go¨ksoy et al. 2004) investigated after washing. Mead et al. (1993) monitored 5 processing plants and reported that the mean TVC obtained from carcasses in 2 processing plants showed significant reductions after spray washing. Although Abu-Rwaida et al. (1994) reported 0.9 log cycle reduction in the TVC, smaller reductions were observed in the numbers of Enterobacteriaceae and Coliforms.

The numbers of total yeast and mould on the carcasses were apparently not substantially affected by the water chilling process. The relatively high log total number of yeast and mould recovered from the chilled carcasses was 3.38 log cfu/cm2, indicated that the numbers of fungi on carcasses decreased by about 0.08 log unit (Table 1). The water-chilling system has been criticised, based on the fact that bacteria can be transferred from chicken to chicken because of contact through water (Petrak, et al., 1999; Mead et al. 2000). Indeed, temperature in the chilling area is critical to the control of micro-organisms gro4wth and consequently should be defined as a CCP in a HACCP system (González-Miret, et al., 2006). Reductions in bacterial numbers as a result of cooling poultry carcasses in water have been reported (James et al., 1992; Jiménez et al., 2003). Chlorine compounds are usually added to carcass cooling waters in bactericidal concentrations. Chlorine dioxide in agitated cooling water was sufficient to reduce the numbers of coliforms and E. coli by about 1.0 log unit and the numbers of presumptive Staphylococci plus Listeria by about 0.5 log unit on dressed carcasses, but the numbers of aerobes were not reduced (Gill et al., 2006). Even so, water chilling may have no effect on or may increase the numbers of bacteria on poultry carcasses (Lillard, 1982; Whyte et al., 2004).

The packing process resulted in a non significant ($P < 0.05$) increase in total yeast and mould count (3.74 log cfu/cm2). This relative high log total number of yeast and mould recovered from the packed carcasses can be regarded as it may be due to spread of microorganisms from carcass to carcass during store in bulk before packing operation.

The findings indicated that the only substantial changes in the numbers of fungi on carcasses after processing were reduction in the numbers of yeast and mould as a result of the freezing operation and increase in their numbers as a result of the cutting and deboning process.

The mean total yeast and mould count obtained from whole frozen carcass products immediately after freezing was 2.87 log cfu/cm2. This data indicated that freezing significantly reduced fungal populations on the carcasses, by about 1.0 log cycle (Table 1).

The mean total yeast and mould count recovered from carcass portions after cutting and deboning processes was 4.89 log cfu/cm2. These findings showed that after mechanical division of carcasses, the numbers of fungi recovered from skin-on carcass portions after the operation were >1.5 log units more than the numbers previously recovered after chilling (Table 1). Significant increase in the numbers of aerobes were 1 log unit more on boneless breasts, and 0.5 log units more on skin-on thighs and breasts than on cooled carcasses (Gill et al., 2006). Contamination of red meats during carcass breaking processes has been shown to occur (Gill et al., 1999), but it has been reported that poultry carcass portioning processes may have little effect on the numbers of bacteria on the product (Holder et al., 1997). Besides, according to results from other studies, the classification stage is one of the main phases involved in poultry contamination in non-automated systems, because of human participation (Bijker et al., 1987; Tsola et al., 2008). The higher numbers of yeast and mould on carcass portions than on cooled carcasses suggested that contaminants were added to product during the portioning process, examination of product before and after the process showed this was so. Thus, the additional contaminants found on portions were probably deposited on product during the portioning operation.

TABLE 2. Mean counts for fungi isolated from plant-processing environment and chicken carcasses at different units of processing under commercial conditions

| Unit | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Samples sources | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Air | $1.17^{bc}$ | 0.08 | $1.53^{ab}$ | 0.31 | $1.49^{ab}$ | 0.12 | $1.6^{a}$ | 0.06 | $1.76^{a}$ | 0.06 | $0.68^{c}$ | 0.40 |
| Tools | $3.25^{ab}$ | 0.17 | $3.42^{ab}$ | 0.28 | $3.50^{ab}$ | 0.16 | $2.62^{b}$ | 0.79 | $3.79^{A}$ | 0.10 | $3.24^{ab}$ | 0.17 |
| Floors | $3.43^{bc}$ | 0.13 | $6.28^{a}$ | 0.28 | $3.31^{c}$ | 0.28 | $3.25^{c}$ | 0.18 | $4.24^{bc}$ | 0.17 | $4.39^{b}$ | 0.85 |
| Walls | $3.23^{bc}$ | 0.19 | $3.45^{b}$ | 0.22 | $2.51^{c}$ | 0.15 | $2.57^{c}$ | 0.19 | $4.8^{a}$ | 0.71 | $4.81^{b}$ | 0.70 |
| Tables | - | - | - | - | - | - | 3.67 | 0.19 | 3.64 | 0.35 | - | - |
| Chicken | $3.22^{cd}$ | .05 | $3.42^{bc}$ | 0.32 | $3.64^{b}$ | 0.35 | $3.38^{bc}$ | 0.62 | $4.65^{a}$ | 0.14 | $2.87^{d}$ | 0.33 |

[1]Data are expressed as mean log colony-forming units per $cm^2$ (± SD). Each mean represents n = 5 measurements. Unit 1: Area of live birds, Unit 2: Area of slaughtering, bleeding and defeathering, Unit 3: Area of evisceration, Unit 4: Area of chilling, Unit 5: Area of portioning and packing and Unit 6: Area of freezing.

Table (2) shows the mean counts of fungi on environmental swabs and broiler carcasses obtained from different units of processing plant during 5 sampling days. It was shown that there were differences ($P < 0.05$) in the numbers of fungi isolated on same samples collected from the different units of processing plant (Table 2). The tools of unit 5 (area of portioning and packing) had a significantly higher mould and yeast counts (3.79 log cfu/cm$^2$) than other plant units; followed by tools of unit 3 (area of evisceration) and unit 2 (area of slaughtering, bleeding and defeathering) which had slight lower mould and yeast counts of 3.50 log cfu/cm$^2$ and 3.42 log cfu/cm$^2$ respectively. Enumeration of microbial populations on poultry processing equipment, using swabs and plate count agar or other suitable media, has been widely recognized as a means of monitoring the effectiveness of equipment sanitation (Russell et al., 1997a). This microbiological indicator has also been used to compare microbiological loads on poultry product samples in a bio-map approach at various stages of processing, such as after defeathering, before and after evisceration, after spray washing, after immersion chilling, and after packaging (Geornaras and von Holy, 2000).

The floors of unit 2 (area of slaughtering, bleeding and defeathering) had a significantly higher level of fungal contamination ($P < 0.05$) where the mean total yeast and mould count recovered from this area was 6.28 log cfu/cm$^2$ (Table 2). It has been established that the handling of contaminated raw poultry meat in the food preparation area will cause the bacteria to become widely disseminated (Cogan et al. 1999). The question arises during which time period they can survive and persist on these surfaces and thus play a role in cross-contamination and subsequent infection.

The walls of unit 5 (area of cutting, deboning and packing) had a significantly higher level of fungal contamination than other processing units. The mean total yeast and mould count isolated from walls of this area was 4.80 log cfu/cm$^2$ (Table 2). However, it is not possible to make definite conclusions as to the cause of this increase from the results of the present study. It is possible that the high level of total yeast and mould count on the walls of area of portioning and packing could be attributed to the greater number of workers in the portioning and packing area, compared to the other areas (Wirtanen et ali, 2002). Human activity has previously been reported to considerably contribute to the microbial contamination of the air, through sneezing, talking, laughing, falling hair, using soiled coats as well as shedding from hands and arms (York, 1973).

The tables surfaces of unit 4 (area of chilling) and unit 5 (area of portioning and packing) had a nearly similar (Table 2) total mould and yeast counts (3.67 log cfu/cm$^2$ and3.64 log cfu/cm$^2$ respectively). It is possible that a contributing factor to the higher fungal levels could have been condensation within the area of chilling as

well as area of portioning and packing; this condensation has previously been more associated with the growth of yeast and moulds rather than with the growth of bacteria. However, higher bacterial contamination in an environment with high relative humidity has also been reported (Marthi et al., 1990). Furthermore, if the initial carcasses are contaminated with fungi, also the contact surfaces in the processing environment become contaminated. These surfaces contribute to cross-contamination of non contaminated poultry meat. Therefore, starting with good quality poultry carcasses should diminish the contamination level of processed poultry products. Furthermore, it has been established that the handling of contaminated raw poultry meat in the food preparation area will cause the bacteria to become widely disseminated (Cogan et al. 1999).

In the present study, the mycotic flora on carcasses and critical points of the processing lines consistedpredominantly of*Aspergillusniger, Aspergillusflavus, Cladosporium sp., Pencillium sp., Alternaria sp., Fusarium sp.* and*Candida albicans*(Table 3).Some species were isolated only from carcasses taken from the processing lineafter the carcass had been passed through one or moreprocessing operations; some species were isolatedonly from critical points of processing operations;while other fungi were isolated from carcassestaken from processing, as well as from points of processing operations (Table 3).*Aspergillusniger* was the predominant mould recovered from these carcasses.

These observations may indicate cross-contamination during processing operations and between carcasses processed at the same facility. Hinton et al. (2004) indicated that bacterial cross-contamination of carcasses occurs during all stages of processing and that some bacteria can survive processing and proliferate on carcasses during refrigerated storage. Furthermore, *Acinetobacter*and *Aeromonas* spp. were the primary isolates recovered from carcasses taken from the processing line.

Other studies have also indicated that cross-contamination of carcasses by *Pseudomonas* spp. is apparent throughout the processing operation (Geornaras et al., 1999).Scald water, rubber picker fingers of the mechanical pickers and evisceration are major sources of cross-contamination in processing facilities (Mulder et al., 1978; Thomas and McMeekin, 1980; Geornaras et al., 1995). Additional carcass contamination may occur during the chilling operation because psychrotrophic spoilage bacteria are routine inhabitants of the immersion chiller water and chiller ice (Thomas and McMeekin, 1980; Fries and Graw, 1999).

TABLE 3. Mycoticfloara isolated from critical points of processing operations and chicken carcasses at different stages of processing under commercial conditions

| Process | Sampling sites | Isolated fungi |
|---|---|---|
| Before shackling | Poxes | *Aspergillusniger* |
| | Chickens' feathers | *Aspergillusniger* |
| After shackling | Hocks | *Aspergillusniger* |
| | Chickens | *Aspergillusniger* |
| After bleeding | bleeding knife | *Aspergillusniger* |
| | Carcasses surfaces | *Aspergillusniger* |
| After scalding | Scalding water | *Aspergillusniger* |
| | Carcasses surfaces | *Aspergillusniger* |
| After defeathering | Rubber fingers of mechanical pucker | *Aspergillusniger, Rodotoria sp.* |
| | Carcasses surfaces | *Aspergillusniger* |
| After washing | Washing water | |
| | Carcasses surfaces | *Aspergillusniger* |
| After evisceration | Evisceration equipments | *Aspergillusniger, Alternaria sp.* |
| | post-evisceration external carcasses surfaces | *Aspergillusniger* |
| | post-evisceration internal carcasses surfaces | *Pencillium sp.* |
| After washing | Washing water | |
| | Carcasses surfaces after washing | *Aspergillusniger* |
| After chilling | Cold water | |
| | carcasses surfaces after chilling | *Aspergillusniger, Pencillium sp.* |
| After cutting | Tables surfaces after cutting and deboning | *Aspergillusniger, Alternaria sp., Cladosporium sp.* |
| | Breast flits | *Aspergillusniger* |
| | Thighs | *Aspergillusniger* |
| | wings | *Aspergillusniger* |
| After packing | plastic bags before packing | *Fusarium sp.* |
| | Carcasses surfaces after packing | *Aspergillusniger, Aspergillusflavus, Fusariu m sp., Cladosporium sp.* |
| After freezing | Blast freezing tunnel | *Cladosporium sp.* |
| | Carcasses surfaces after freezing | *Candida albicans* |

The spread and persistence of mycoticflora in the processing environment and chicken carcasses at different processing units is shown in Table (4). These floara consisted primary of Aspergillusniger, Aspergillusflavus, Cladosporium sp., Pencillium sp., Alternaria sp., Fusarium sp. and Candida albicans. Some species were isolated only from carcasses after they had been passed through one or more processing units; while other species were isolated only from processing environmental surfaces.However, only Aspergillusniger andAspergillusflavus were positive for both carcasses andenvironmental surfaces at the same facility (Table 4).These results can explain the high numbers of contaminated poultry meat on the retail market. If the initial carcasses are contaminated with mould and yeast, also the contact surfaces in the processing environment become contaminated. These surfaces contribute to cross-contamination of non-contaminated poultry meat (Cogan et al., 1999; Cools et al., 2005). Therefore, starting with good quality poultry carcasses should diminish the contamination level of processed poultry products.

Unit 1: Area of live birds, Unit 2: Area of slaughtering, bleeding and defeathering, Unit 3: Area of evisceration, Unit 4: Area of chilling, Unit 5: Area of portioning and packing and Unit 6: Area of freezing.

## CONCLUSION

Overall, the present study concluded that, although the levels of fungi on broiler carcass end products are reduced during modern poultry processing, the carcass portions had a significantly higher mould and yeast counts. This should be reduced by implementing satisfactory manufacturing practices and effectively training plant workers in hygiene, safety, and quality assurance.

On the other hand, carcass cross-contamination by mould and yeast, such as *Aspergillusniger*and*Aspergillusflavus*, are widespread and occurs continuously during processing. Methods for reducing carcass contamination during the processing operations deserve further study. This should be reduced by implementing satisfactory manufacturing practices and effectively plant workers training in hygiene, safety, and quality assurance. It is therefore important to keep exposure of chilled meat in the processing and packaging areas as low as possible to reduce the risk of foodborne illness and food spoilage.

Finally, development of intervention techniques that can reduce the spread of fungal contaminants during poultry processing will produce safer products with an extended shelf life.

TABLE 4. Mycoticfloara isolated from plant-processing environmentand chicken carcasses at different units of processing under commercial conditions

| Units→ / Samples sources↓ | Unit 1 | Unit 2 | Unit 3 | Unit 4 | Unit 5 | Unit 6 |
|---|---|---|---|---|---|---|
| Tools | *Aspergillu sniger* | *Aspergillusfl avus* | *Aspergillu sniger Alternaria sp. Fusarium sp.* | *Aspergillu sniger Alternaria sp. Fusarium sp. Candida albicans* | *Alternaria sp.* | *Candida albicans* |
| Floors | *Aspergillu sflavus* | *Aspergillus flavus Alternaria sp. Cladosporiu m sp.* | *Aspergillu sniger Alternaria sp.* | *Aspergillu sniger* | *Aspergillusniger* | *Aspergillus niger Candida albicans* |
| Walls | *Aspergillu sniger* | *Aspergillusni ger Candida albicans* | *Aspergillu sniger* | *Aspergillu sniger Pencilliu m sp.* | *Aspergillusniger* | *Aspergillus niger* |
| Tables | - | - | - | *Candida albicans* | *Aspergillusniger Alternaria sp. Cladosporium sp.* | - |
| Chickens | *Aspergillu sniger* | *Aspergillusni ger* | *Aspergillu sflavus Cladospori um sp.* | | *Aspergillusflavus Aspergillusniger Penicillium sp. Fusariumsp Candida Albicans Cladosporiumsp.* | *Aspergillus niger Pencillium sp.* |

## REFERENCES

1. Abu-Rwaida, A. S., W. N. Sawaya, B. H. Dashti, M. Murad, and H. A. Al-Othman. 1994. Microbiological quality of broilers during processing in a modern commercial slaughterhouse in Kuwait. J. Food Prot., 57:887–892.
2. Allen,V.M., M.H. Hinton, D.B. Tinker, C. Gibson, G.C. Mead, C.M. Wathes .2003. Microbial cross-contamination by airborne dispersion and contagion during defeathering of poultry. British Poultry Science:, 44: 567–576
3. APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition.American Public Health Association, Washington, D.C.
4. Barnes, E.M. 1976. Microbiological problems of poultry at refrigeration temperature - a review. J. Sci. Food Agri., 27: 777-782.
5. Bijker, P.G.H.; J.G. van Logtestijn; D.A.A. Mossel. 1987. Bacteriological quality assurance (BQA) of mechanically deboned meat (MDM) Meat Science, 20, 237–252
6. Bolder, N.M. 1998.The microbiology of the slaughter and processing poultry. In The Microbiology of Meat and Poultry, (A. Davies and R. Board, eds.) pp. 158-173, Blackie Academic & Professional, London.
7. Bryan, F.L. 1980. Poultry and poultry meat products. In Microbial Ecology of Foods.2: 410-458, Academic Press, New York.
8. Burge, H.A. 1995. Bioaerosols. Boca Raton, FL. CRC Press. Clouser, C. S., M. Doores, M. G. Mast, and S. J. Knabel. 1995. The role of defeathering in the contamination of turkey skin by Salmonella species and Listeria monocytogenes. Poult. Sci. 74:723–731.
9. Clouser, C.S., S.J.Knabel, M.G. Mast, , S.Doores, .1995b. Effect oftype of defeathering system on Salmonella cross-contaminationduring commercial processing. Poult. Sci. 74: 732–741.
10. Cogan, T.A., S.F. Bloomfield, and T.J. Humphrey, 1999. The effectiveness of hygiene procedures for prevention of cross-contamination from chicken carcasses in the domestic kitchen. Lett Appl. Microbiol. 29:354–358.
11. Cools, I., M. Uyttendaele, J. Cerpentier, E. D'Haese, H.J. Nelis and J. Debevere 2005. Persistence of Campylobacter jejuni on surfacesin a processing environment and on cutting boards. Lett Appl. Microbiol, 40: 418–423.
12. Davies, A. and R. Board, 1998. The Microbiology of Meat and Poultry, p. xi, Blackie Academic & Professional, London.

13.Donos A.G. 1975. Slaughter hygiene–process-hygiene meat control Sanitary inspection of poultry–meat and hygiene disposal, University of Ioannina, Ioannina, pp. 18–31

14.Ellerbroek, L. 1997.Airborne microflora in poultry processing establishments. Food Microbiology, 14: 527–531

15.Escudero-Gilete, M.L., M.L. González-Miret, R. Moreno Temprano, F.J. Heredia 2007.Application of multivariate concentric method system for the location of *Listeria monocytogenes* in a poultry slaughterhouse.Food Control, 18:69–75

16.Fries, R., C. Graw, C. 1999. Water and air in two poultry processing plants' chilling facilities—a bacteriological survey. British Poultry Science 4: 52–58.

17.Genigeorgis, C., M. Hassuneh , P. Collins, . 1986. Campylobacter jejuni infection on poultry farms and its effect on poultry meat contamination during slaughtering. J. Food Prot. 49:895–903.

18.Geornaras, I., A.de Jesus, , E.van Zyl, A. von Holy, 1995 . Microbiological survey of a South African poultry processing plant. Journal of Basic Microbiology 35: 73–82.

19.Geornaras, I., A. de Jesus, E. van Zyl, and A. van Holy. 1997. Bacterial populations of different sample types from carcasses in the dirty area of a South African poultry abattoir. J. Food Prot. 60:551–554.

20.Geornaras, I., N.F. Kunene, A.von Holy, J.W. Hastings, 1999. Amplified fragment length polymorphism fingerprinting Pseudomonas strains from a poultry processing plant. Applied and Environmental Microbiology 65: 3828–3833.

21.Geornaras, I. and A. von Holy. 2000. Bacterial counts associated with poultryprocessing at different sampling times. J. Basic Microbiol. 40:5-6, 343-349.

22.Gill, C.O., Badoni, M., McGinnis, J.C., 1999. Assessment of the adequacy of cleaning of equipment used for breaking beef carcasses. International Journal of Food Microbiology 46: 1–8.

23.Gill, C.O., L.F. Moza , M. Badoni ,S. Barbut .2006. The effects on the microbiological condition of product of carcass dressing, cooling, and portioning processes at a poultry packing plant International Journal of Food Microbiology 110 187–193

24..Go¨ksoy, E. O, S. Kirkan, and F. Ko¨k. 2004. Processing and products, Microbiological Quality of Broiler Carcasses During Processing in Two Slaughterhouses in Turkey,Poultry Science Association, Inc.

25.Gonzàlez-Miret, M. L., M. L. Escudero-Gilete, F. J. Heredia. 2006. Theestablishment of critical control points at the washing and air chilling stagesin poultry meat production using multivariate statistics. Food Control, 17:935–941.

26.Hinton, A. Jr., J.A. Cason, K. D. Ingram 2004. Tracking spoilage bacteria in commercial poultry processing and refrigerated storage of poultry carcasses. International Journal of Food Microbiology 91: 155– 165.

27.Holder, J.S., J.E.L.Corry, ,M.H.Hinton. 1997. Microbial status of chickenportions and portioning equipment. British Poultry Science 38: 505–511.

28.ICMSF, 1988. Microorganisms in foods 4, Application of the hazard analysis critical control point (HACCP) system to ensure microbiological safety and qualityBlackwell Scientific, Oxford

29.James,W.O., Prucha, J.C., Brewer, R.L., Williams Jr.,W.O., Christensen,W.A., Thaler, A.M., Hogue, A.T., 1992. Effects of countercurrent scalding and postscald spray on the bacteriological profile of raw chicken carcasses.Journal of the American Veterinary Medical Association 201:705–708.

30.Jiménez, S.M., Tiburzi, M.C., Salsi, M.S., Pirovani, M.E., Moguilevsky, M.A., 2003. The role of visible faecal material as a vehicle for generic Escherichia coli, coliform and other enterobacteria contaminating poultry carcassesduring slaughter. Journal of Applied Microbiology 95:451–456.

31.Kotula, K. L., and Y. Pandya. 1995. Bacterial contamination of broiler chickens before scalding. J. Food Prot. 58:1326–1329.

32.Lahallec, C., C. Meurier, and M. Catsarsas. 1973. La flore psychtrophe des carcasses de volaille. II. Evolution au cours de l'evisceration. Ann. Rech. Vet. 4: 499

33.Lillard, H.S. 1982. Improved chilling systems for poultry. Food Technology 36 (2) :58–67.–512.

34.Lillard, H. S. 1989. Factors affecting the persistence of Salmonella during processing of poultry. J. Food Prot. 52:829–832.

35.Lillard, H. S. 1990. The impact of commercial processing procedures on the bacterial contamination and cross contamination of broiler carcasses. J. Food Prot. 53.202–204.

36.Marthi, B., V. P. Fieland, M. Walter, R. J. Seidler. 1990. Survival of bacteria during aersolization. Applied and Environmental Microbiology, 56: 3463–3467.

37.McNamara, A. M. 1997. Generic HACCP applications in broiler slaughter and processing. National Advisory Committee on Microbiological Criteria for Foods. J. Food Prot. 60:579–604.

38.Mead, G.C. 1976. Microbiology of the poultry carcass and processing plant. Royal SOC. Health J. 96: 164-168.

39.Mead, G.C. 1989. Hygiene problems and control of process contamination G.C. Mead (Ed.), Processing of Poultry, Elsevier Applied Science, Barking, England, pp. 183–220

40.Mead, G.C. 1992. Food poisoning salmonellas in meat in the poultry meat industry - the current prospects for controlling Salmonella in the poultry industry. Meat Hygiene 73:6-12.

41.Mead, G. C., W. R. Hudson, and M. H. Hinton. 1993. Microbiological survey of five poultry processing plants in the UK. Br. Poult. Sci. 34: 497–503

42.Mead, G. C., V. M. Allen, C. H. Burton AND J. E. L. Corry .2000. Microbial cross-contamination during air chilling of poultry. British Poultry Science 41: 158–162

43.Mulder, R. W .A. W., Dorresteuin, L. W.J. and Vander Brock, J. 1978. Cross contamination during scalding and plucking of broilers. British Poultry Sci. 19: 61-70.

44.Mulder, R. W. A. W., and C. H. Veerkamp 1974. Improvements in poultry slaughterhouse hygiene as a result of cleaning before cooling. Poult. Sci. 53.1690–1694.

45.NarasimhaRao, D., Nair, K.K.S. and Sakhare, P.Z. 1998. Meat microbiology and spoilage in tropical countries. The Microbiology of Meat and Poultry (A. Davies and R. Board, eds.) pp. 220-265, Blackie Academic & Professional, London.

46.Notermans, S., F. M. van Leusden, and M. van Schothorst. 1977. Suitability of different bacterial groups for determining fecal contamination during post-scalding in the processing of broiler chickens. J. Appl. Bacteriol. 43:383–389.

47.Notermans, S. F., R. J. Terbijhe, and M. van Schothorst. 1980. Removing faecal contamination of broilers by spray cleaning during evisceration. Br. Poult. Sci. 21:115–121.

48.Oosterom, J., S.Notermans, H. Karman, , G.B. Engels, 1983. Origin and prevalence of Campylobacter jejuni in poultry processing. J. Food Prot. 46, 339–344.

49.Patterson, J .T. 1971. Microbiological aspects of poultry processing. British Poultry Sci. 12: 197-203.

50.Petrak T.; Kalodera Z.; Novakovic P.; GumhalterKarolyi L. 1999. Bacteriological comparison of parallel and counter flow water chilling of poultry meat. Meat Science, 53, 4: 269-271(3)

51.Saleha, A.A., G.C. Mead, A.L. Ibrahim 1998. Campylobacter jejuni in poultry production and processing in relation to public health.World Poultry Science Journal, 54 (1): 49–58

52.Shackelford, A.D., Whittemore, A.D. and Wilson, R.L. 1993. Evaluation of carcass washers. J. Appl. Poultry Res. 2: 159-165.

53.Simonsen, B., F.L. Bryan, J.H.B. Christian, T.A. Roberts, and R.B. Tompkin, J.H. Silliker 1987. Prevention and control of food-borne salmonellosis through application of hazard analysis critical control point (HACCP). International Journal of Food Microbiology, 4:227–247

54.Smulders, F.J.M. 1987. Prospective for microbial decontamination of meat and poultry by organic acids with special reference to lactic acid. In Elimination of Pathogenic Organisms from Meat and Poultry (F.J .M. Smulders, ed.) pp. 319-344, Elsevier, New York. SPSS Inc. 1992. SPSS for Windows, Release 6.0.

55.SPSS Inc. 1992: Software and Solutions; Predictive Analytics, Westlands Centre, Westlands Road, Quarry Bay, HK, Website: http://www.spss.com.hk/?source=homepage&hpzone=nav_bar.

56.Surak J.G. 2002. The certified quality auditor's HACCP handbook, Publisher; American Society for Quality press, Wilwaukee, ISBN: 0873897064

57.Thomas, C.J., T.A. McMeekin, 1980. Contamination of broiler carcass skin during commercial processing procedures: an electron microscopic study. Applied and EnvironmentalMicrobiology 40: 133– 144

58.Tsola, E, E.H. Drosinos, P. Zoiopoulos. 2008. Impact of poultry slaughter house modernization and updating of food safety management systems on the microbiological quality and safety of products. Food Control, 19, 4: 423–431.

59.Whyte, P., J.D. Collins, K. McGill, C. Monahan, H. O'Mahony 2001. Distribution and prevalence of airborne microorganisms in three commercial poultry processing plants Journal of Food Protection, 64 (3): 388–391

60.Whi'itemore, A.D. and Lyon, C.E. 1994. Microbiological profile of rubber defeathering fingers and carcasses from processing lines with single and triple stage scalding, Abstract 70, p 24). Poultry Sci. 73 (Supl.1).Eighty third A M U ~M eeting of the Poultry Science Association August 7-12, 1994. Mississippi State University, Mississippi.

61.Wirtanen, G., H.Miettinen, S.Pahkala, S.Enbom, , L. Vanne. 2002. Clean air solutions in food processing, 1–100.

62.Yashoda, K.P. ,N.M. Sachindra, P.Z. Sakhare. 2001. Microbiological quality of broiler chicken carcasses processed hygienically in a small scale poultry processing unit. journal of food quality 24: 249-259.

63.York, G. H. 1973. Airborne microorganisms in meat plants. MeatProcess.Conf., 42.

# أثر خطوط الإنتاج وبيئة المصنع على التلوث الفطري لذبائح الدواجن في مجزر الدواجن

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أجريت هذه الدراسة لمعرفة أثر خطوط الأنتاج وبيئة المصنع على التلوث الفطري لذبائح الدواجن في أحد مجازر الدواجن بمحافظة الغربية – مصر.حيث تم أخذ مسحات من جلود ذبائح الدواجنفي النقاط المختلفة لخطوط الإنتاج خلال خمسة أيام.وفي نفس الوقت تم تجميع مسحات من بيئة المصنع في نفس الفترات السابقة من الوحدات المختلفة للمجزر وذلك بغرض فحص الفطريات.وقد أفاد التحليل الإحصائي للنتائج عن وجود زيادة معنوية في العد الكلي للفطريات والخمائر المعزولة من ذبائح الدواجن بعد عمليات الذبح والترييش ونزع الأحشاء الداخلية، بينما أدت عمليات السمط والشطف بالمياه إلى نقص معنوي للتجمعات الفطرية في ذبائح الدواجن، ولكن لم تظهر أي أثار جوهرية في أعداد الفطريات بذبائح الدواجن بعد تبريدها بالمياه. وقد أفادت النتائج أن التغيرات الجوهرية في أعداد الفطريات لذبائح الدواجن قد ظهرت بعد عمليات تجميد الذبائح التى أدت إلى نقص ملحوظ في العد الكلي للفطريات والخمائر (٢,٨٧ لوج خلية /سم٢ ) في حين أدت عمليات التقطيع والتجزئة لذبائح الدواجن إلى زيادة ملحوظة في أعداد تلك الفطريات ( ٤,٨٦ لوج خلية /سم٢). وبالنسبة إلى مدى انتشار التلوث الفطري بين ذبائح الدواجن والنقاط الحرجة لخطوط الإنتاج أو بيئة المجزر في الوحدات المختلفة قد أوضحت النتائج أنه تم عزل بعض أنواع الفطريات من ذبائح الدواجن وكذلك أسطح بيئة المصنع أو خطوط الإنتاج في نفس المرحلة حيث كانت أهم الأنواع المعزولة من تلك الذبائح هي أسبرجلس نايجر وأسبرجلس فلافس وكلادوسبوريم والبنسليوم والترناريا والفيوزريم وكانديدا البيكانز.

وقد خلصت الدراسة إلى أن المجازر الحديثة لتجهيز ذبائح الدواجن قد أدت إلى نقص ملحوظ في مستوى التلوث الفطري في المنتج النهائي لذبائح الدجاج وعلى العكس فان مستوى التلوث الفطري في مجزءات وقطعيات تلك الذبائح كان أعلى من المتوقع . علاوة على ذلك تبادل التلوث بالفطريات والخمائرمثل أسبرجلس نايجر وأسبرجلس فلافس بين ذبائح الدواجن والبيئة المحيطة كان شائعا وتكرر حدوثه أثناءالإنتاج ولذلك تلزم دراسات أخرى للحد من هذا التلوث أثناء عملية التصنيع. كما يمكن تفادى التلوث بتنفيذ ممارسات التصنيع الجيدة والتدريب الفعال لعمال المجزرعلى النظافة والسلامة وتأكيد الجودة.