

## Microbiological Quality of Poultry Meat on the Meknès Market (Morocco)

Chaiba A.<sup>1</sup>, Rhazi Filali F.<sup>1\*</sup>, Chahlaoui A.<sup>1</sup>, Soulaymani Bencheikh R.<sup>2</sup> and Zerhouni M.<sup>3</sup>

<sup>1</sup> Department of biology, College of sciences, Moulay Ismail University. BP 11 201. Zitoune Meknès. Morocco

<sup>2</sup> Anti Poison Center, BP 6671.Rabat institutes, Madinat Al Irfane- Morocco

<sup>3</sup> Laboratory of Epidemiology and hygiene, Delegation of Public health, Meknès. Morocco

**Abstract:** This paper presents an investigation of the microbiological quality of poultry meat on the Moroccan market. A total of 96 samples of chicken meat were collected from retail outlets (popular market, artisanal slaughterhouses, poulterers' shops and supermarket) in Meknes (Morocco). The level of microorganisms on chicken carcasses was assessed using the excised breast-skin technique. Levels of mesophiles, coliforms, *Escherichia coli* and *Staphylococcus aureus* on carcasses from popular market and artisanal slaughterhouses were significantly higher ( $P < 0.05$ ) than in poulterers' shops and supermarket. On the basis of the CNERNA "Centre Nationale d'Etudes et de Recommendations sur la Nutrition et l'Alimentation" Standards, 24 % of the samples from popular market and 16 % from artisanal slaughterhouse were also regarded as being of unacceptable quality. The main reason for the lack of acceptability was excessive counts of mesophiles and coliforms. Three classes of retail outlets have also been put into evidence differing from each other in terms of hygienic conditions in the slaughtering and sale of poultry meat.

**Key words:** Chicken, Market, Microbiological quality, Microbial counts, Morocco, Poultry, retail outlets

\* Corresponding author. mailing address: Department of biology, College of sciences, Moulay Ismail University BP 11 201. Zitoune. Meknès. Morocco, Tel: +21264488238, E-mail: [abchaiba@yahoo.fr](mailto:abchaiba@yahoo.fr)

### Introduction

In recent years, foodborne infections and intoxications have assumed significance as a health hazard. Epidemiological reports suggest that poultry meat is still the primary cause of human food poisoning (Mulder, 1999). Poultry meat is more popular in the consumer market because of advantages such as easy digestibility and acceptance by the majority of people (Yashoda *et al.* 2001). However, the presence of pathogenic and spoilage microorganisms in poultry meat and its by-products remains a significant concern for suppliers, consumers and public health officials worldwide. Bacterial contamination of these foods depends on the bacterial level of the poultry carcasses used as the raw product, the hygienic practices during manipulation and on the time and temperature of storage (El-Leithy and Rashad, 1989). Mesophiles, psychrotrophs, coliforms, *Escherichia coli* and *Staphylococcus aureus* have been used in poultry products to assess microbiological safety and sanitation conditions during processing and keeping quality of product (Bean and Griffin, 1990). To satisfy the requirements of consumers in protein animal, the production of poultry meat shows an upward trend in Morocco. However, the control and inspection during production, storage and distribution are generally rare. Therefore, it is important to prevent the hazards and to provide a safe and wholesome product for human consumption (Singh *et al.*, 1984).

This study was designed to evaluate the bacteriological quality of chicken meat and to compare the level of contamination of four groups of chicken carcasses (from popular market, from artisanal slaughterhouse, from poulterers' shops and from supermarket) in Morocco.

### Materials and Methods

**Sample.** Ninety-six samples of chicken breasts with skin were collected from retailers, of which 24 samples were from popular market, 24 from artisanal slaughterhouses, 24. Table 1. Bacterial counts ( $\text{Log}_{10}$  cfu/g) found in retail chicken outlets (n = 96)

	Samples from Popular market	Samples from Artisanal slaughterhouses	Samples from Poulterers' shops	Samples from Supermarket
Mesophiles	$6.18 \pm 0.55^a$	$6.14 \pm 0.69^a$	$5.42 \pm 0.33^b$	$4.74 \pm 0.34^c$
Psychrotrophs	$4.48 \pm 0.27^a$	$4.36 \pm 0.30^a$	$4.07 \pm 0.34^b$	$4.02 \pm 0.35^c$
Total Coliforms	$4.64 \pm 0.53^a$	$4.60 \pm 0.44^a$	$3.99 \pm 0.37^b$	$3.54 \pm 0.27^c$
Fecal Coliforms	$3.89 \pm 0.42^a$	$3.61 \pm 0.40^a$	$3.10 \pm 0.46^b$	$2.34 \pm 0.50^c$
<i>Escherichia coli</i>	$2.34 \pm 0.5^a$	$2.32 \pm 0.36^a$	$1.81 \pm 0.45^b$	$0.70 \pm 0.34^c$
<i>Staphylococcus aureus</i>	$2.43 \pm 0.49^a$	$2.42 \pm 0.42^a$	$1.87 \pm 0.79^b$	$0.68 \pm 0.72^c$

Values in table are mean  $\pm$  SE.

Averages in rows followed by the same letters are not significantly different ( $P > 0.05$ ).

from poulterers' shops and 24 from a supermarket in Meknes (centre-south Morocco). Each sample was placed in a separate sterile plastic bag. Samples were transported to the laboratory immediately after collection in an ice chest and tested upon arrival or stored at 2°C for no longer than 4 h.

**Microbiological analysis.** A 25 g sample of skin was taken aseptically by scalpel excision and stomached in a sterile stomacher bag containing 225 ml of peptone water (PW, Oxoid Ltd., Hampshire, England) for 2 min. Decimal dilutions were carried out using the same diluents.

Mesophiles and psychrotrophs were determined using plate count agar (Oxoid Ltd.) spread plates incubated at 30°C for 72 h. For enumeration of coliforms, the pouring plate technique was used. Desoxycholate Lactose Agar (45–50°C) was poured into 0.1 ml of inoculum. The plates were incubated at 37°C for enumeration of total coliforms and at 44°C for enumeration of fecal coliforms for 24 - 48 h. All typical colonies (red colonies) were counted.

*Escherichia coli* was isolated and enumerated using MacConkey's agar with crystal violet and eosin methylene blue (EMB) agar (37°C, 24 - 48 h). Colonies on MacConkey's agar were small, round and pink, whereas colonies were round with a typical metallic sheen on EMB agar. Two to three characteristic colonies were labelled and transferred to nutrient broth for further identification. Microscopic examination was carried. Characterization and identification of organisms was done using various biochemical tests (motility, catalase, indole, methyl red, Voges Proskauer test, urease, nitrate reduction, gelatin liquefaction, acid and gas from carbohydrates).

*S. aureus* was determined by the spread plate method using Baird-Parker agar with egg yolk tellurite emulsion (Oxoid Ltd.). The plates were incubated at 37°C for 48 h. In order to determine *S.aureus* counts, random isolates from suitable plates were picked, purified and tested for gram stain, catalase activity, modified oxidase test, coagulase

activity and thermo-stable nuclease activity (Lancette and Tatini, 1992).

The data were transformed to  $\log_{10}$  cfu/cm<sup>2</sup> so as to enable a true comparison of the different counts reported by other authors with that determined in this study. Therefore, studies were carried out to relate the weight with the surface of the chicken skin. It was found that 1g of skin corresponded to an average of 6.56 cm<sup>2</sup> of skin. The following equation was used:  $\text{Log}_{10}$  cfu/cm<sup>2</sup> skin =  $\log_{10}$  cfu /g skin -  $\log_{10}$  6.56

**Statistical analysis.** To compare the  $\log_{10}$  values of microbial counts, the data were analysed using Student's t test for each type of micro-organism. The data from the different retail outlets were combined to compare the microbial loads according to the type of outlet (popular market, artisanal slaughterhouses, poulterers' shops and supermarket). Significance was determined at the 5% level.

## Results

Table.1 shows average counts ( $\log_{10}$  cfu/g) depending on the retail outlets of all the microbial groups studied. The grouping of 96 chicken carcasses according to the degree of contamination can be seen in Fig. 1.

Counts of mesophiles (Fig. 1.a) in samples purchased from popular market and artisanal slaughterhouses ( $6.18 \log_{10}$  cfu/g or  $5.37 \log_{10}$  cfu/cm<sup>2</sup> and  $6.14 \log_{10}$  cfu/g or  $5.33 \log_{10}$  cfu/cm<sup>2</sup>, respectively) were similar to those noted by Fliss *et al.* (1991). These authors found counts of  $5.25 \log_{10}$  cfu/cm<sup>2</sup> chicken skin. The contamination level (6.5 to 6.6  $\log_{10}$  cfu/g) detected by Abu-Ruwaida *et al.* (1994) was also higher than the ones described in this paper. On the other hand, mean contamination levels lower than ours were obtained by Johnston and Tompkin (1992) in fresh chicken carcasses in the United States: 2 to 4  $\log_{10}$  cfu/cm<sup>2</sup>.

Average counts of mesophiles in samples purchased from poulterers' shops and supermarket (4.74 log<sub>10</sub> cfu/g or 3.93 log<sub>10</sub> cfu/cm<sup>2</sup> and 5.42 log<sub>10</sub> cfu/g or 4.61 log<sub>10</sub> cfu/cm<sup>2</sup>

respectively) are similar to those obtained by Mead *et al.* (1993), and by Izat *et al.* (1989). These authors found

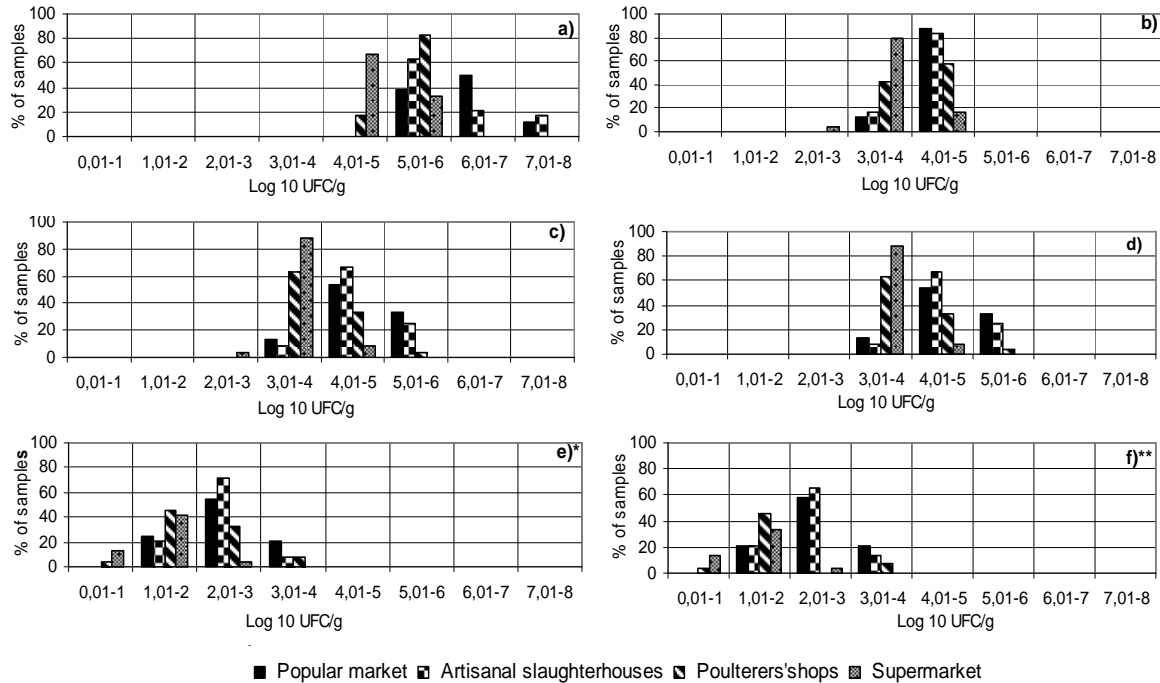


Figure 1. Distribution of microbial counts in poultry meat by outlets.

a) Mesophiles; b) Psychrotrophs; c) Total Coliforms; d) Fecal Coliforms; e) *Escherichia coli*; f) *Staphylococcus aureus*

\* *Escherichia coli* was not detected in 9% of samples collected from poulterers' shops or in 42% of samples collected from supermarket.

\*\* *Staphylococcus aureus* was not detected in 8% of samples collected from poulterers' shops or in 50% of samples collected from supermarket

counts of 4.4 to 5.3 log<sub>10</sub> cfu/g and of 4.73 log<sub>10</sub> cfu/cm<sup>2</sup> chicken skin, respectively. On the other hand, mean contamination levels lower than ours were obtained by Lillard (1989): 3.71 log<sub>10</sub> cfu/g.

There are no Standards in Morocco referring to the contamination of fresh chicken carcasses. In France, the "Centre Nationale d'Etudes et de Recommendations sur la Nutrition et l'Alimentation" (CNERNA-CNRS, 1996) established a guideline with a maximum level of 5.70 log<sub>10</sub> cfu/g. Taking into account these microbiological criterion, 29 % and 17 % of samples purchased from popular market and artisanal slaughterhouses outlets respectively showed unacceptable contamination level with mesophilic microorganisms (Fig.1).

Psychrotrophic micro-organisms were 4.48 log<sub>10</sub> cfu/g (3.67 log<sub>10</sub> cfu/cm<sup>2</sup>), 4.36 log<sub>10</sub> cfu/g (3.55 log<sub>10</sub> cfu/cm<sup>2</sup>), 4.07 log<sub>10</sub> cfu/g (3.26 log<sub>10</sub> cfu/cm<sup>2</sup>) and 4.02 log<sub>10</sub> cfu/g (3.21 log<sub>10</sub> cfu/cm<sup>2</sup>) in samples purchased from popular market, artisanal slaughterhouses, poulterers' shops and supermarket outlets, respectively (Fig. 1.b). These were similar to those noted by Dennai *et al.* (2001) in fresh beef meat 4.47 and 4.57 log<sub>10</sub> cfu/g. The contamination level

higher than ours was found by Álvarez-Astorga *et al.* (2002): 5.96 to 7.87 log<sub>10</sub> cfu/g of refrigerated chicken parts. On the other hand, our results exceed those that Sofos (1994) considered to be most normal in fresh chicken carcasses: between 1 and 3 log<sub>10</sub> cfu/cm<sup>2</sup>.

The contamination level with total coliforms (Fig. 1.c) of samples purchased from popular market, artisanal slaughterhouses, and poulterers' shops outlets was 4.64 and 4.60 log<sub>10</sub> cfu/g respectively. For fecal coliforms (Fig. 1.d), average counts were 3.89 log<sub>10</sub> cfu/g in samples purchased from popular market and 3.61 log<sub>10</sub> cfu/g in those purchased from artisanal slaughterhouses.

In samples purchased from poulterers' shops and supermarket outlets, total coliforms and *E. coli* counts were also similar to those found by other authors. Gill *et al.* (1997) reported counts of 1.62 to 3.63 log<sub>10</sub> cfu/g and 0.88 to 1.15 log<sub>10</sub> cfu/g for total coliforms and *E. coli*, respectively. Taking into account the CNERNA-CNRS guideline (1996), *E. coli* counts were satisfactory in 100 % of samples.

Average counts of *S. aureus* in samples purchased from popular market and artisanal slaughterhouses outlets were

2.43 and 2.42 log<sub>10</sub> cfu/g respectively (Fig. 1.f). These levels of contamination were similar to those obtained by Álvarez-Astorga *et al.* (2002) in chicken legs. Counts found by other authors are very variable. However, in samples purchased from poulterers' shops and supermarket, *S. aureus* counts were lower than those of other outlets.

On the basis of the CNERNA-CNRS (1996) guidelines, 100%, 92%, 87%, 79% of the samples purchased from supermarket, poulterers' shops, artisanal slaughterhouses and popular market outlets, respectively, showed satisfactory quality. The rest of the samples were considered of the acceptable quality.

As can be seen in Table 1, levels of contamination of samples were significantly ( $P < 0.05$ ) higher in poulterers' shops than in supermarkets, possibly due to the good hygienic conditions in the supermarkets at the time of the previous stages.

In general, microbial counts in chicken samples were similar to those reported by other authors. However, counts of psychrotrophs, *E. coli* and *S. aureus* did not attain the acceptable limits established in the CNERNA-CNRS (1996) guideline for poultry meat. On the basis of this guideline, 24% and 16% of popular market and artisanal slaughterhouses samples, respectively, were regarded as being of unacceptable quality. These percentages are higher than those obtained in samples purchased from supermarket and poulterers' shops. This difference in the level of contamination is due to the inappropriate working conditions in the "artisanal sector". In popular market and artisanal slaughterhouses, slaughtering and sale of chicken meat are done in the same place, which provokes the cross-contamination of the carcasses. Moreover, the carcasses are kept at ambient temperature, which could allow for the multiplication of mesophilic micro-organisms. However, the carcasses are kept at temperatures of around 4°C in the supermarkets and poulterers' shops, which hinders the multiplication of bad competitor micro-organisms at refrigeration temperatures.

Three classes of retail outlets have also been put into evidence: supermarket, poulterers' shops, and artisanal slaughterhouses and popular market, differing from each other in terms of hygienic conditions in the slaughtering and sale of poultry meat.

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