International Food Research Journal 22(1): 59-63 (2015)
Journal homepage: *http://www.ifrj.upm.edu.my*

Visible contamination in broiler carcasses and its relation to the stages of evisceration in poultry slaughter

[1*]Brizio, A.P.D.R., [2]Marin, G., [2]Schittler, L. and [1]Prentice, C.

[1] *Federal University of Rio Grande - FURG, School of Chemistry and Food – EQA, Rio Grande/RS, Brazil*
[2] *University of Estado de Santa Catarina, UDESC, Pinhalzinho/SC, Brazil*

Article history

Received: 16 March 2014
Received in revised form: 10 July 2014
Accepted: 18 July 2014

Keywords

Broiler carcasses
Contamination fecal
Contamination biliary
Evisceration

Abstract

Research has been conducted to establish a relationship between visible carcass contamination during different stages of evisceration and relating this data to the slaughtering speed, average weight and feed withdrawal period of broiler chickens. For this, a total of 51,500 carcasses were analyzed in two different stages of evisceration: after removal of the viscera package by the eviscerator and after manual separation of the edible giblets. Results showed that the highest incidence of contamination in the evisceration line was fecal and biliary. The figures highlight the need to standardize the weight of slaughtered birds' lots, adapt the capacity/number of employees in the stage of separating edible giblets and adjust the period of birds' pre-slaughter fasting as a measure to reduce the visible contamination levels found in this study.

Introduction

Brazil produced, in 2012, about 12 million tons of chicken meat, becoming the third largest producer in the world and the first in exports (UBABEF, 2013). The opening of foreign markets for Brazilian beef has had great influence on the improvement of systems controlling its quality throughout the production chain (Rodrigues *et al*., 2008). In this context and determined to reduce the number of pathogenic microorganisms associated with processed poultry, the Ministry of Agriculture, Livestock and Food Supply (MAPA) has established, since 2006, a policy of zero tolerance for the presence of visible gastrointestinal and biliary material in broiler carcasses as soon as they enter the pre-cooling system by proceeding to the visual checking of 100% of the carcasses in the stage of evisceration (Brasil, 2006).

During the process of evisceration, the chicken viscera pack is removed from the carcass, when edible and inedible giblets are separated. This procedure must be done to avoid the disruption of the bird's digestive tract and consequent cross contamination (Arsenault *et al*., 2007). The presence of visible gastrointestinal/biliary material on the surface of the carcass must be removed by cutting the portion contaminated, since the affected area may indicate probable points of microbiological contamination (Denadai *et al*., 2002). According to Tsola *et al.* (2008) and Denadai *et al*. (2002), contamination during evisceration not only delays the slaughter process, but also increases the processing cost. Moreover, consumer's health is endangered when the quality control of slaughterhouses is not efficient.

Results published by Russell and Walker (1997), Buhr and Dickens (2001) and Russell (2003) reported percentages between 2 and 34% of visible contamination in broiler carcasses. However, there is currently little information regarding the presence of such contamination in Brazil. This study hence aimed to quantify the prevalence of visible contamination from fecal, biliary and gastric material in broiler carcasses during different stages of evisceration, relating this data to the slaughtering speed, average weight and feed withdrawal period of broiler chickens.

Materials and Methods

Facility features

The study was carried out in a poultry slaughterhouse under Federal Inspection in the state of Rio Grande do Sul, Brazil. The birds slaughtered were the commercial breeds COBB® and ROSS®, of both sexes, aged between 42 and 48 days. The poultry facility features a slaughter volume of 170,000 animals per day, where evisceration is performed automatically through specific equipment at a rate of

*Corresponding author.
Email: *anabrizio@yahoo.com.br*

10,000 carcasses per hour. Following the eventration process by the evisceration machine, the edible giblets are manually separated from the viscera pack by 18 trained employees.

Experimental design

A total of 51,500 chicken carcasses were assessed from July to September 2011. Visual contamination checking was daily performed in 100 consecutive carcasses every 30 minutes of slaughter (time equivalent to the killing of a production lot) in the locations identified in Figure 1: Point 1 - after viscera package removal by the eviscerator and Point 2 - after manual separation of edible giblets.

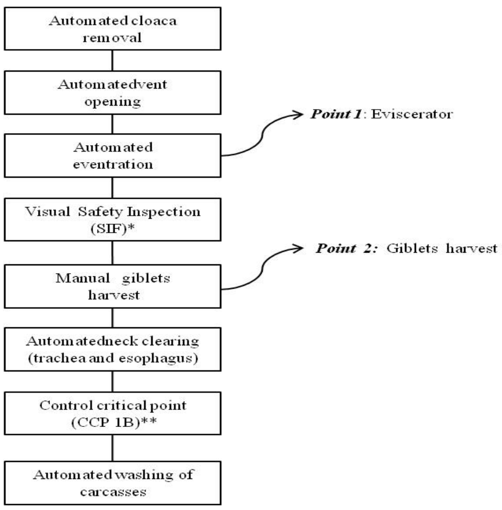

Figure 1. Flowchart of the evisceration process of broiler carcasses with their respective points monitored in this study

* Visual safety inspection of broiler carcasses and viscera by the Federal Inspection Service (SIF).

**Critical point of biological control

To perform visual assessment of carcass surfaces for the presence of contamination by feces, bile and food, it was followed the criteria mandated by the Regulation for Industrial and Sanitary Inspection of Animal Origin Products - RIISPOA (Brasil, 1952). To verify the influence of the operation speed in the incidence of contamination, monitoring was performed in different slaughter capacities (8,000; 8,500 and 9,600 birds/hour in the eviscerator) (Point 1), corresponding, respectively, to 478, 486 and 549 viscera pack/hour in the manual separation of giblets (Point 2). The interference of bird weight and feed withdrawal length in the presence of visible fecal, biliary and gastric content in chickens was also evaluated.

Statistical analysis

In order to observe the behavior of the data, a descriptive analysis using the software Statistica 7.0 was performed. To evaluate the mean values of contamination found at Point 1 (Eviscerator) and Point 2 (Giblets Harvest), and also to compare the effect of slaughtering speed on the incidence of fecal, biliary and gastric material in broiler carcasses, it was used the analysis of variance (ANOVA) and the Tukey test with significance level of 5%. Next, the Linear Regression Analysis was performed to determine the influence of bird weight and feed withdrawal period in relation to the presence of visible contamination on carcasses.

Table 1. Mean percent values for fecal, biliary and gastric contamination analyzed in 51,500 broiler carcasses

	---Means ± Standard Deviation---			
Monitored Points	Fecal (%)	Biliary (%)	Gastric (%)	Total (%)
1	6.00 ± 2.52^{b}	1.45 ± 1.58^{a}	1.90 ± 1.51^{a}	9.35 ± 4.13
2	3.15 ± 1.80^{a}	4.15 ± 2.67^{b}	1.90 ± 1.37^{a}	9.20 ± 3.53

1: Eviscerator. 2: Giblets harvest.

Mean values followed by the same letter in the same line are not significantly different at $p< 0.05$ (Tukey Test).

Results and Discussion

Table 1 shows the average results for visible contamination from fecal, biliary and gastric material found on the surfaces of poultry carcasses evaluated at Points 1 and 2, respectively. Research results show higher values of visible contamination on poultry carcasses when compared to those found in this study (Table 1). Russel (2003) found a maximum percentage of visual contamination of 34.0% in his samples, while Smith *et al*. (2007) reported disruption of the digestive tract during evisceration in 5.5-25.2% of the broiler carcasses evaluated.

Fecal contamination had the highest incidence at Point 1, with a prevalence of 6.0% in the carcasses considered. Tsola *et al*. (2008) and Santana *et al.* (2008) state that disruption of the digestive tract during the evisceration process and consequent leakage of fecal contents is one of the biggest problems faced by industries using automated mechanical evisceration.

At Point 2, the highest mean contamination percentage was 4.2% from biliary content, with least significant difference ($p<0.05$) compared to gastric and fecal material – 3.10% and 1.90%, respectively (Table 1). Different results were found by Jimenez *et. al.* (2003), where higher percentages of fecal contamination (11.3%) were observed for contamination from biliary material (5.2%) at this stage.

Table 2 shows the results for visual contamination in relation to the slaughter speeds analyzed. As Table

Table 2. Mean contamination in relation to poultry slaughtering speed

Speed	Fecal	Biliary	Gastric	Total
	(%)	(%)	(%)	(%)
(birds/hour)		*Point 1 – Eviscerator*		
8,000	6.60^a	1.00^a	4.80^a	10.0
8,500	6.25^a	1.75^a	1.92^a	9.90
9,600	5.98^a	1.45^a	1.87^a	9.30
Viscera packs*/hour		*Point 2 – Giblets harvest*		
478	3.00^a	3.50^a	1.25^a	7.75
486	2.83^a	3.96^a	1.91^a	8.70
549	3.14^a	4.76^b	1.89^a	9.79

*Viscera packs.
Mean values followed by the same letter in the same line are not significantly different at $p< 0.05$ (Tukey Test).

2 shows, at Point 1 there was no significant difference ($p>0.05$) of visible contamination at the slaughter speeds 8,000, 8,500 and 9,600 birds/hour, a result that validates the nominal capacity of the evisceration machine studied in this work (according to the manufacturer: 10,000 birds/hour). Regarding Point 2, it was observed a significant increase of biliary contamination ($p<0.05$) when the speed went from 486 to 549 packs/hour. This result corroborates the view of Barbut (2002) and Rasekh *et al*. (2005), who reports that biliary contamination is influenced not only by the speed of slaughter/number of employees performing this task, but also by these employees' good operational practices.

The average weight of live birds ranged from 2,100 to 3,500 g along the period studied. The scatter plots for visual contamination percentage versus birds' average weight at Points 1 and 2 are shown in Figure 2. Figure 2 (A) shows that the weight gain of birds is linearly increased with biliary and fecal contamination. The regression adjustment to determine the relationship between the variables (R^2) was equal to 0.906 and 0.962, respectively. Concerning gastric contamination, the best adjustment was a parabola, showing no linear dependence between two variables. The data show there is a positive relationship between increased bird weight and the percentage of fecal and biliary content on the surface of carcasses after eventration by the evisceration machine. According to Santana *et al*. (2008), marked variations in the weight of birds complicate the entry of the mechanical extraction system in the abdominal cavity of the chicken, causing intestinal breakage and consequently fecal leakage. Rasekh *et al*. (2005) argue that heavier broilers present higher percentage of visible contamination, since they have less gastrointestinal transit, thus causing an increase

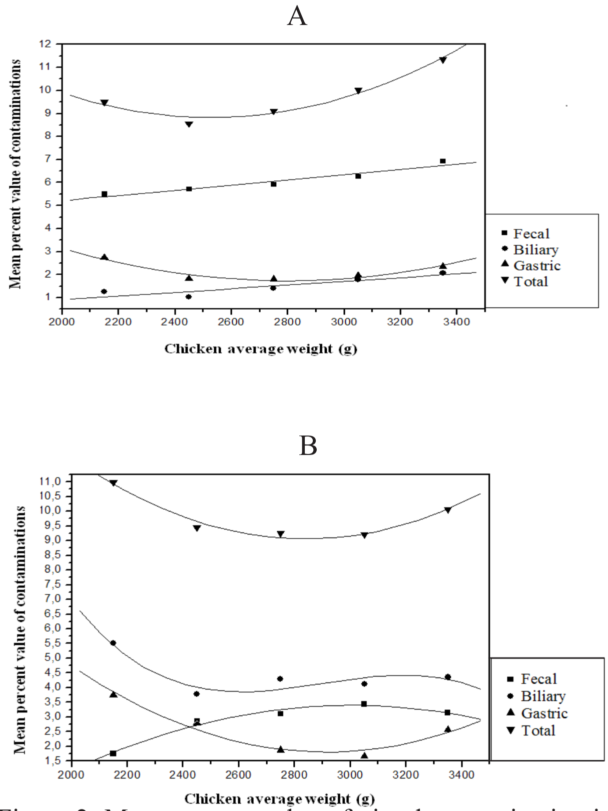

Figure 2. Mean percent value of visual contamination in relation to chicken average weight (a) *point 1 - eviscerator;* (b) *point 2 – giblets harvest*

in fecal contamination in the stage of automatic evisceration.

In Figure 2 (B) it is observed that the percentage of fecal, gastric and biliary contamination during manual separation of the viscera pack shows no correlation with the broiler's weight gain. Broilers were fasted for 7-15 hours along the study period. The scatter plots for visual contamination percentage versus pre-slaughtering fasting time at Points 1 and 2 are shown in Figure 3. It is possible to observe in Figure 3(A) that during the mechanical process of eventration there was no linear relationship between the presence of visible contamination and the bird's fasting time. However, because of an increase in this feed withdrawal length, a mild reduction of contamination is noticed. Arsenault *et al*. (2007) recommend intervals between 8-12 hours of food withdrawal prior to slaughter. Hence, the digestive tract will be almost entirely clean and the intestines will be still firm, reducing the risk of rupture during mechanical processing.

For Point 2 (Figure 3B), statistical results show that the linear regression models were well adjusted, yielding correlation coefficients (R^2) of 0.878, 0.963 and -0.867 for fecal, biliary and gastric contamination, respectively. Assessing the fecal visible content it is possible to conclude that there was no significant

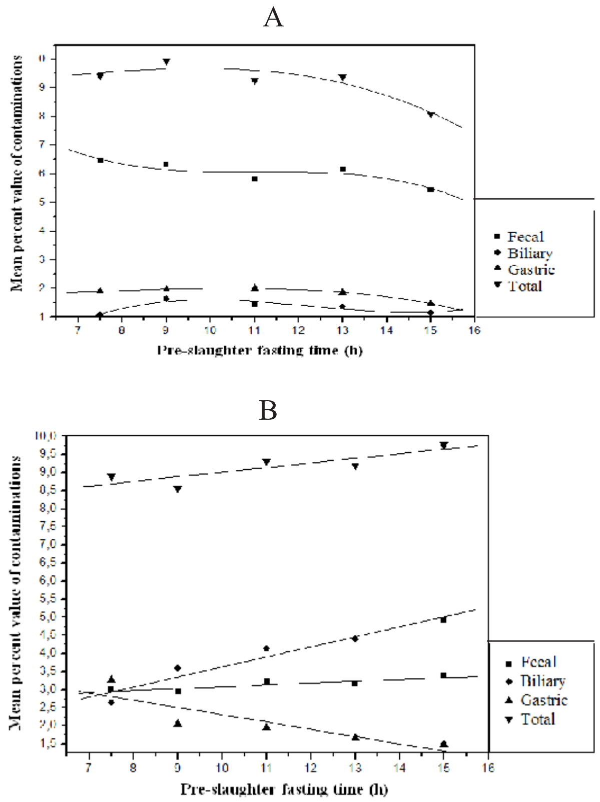

Figure 3. Mean percent value of visual contamination in relation to pre-slaughter fasting time (a) *point 1 - eviscerator*; (b) *point 2 – giblets harvest*

difference between the samples (p<0.05), i.e., the fasting time did not influence the presence of fecal contamination at this stage. On the other hand, with regard to biliary contamination, it was possible to verify that an increase in the fasting time influences the presence of visible biliary content. According to Mendes (2001), this behavior is caused by a dilation of the gall bladder over time, as it tends to break more easily, releasing bile and contaminating the carcass.

Conforming to Arsenault *et al.* (2007), the field problem has been associated with bladder contamination over long fasting periods (longer than 12 hours), after which broilers have a greater gall bladder diameter. Because of this, the gallbladder becomes sensitive and reaches its maximum capacity, provoking the return of excess bile into the liver or into the gizzard and duodenum, causing changes in peristalsis and ultimately contaminating the viscera.

A reduction in gastric contamination in the course of fasting time can be observed in Figure 3(B). This fact is explained by Mendes (2001), who states that feed content is eliminated by broilers over time. As reported by Castro *et al.* (2008), adjusting the fasting period prior to slaughter is essential in controlling the incidence of carcasses visible contamination during evisceration, since in short fasting periods (less than 6 hours) the intestines are full, increasing the likelihood of gastrointestinal contents leakage during evisceration. However, for very long fasting periods (over 12 hours), it is also noticed that the intestines and gall bladder become fragile and the tendency of breakage increases.

In short, the greatest incidence of contamination in the evisceration line was fecal and biliary, with least significant difference (p<0.05) at each monitored point. The results provide support for the development of strategies aiming at a better control of the industrial process, highlighting the need to standardize the weight of slaughtered birds' lots, adapt the capacity/number of employees in the stage of separating edible giblets (maximum capacity of manual separation 500 viscera pack/hour) and adjust the pre-slaughter fasting period of birds for 8-12 hours as a measure to reduce the visible contamination levels found in this study.

References

Arsenault, J., Letellier A., Quessy, S. and Boulianne, M. 2007. Prevalence and Risk Factors for *Salmonella* and *Campylobacter* spp. Carcass Contamination in Broiler Chickens Slaughtered in Quebec, Canada. Journal of Food Protection 8: 1784-1993.

Barbut, S. 2002. Poultry products processing: an industry guide. Boca Raton: CRC, p.420.

Brasil, Ministério da Agricultura e Abastecimento. Decreto nº 30.691/1952. Regulamento da Inspeção Industrial e Sanitária de Produtos de Origem Animal (RIISPOA), 1952.

Brasil, Ministério da Agricultura Pecuária e Abastecimento. Circular n°668/2006. Diretrizes para preparação de Plano de APPCC (HACCP) para o processo de abate de aves, 2006.

Buhr, R.J. and Dickens, J.A. 2001. Crop extraction load and efficiency of crop removal during manual evisceration of broilers: I. Evaluation of stunning voltage and method of bleeding. Journal of Applied Microbiology 10: 71 – 78.

Castro, J.B.J., Castillo, C.J.C., Ortega, E.M.M. and Pedreira, A.M.S. 2008. Feed withdrawal periods in the quality of broilers meat raised in the conventional system. Ciência Rural 38(2): 470 – 476.

Denadai, J.C., Mendes, A.A., Garcia, R.G., Almeida, I.C.L., Moreira, J., Takita, T.S., Pavan, A.C. and Garcia, E.A. 2002. Effect of feed and water withdrawal on carcass yield and breast meat quality of broilers. Brazilian Journal of Poultry Science 4(2): 101 – 109.

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

Mendes, A.A. 2001. Pre-Slaughter Feed Withdrawal in Broiler Chickens. Brazilian Journal of Poultry Science 3(3): 199-209.

Rasekh, J., Thaler, A. M., Engeljohn, D. L. and Pihkala, N.

H. 2005. Food Safety and Inspection Service Policy for Control of Poultry Contaminated by Digestive Tract Contents: A Review. The Journal of Applied Poultry Research 14(3): 603-611.

Rodrigues, A.C.A., Pinto, P.S.A., Vanetti, M.C.D., Bevilacqua, P.D., Pinto, M.S. and Nero, L.A. 2008. Analysis and monitoring of critical points in the poultry slaughter using microbiological indicators. Ciência Rural 38(7): 1948-1953.

Russel, S.M. 2003. The effect of airsacculitis on bird weights, uniformity, fecal contamination, processing errors, and populations of *Campylobacter* spp. and *Escherichia coli.* Poultry Science 82(8): 1326 – 1331.

Russel, S.M. and Walker, J.M. 1997. The effect of evisceration on visible contamination and the microbiological profile of fresh broiler chicken carcasses using the Nu-Tech evisceration system or the conventional streamlined inspection system. Poultry Science 76: 780 – 784.

Santana, A.P., Murata, L.S., Freitas, C.G., Delphino, M.K. and Pimentel, C.M. 2008. Causes of condemnation of carcasses from poultry in slaughterhouses located in State of Goiás, Brazil. Ciência Rural 38(9): 2587 – 2592.

Smith, D.P., Northcutt, J.A., Cason, A., Hilton, JR. A., Buhr, R.J., and Ingram, D. 2007. Effect of external or internal fecal contamination on numbers of bacteria on prechilled broiler carcasses. Poultry Science 86: 1241 – 1244.

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

UBABEF. União Brasileira de Avicultura. Relatório Anual 2012/2013. Acesso em: 28/02/2014. Disponível em: *(http://www.abef.com.br/ubabef/publicacoes_ relatorios anuais.php).*