BACTERIAL CONTAMINATION COMPARATIVE ASSESSMENT IN HIGH- AND LOW-CAPACITY SLAUGHTERHOUSE

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Background

The law in force concerning the hygienic production of fresh meat identifies two slaughterhouse typologies: high- and low capacity slaughterhouse (HCS and LCS). The LCS in Italy are allowed to slaughter a maximum of 20 units/week and/or 1,000 units/year. Furthermore, meats obtained in LCS can be only commercialised in national territory, probably in order to their low shelf-life. There are a lot of references on this matter; generally, a lower slaughter rate should lead to a reduction in stress for the workers and may result in better hygiene, but, from an other point of view, the lower dimensions of abattoir could be on the basis of an increase of bio-aerosol. Furthermore the lower technological abattoir level of LCS could cause cross-contamination during the slaughter.

An investigation in the United States (Hogue et al., 1993), showed that high volume of beef slaughter led to a reduction in the total bacteria counts on brisket and ground beef. Also a study carried out in Sweden (Hansson 2001) shows a grater amount of aerobic micro-organisms in beef carcasses slaughtered at low-capacity slaughterhouses.

In spite of the above studies quantified the contamination level of carcasses in relation to volume of slaughter, size of abattoir, technique of skinning and evisceration, there is a lack of quantitative data on influence of hygiene slaughter operation. It is well known that most bacterial contamination of carcass surface occurs during slaughter from a variety of source, such as hides, intestinal contents, contact surfaces and handling by workers (Gill 1996, Snijders, 1989, Snijders et al. 1984). Also airborne bacteria have an important role in carcass contamination; some Authors (Sirami 1989, Rahkio & Korkeala 1997) found association between airborne bacteria and contamination level of beef and pork carcasses. The monitoring of all this parameters is very important to quantify the influence of slaughter processing on bacterial contamination of carcass and to exactly compare the hygienic status of production in HCS and LCS. On this regard quantitative monitoring systems (Giuffrida et al. 1998, Giuffrida et al. 2000, Hudson et al. 1996, Ziino et al. 2000), especially for good manufacturing practices visual inspection, would be very useful.

Objectives

The aim of this work was to compare bacterial contamination level of beef-carcasses produced in HCS and LCS, correlating eventual differences to hygiene processing scores obtained by Quantitative Monitoring System, already used in previous works for beef (Giuffrida et al. 1998), pork (Giuffrida et al. 2000), rabbit (Ziino et al. 2000) carcass production. This in order to characterise bacterial contamination risk in different slaughterhouse typologies.

Methods

Slaughterhouse. The present study was carried out considering n. 5 slaughtering cycles of n. 3 LCSs (A, B and E) and 2 HCSs (C and D). LCSs slaughtered between 350 and 600 cattle/year and were characterised by manual skinning and a collection viscera system (at evisceration) constituted by a movable stainless steel recipient. HCSs slaughtered between 2600 and 3500 cattle/year and had a mechanical skinning system and automated collection viscera system.

Bacterial sampling and analysis. Carcasses samples were taken from 100 cm^2 of the loin and 100 cm^2 of brisket from 25 beef carcasses (5 for each slaughtering cycle), before refrigeration. Sampling was carried out with sterile cotton swabs moinsted with 0.1 % peptone water. Air sampling was carried out using 10 sedimentation plates exposed for 1 hour at various sites of establishment. The bacteriological parameters for each sample were Mesophilic Aerobic Microorganisms Count (APC) (Plate Count Agar, Oxoid, 30°C x 72h), Psycrophilic Aerobic Microorganisms (PAC) (Plate Count Agar, Oxoid, 18°C x 72h), Faecal Coliforms and Escherichia coli Count (Chromocult Agar, Merk, 37°C x 24h), Staphylococci coag.+ (Barid-Parker-agar, Oxoid, 37°C x 48h)

Quantitative Monitoring System (QMS - see tab. 2). It is based on objectification of visual monitoring, through the use of **data** collection related to the size of control. A heterogeneous numerical **Index** (the index specifies the way to do the control by indicating the numerical findings to be collected) is obtained from data and transformed in a homogeneous numerical **Indicator** (from 0 to 1) using the ***curve transformation method***. This is done by placing on abscissa axis of a Cartesian diagram all potential index manifestation and on ordinate axis the related values (from 0 to 1). The values of transformation curve are chosen on the basis of pertinent literature (Gill 1996, Snijders, 1989, Snijders et al. 1984, Hudson et al. 1996).

Furthermore, a homogeneous numerical values for each phase of control ("**Animal status**", "**Skinning**" and "**Evisceration**") was obtained through the "**weighted sum**" of all indicator values correspondent to each phase. On this regard it is necessary to couple a **weight** (from 0 to 1) to every indicator, on the basis of relative hygienic influence of indicator.

Indices, indicators for each phase as well as the weights for each indicator are showed in tab. 2.

Statistical analysis. Statistical analysis were performed with STATISTICA 5.1 for Windows (StatSoft, Inc. – 1996, Tulsa, OK). In particular, in order to evaluate significantly difference among carcass bacteriological data, T. test was performed. Furthermore, Pearson product moment correlation were carried out among all trends data. A multiple regression analysis with stepwise method was also performed using trends of bacteriological data as dependent variable and trends of control phases ("Animal status", "Skinning" and "Evisceration") as independent variables.

Results and Discussion

Means of bacteriological results of carcasses and T. test are shown in Tab. 1, while results of visual inspection for considered phase and index and indicator values are shown in Tab. 2. Found significant differences demonstrate that bacterial contamination of carcasses is not strictly related to slaughterhouse typology but to hygienic characteristics of process. This is also shown by correlation among the trends of APC and Faecal Coliforms of carcasses and the trends of control phases (Tab. 3). Furthermore, the correlations among trends of air bacteriological load (APC and Faecal Coliforms) and hygiene of process as well as the correlation between carcasses contamination and air contamination, show an important influence of hygiene of process on airborne bacteria and, indirectly, on hygiene of carcasses surfaces.

The multiple regression with stepwise method indicates that APC of carcasses is more related to Animals status and Skinning and not to Evisceration, while Faecal coliforms of carcasses are more related only to Animals status.

In conclusion the volume of beef slaughter and technological level of process would be less influent than hygiene of process, however, according to our results (Slaughter cycle E), at LCS low hygiene process levels could affect the carcass hygiene more than HCS.

Pertinent Literature

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Table 1: mean of bacteriological results of carcasses (Log ufc/10 cm^2)

	Slaughterhouse A	Slaughterhouse B	Slaughterhouse C	Slaughterhouse D	Slaughterhouse E
APC	$1,79^{a}$	$1,17^{b}$	$2,43^{c}$	$2,24^{ac}$	$4,01^{d}$
PAC	$-0,19^{a}$	$0,19^{ad}$	$1,01^{aeh}$	$0,87^{bfh}$	$3,18^{cgi}$
Faecal coliforms	$-0,40^{a}$	$-0,51^{a}$	$1,31^{be}$	$0,83^{ade}$	$2,31^{c}$
E. coli	$-1,00^{ac}$	$-1,60^{ac}$	$-0,32^{bc}$	$-1,48^{ac}$	$-0,01^{ad}$
Staph. Coag. +	$0,48^{a}$	$0,54^{a}$	$1,30^{bc}$	$1,19^{ac}$	$2,25^{bd}$

Different letters in the same line indicates a significant difference at $p < 0.05$

Table 2: values of indices, indicators and control phases for each slaughtering cycle. Values of transformation curve and weights are the same for every cycle.

			Values of Control Phases / Indices / Indicators				
	Indicators weights		Sl. A	Sl. B	Sl. C	Sl. D	Sl. E
Animal status			**0,720**	**0,760**	**0,540**	**0,700**	**0,340**
skin lesions		**Indices**	0,042	0,000	0,045	0,000	0,214
	0,4	**Indicators**	***0,900***	***1,000***	***0,900***	***1,000***	***0,400***
hide dirtying		**Indices**	0,278	0,283	0,500	0,367	0,571
	0,6	**Indicators**	***0,600***	***0,600***	***0,300***	***0,500***	***0,300***
Skinning			**0,730**	**0,940**	**0,770**	**0,650**	**0,490**
Handling		**Indices**	3,667	1,000	7,833	2,273	30,000
	0,3	**Indicators**	***1,000***	***1,000***	***0,900***	***1,000***	***0,200***
Contacts hide / carcass		**Indices**	0,000	0,000	1,250	0,727	0,143
	0,4	**Indicators**	***1,000***	***1,000***	***0,500***	***0,800***	***1,000***
Time of skin removing		**Indices**	6,760	1,450	0,330	29,200	4,600
	0,3	**Indicators**	***0,100***	***0,800***	***1,000***	***0,100***	***0,100***
Evisceration			**0,500**	**0,700**	**0,550**	**0,350**	**0,050**
Cutting of viscera		**Indices**	0,167	0,000	0,455	0,100	0,429
	0,5	**Indicators**	***0,300***	***1,000***	***0,100***	***0,300***	***0,100***
Handling		**Indices**	12,750	22,500	4,200	21,875	100,000
	0,5	**Indicators**	***0,700***	***0,400***	***1,000***	***0,400***	***0,000***

Table 3: results of Pearson product moment correlation

	Animal status	Skinning	Evisceration	APC carcasses	Faecal colif. carc.	APC air	Faecal colif. air
Animal status	1	0,7553	0,7902	**-0,957**	**-0,932**	**-0,886**	**-0,959**
Skinning	0,7553	1	**0,9788**	**-0,91**	-0,7983	**-0,908**	**-0,756**
Evisceration	0,7902	**0,9788**	1	**-0,929**	-0,8131	**-0,943**	**-0,755**
APC carcasses	**-0,957**	**-0,91**	**-0,929**	1	**0,9452**	**0,9674**	**0,9348**
Faecal colif. carc.	**-0,932**	-0,7983	-0,8131	**0,9452**	1	**0,9509**	**0,9821**
APC air	**-0,886**	**-0,908**	**-0,943**	**0,9674**	**0,9509**	1	**0,8955**
Faecal colif. air	**-0,959**	-0,7555	-0,7547	**0,9348**	**0,9821**	**0,8955**	1

***Marked** correlations are significant at $p < ,05$*