Analysis of microbiological and chemical quality of poultry meat in the vicinity of the Mbeubeuss landfill in Malika (Senegal)

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Summary

One hundred (100) samples of poultry meat were collected in poultry farms in the vicinity of the Mbeubeuss landfill in the Niayes (Senegal) for microbiological and chemical analysis. Fifty five (54) samples were collected in farms located at less than 1 km of the landfill and 46 samples were collected in farthest farms (more than 1 km from the landfill). Microbiological quality was determined using techniques recommended by AFNOR. Lead and cadmium concentration in poultry meat was measured by flame spectrometry while total mercury was determined by atomic absorption spectrometry.

Three percent (3%) of the samples quality were unsatisfactory for E. coli, 1% for staphylococci and 7% for salmonella. Poor meat quality was found either in farms located less than 1 km of the landfill or in farms located at more than 1

km of the landfill. Except for Salmonella, only meat samples from poultry receiving drinking water from well showed unsatisfactory microbiological quality.

The samples were free of cadmium and lead but were contaminated by mercury. Sixty heigh percent (68%) of the samples contained mercury with the contamination level ranging from 0.7-0.9 mg/kg (48% of the samples) to 0.13-0.30 mg/kg (20% of the samples). No significant difference was found between nearest and farthest farms from the landfill while the source of drinking water seemed to be the main cause of contamination of poultry meat by mercury.

Keywords : microbiological, chemical quality, poultry, Mbeubeuss landfill, Niayes, Senegal

Introduction

In Senegal, modern poultry production is developing due to advantages such as short cycle production, source of revenues and employment, high quality of products. During this last decade meat productions from this sector have increased from 6 672 tons in 1998 to 16 366 tons in 2007 (Gueye, 2008). Poultry farms are mainly located in the periurban area of Dakar where in 1990, 80% of broiler and 90% of layers farms were encountered (Laurent et Msellati, 1990). This concentration of poultry farms around the Senegalese capital arises from the proximity of a major consumption center, airport and port (access to inputs) and the cool and subcananean climate that characterizes the Niayes belt which surrounded Dakar and which is favourable for poultry production (Arbelot et al., 1997).

In this poultry production basin, mainly in the town district of Malika, was created in 1968, the Mbeubeuss landsfill, which collects each year 475 000 t of domestic and industrial wastes from the city of Dakar. Covering a total surface area of 175 ha of land, it presents risks of contamination of the environment (ground and surface water and air) with potential impacts on health for both humans and animals. In developed countries, epidemiological studies have revealed various health problems in human populations living along landfills (Fielder et al. 2000, Elliot et al. 2001, Gilbreath and Kass, 2006). In Senegal, data available on the negative impact of the Mbeubeuss landfill on poultry are relative to poultry products. According to Fofana (2004) poultry meat produced in the Niayes belt is highly contaminated by microbes. Furthermore, a recent study carried out by Pesticide Action Network (PAN) Africa (2005),

showed that eggs produced in the vicinity of the Mbeubeuss landfill are contaminated by dioxins, polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB). Although these data are scarce, disparate and even questionable (only 10 eggs from the traditional poultry production sector were analysed in this last study), they seem to demonstrate that public health concerns could arise from the consumption of poultry products from farms surrounding the Mbeubeuss landfill.

This study was undertaken to analyze the impact of the Mbeubeuss landfill on the quality of poultry meat produced in its vicinity.

Materials and methods

Sampling

This study was carried out from January 2007 to February 2008 in the town district of Malika located in the Niayes, at 40 km from Dakar. For sampling procedure, all poultry farms around the Mbeubess landfill were identified, geo-referenced with a Global Position System (GPS) and characterised throughout a transversal survey and multivariate statistical analysis (unpublished data). One hundred (100) samples of broiler meat were collected from farms of reference of the topology at different distance from the landfill. Fifty four (54) and forty six (46) samples were provided from poultry farms located, respectively, at less and more than 1 km from the landfill. The choice of this distance was made on the basis of previous studies which revealed negative impact of landfills within this distance (Golberg et al., 1999).

Laboratory analysis

All the samples were submitted to the bacteriological analysis while the chemical analysis, given their cost, were carried out on a quarter of the samples.

The bacteriological quality of meat samples was determined according to the NF V 08-052 techniques recommended by the Association Française de Normalisation (AFNOR) (table I).

The chemical analysis carried out were those recommended by AOAC (1975). Lead and cadmium were measured by flame spectrometry while total mercury was determined by atomic absorption spectrometry.

Data analysis

The distribution map of farms around the Mbeubeuss landfill (figure 1) was constructed and the distance between poultry farms and the landfill was calculated using the Arcview package. The Statistical Package for the Social Science (SPSS) was used for the descriptive statistical analysis.

Results and discussion

Microbiological quality of poultry meat

Level of contamination of broilers

On the basis of a three-class clustering (satisfactory, acceptable and unsatisfactory), three percent (3%) of the samples were found to be unsatisfactory for E. coli, 1% for staphylococci and 7% for salmonella (Figure 2). In the absence of multiple contaminations, only 11% of meat samples were considered unsatisfactory when all the 6 microorganism analysed were considered. The microbiological quality of broiler meat produced in the vicinity of the Mbeubeuss landfill is very satisfactory compared to that reported by different authors in Senegal on local and imported poultry products. Musabyerarya et al. (2004), Sakho (1988) and Kane (2002) on imported poultry cuts, showed level of contamination by aerobic flora and E. coli ranging from 45.26 to 100%. According Fofana (2004), whose study concerned only Salmonella spp and E. coli, 77.5% of the chickens produced locally in the Niayes were contaminated. The prevalence of Salmonella observed in this study is higher than that reported by Sakho (1988), Kane (2002) and Musabyerarya et al. (2004), but salmonella are pathogens that are most frequently isolated from poultry farms. Of 904 poultry meat samples analysed in Japan, 50% were positive for this germ (Murase et al., 2001). Poultry is the largest reservoir of salmonella and its dissemination in the meat occurs during the slaughtering procedure (Demerig, 1998; Lahelec, 1988)

Factors of variation of the level of contamination of poultry meat

The comparison of the microbiological quality of the poultry meat on the basis of the distance separating the farms

and the Mbeubeuss landfill showed that poor-quality products are observed in the two types of farms (less and more than 1 km from the landfill). For E. Coli, the proportion of unsatisfactory samples was 3.7% on farms located less than 1 km from the landfill and 2.2% in those beyond (table II). Farms farthest from the landfill showed more contaminated poultry meat for Salmonella and Staphylococci. In contrast, when drinking water was considered (table III), with the exception of Salmonella, which as previously indicated is a fairly common germs in poultry farms, all samples found to be unsatisfactory originated from farms where the well is the source of drinking water.

Chemical quality of poultry meat

Level of contamination

The meat samples studied are free of lead and cadmium although a high level of lead was noticed mainly in the rainy season in the drinking water collected from the well (unpublished results). This is in controversy of results published by Gonzalez-Weller et al. (2006) who reported that meat of different species (cattle, porc, chicken) from the Tenerife Island in Spain contained various levels of lead and cadmium. Total mercury is found in 68%. of the samples with a high level (0.014 to 0.30 mg/kg) in 20% of them.. This level of mercury contamination is higher than that reported in swine (Vos et al., 1986) and in sheep meat (Vos et al., 1988) in The Netherlands, in poultry in the northern part of Poland (Falandysz, 1991), in swine meat in a mining area of China (Feng et al., 2008) and even in Japanese cetaceans (Simmonds et al., 2002). In Sweden, the presence of this heavy metal in the form of traces is revealed in pig meat and was linked to the use of fish meal in pig feed. The high contamination of poultry meat by mercury around the Mbeubeuss landfill is a matter of public health concerns. It could be a proof of the presence of other contaminants (biphenyls, organochlorine pesticides, hexachlorbenzene) as revealed by PAN (2006) in eggs produced around the landfill. In Japan the contamination of whale meat by mercury was associated with that of these contaminants (Simmonds et al., 2002). The risks posed by human exposure to mercury compounds are mainly neurotoxicity in terms of brain and nerve tissue damage and nephrotoxicity. However one should be cautious about our results because methyl mercury which is the toxic form of this heavy metal was not determined in our study. Feng et al., (2008) demonstrated in swine meat that high level of total mercury could however be associated to a low level of methyl mercrury.

Source of contamination

The rate of contaminated meat is higher (26.7%) in the nearby farms (less than 1 km from the landfill) than in farthest farms (11.1%) (more than 1 km from the landfill). However, when the comparison took into account the source of water (Table IV), only chickens from farms where drinking water was from wells showed unsatisfactory chemical quality.

Conclusion

The analysis of the impact of the Mbeubeuss landfill on the quality of meat of poultry in surrounding farms has showed good microbiological quality whatever the localisation of the farm from the landfill. It however revealed a high total mercury contamination of poultry meat which is from well water origin. For a precise appraisal of human exposure to this contamination methyl mercury which is the toxic form of this heavy metal needs to be determined and average daily intake calculated. However for caution, we advocate the connection of poultry production units to the urban water supply network.

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References

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMIST AOAC (1975). Official methods of analysis, 12th Ed. AOAC. Washington, D.C.

ARBELOT, B., FOUCHER, H., DAYON, J.F. and MISSOHOU A. (1997). Typologie des aviculteurs dans la zone du Cap vert au Sénégal. Revue d'élevage et de médecine vétérinaire des pays 50 : 75-83.

DEMERIG, Ch., (1998). Système HACCP et la qualité microbioolgique des viandes de volaille et des ovoproduits. Microbiologie. Alimentaire. (N° spécial)-volailles-œufs-ovoprodiuts.

ELLIOT, P.,BRIGGS, D., MORRIS S., DE HOOGH, C., HURT, C., KOLD, JENSEN T., MAITLAND, I., RICHARSON, S.,WAKEFIELD, J. and JARUP L. (2001). Risk of adverse birth outcomes in populations living near landfill sites. British Medical Journal 323: 363-368.

FALANDYSZ, J. (1991). Mangenese, copper, zinc, iron, cadmium, mercury and leat in muscle meat, liver and kidneys of poultry, rabbit and sheep slaugheterd in the northern part of Poland, 1987. Food Addit. Contam., 8, 71-83.

FENG, X., LI P., QIU G., SHANG, I., JIANG, H., LI, Z. and FU X. (2008). Human exposure to methylmercury through rice intake in mercury mining areas, Guishou province, China. Environ. Sci. Technol., 42, 326-332.

FIELDER, H M P., POON-KING, C. M., PALMER, S R., MOSS N. and COLEMAN G. (2000). Assessment of impact on health of residents living near the Nant-y-Gwyddon landfill site : retrospective analysis. British medical journal., 320, 19-23.

FOFANA, A. (2004). Etude de la résistance aux antibiotiques des souches de salmonella (spp) et de Escheichia coli isolées de la vainde des poulets de chair au Sénégal. Memoire de DEA : Productions Animales, Dakar, EISMV/UCAD, 6.

GILBREATH, S. and KASS, P H. (2006). Adverse birth outcomes associated with open dumpsites in Alaska native villages.Am. J. Epidemiol.,164, 518-528.

GOLBERG, M.S., SIEMIATYCK, J., DEWAR, R., DESY, M. and RIBERDY, H. (1999). Risks of developing cancer relative to living near a municipal solid waste landfill site in Montreal, Quebec, Canada. Arch. Envir Health, 1999, 54: 291-296.

GONZALEZ-WELLER, D., KARLSSON, L., CABALLERO, A., HERNANDEZ, F., GIUTIERREZ, A., GONZALEZ-IGLESIAS, T., MARINO, M. and HARDISSON A. (2006). Lead and cadmium in meat and meat products consumed by the population in Tenerfe Island, Spain. Food additives and Contaminants, 23, 757-763.

GUEYE, B. (2008). Présentation de la filière avicole Sénégalaise. Conférence Internationale sur le renforcement de la compétitivité en aviculture semi-industrielle en Afrique., 5-9 mai 2008, Dakar, Sénégal.

KANE, M. (2002). Contribution à l'étude de la qualité bactériologique des cuisses de poulets importées au Sénégal. Thèse Médecine Vétérinaire, EISMV, Dakar, Sénégal.

LAHELEC, C. (1988). Technologie et hygiène de la préparation de la viande des volailles : leur influence sur la qualité microbiologique, physique et organoleptique (687-697). In : l'aviculture française-Paris : Informations techniques des services vétérinaires ; Rosset R. 816 p.

LAURENT, J. and MSELLATI L. (1990). Développement de l'aviculture au Sénégal : étude péparatoire. Maisons-Alfort IEMT, 133 p.

MURASE, T., DENJYUKO, K ., MAEDA, T., TANAKA, M., SAKAYE, H., MASTUMOTO, Y., KANEDA, Y., ITO, T. and OTSUKI K. (2001). Monitoring of chicken houses and attached egg-processing fcility in a laying farm for salmnella contamination between 1994 and 1998. Journal of Food Protection 64 : 1912-1916.

MUSABYEMARYA, B., SYLLA, K.S.B. and SEYDI Mg. (2004). Niveau de contamination bactérienne des cuisses de poules congelés importés au Sénégal. Revue Africaine de Santé et de Productions Animales 2 : 241-244.

PAN. (2005). Contamination of chicken eggs near the Mbeubeuss dumpsite in a suburb of Dakar by dioxins, PCB_S and hexachlorobenzene: rapport.- Dakar; Pesticide Action Network; Arnika Association.-29 p.

SAKHO, M.O. (1988). Contribution à l'étude de la qualité bactériolgique des viandes de volailles importées congelées au Sénégal. Thèse Médecine Vétérinaire, EISMV, Dakar, Sénégal.

SIMMONDS, M.P. , HARAGUCHI, K., ENDO, T., CIPRIANO, F., PALUMBI, S.R. and TROISI, G.M. (2002). Human health significance of orgnochlrine and mercury contaminants in Japanese whale meat. Journal of Toxicology and Environmental Health 65: 1211-1235.

VOS, G., TEEUWEN, J.J. and VAN DELFT W. (1986). Arsenic, cadmium, lead and mercury in meat, livers and kidneys of swine slaughtered in The Netherlands during the period 1980-1985. International Journal of Food Research and Technology 183: 397-401.

VOS, G., TEEUWEN J.J. and VAN DELFT W. (1988). Arsenic, cadmium, lead and mercury in meat, livers and kidneys of sheep slaughtered in The Netherlands. International Journal of Food Research and Technology 187: 1-7.

Figure 1. Distribution of poultry farms around the Mbeubeuss landfill

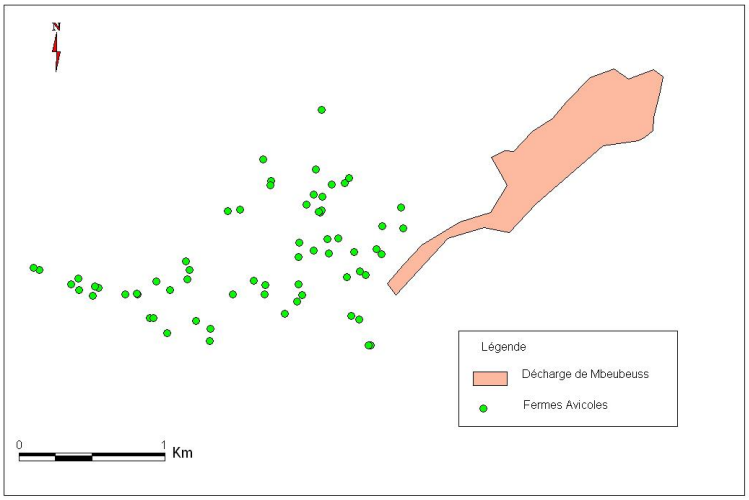

Figure 2. Distribution of unsatisfactory samples of poultry meat for E. coli, staphylococci and salmonella around the Mbeubeuss landfill

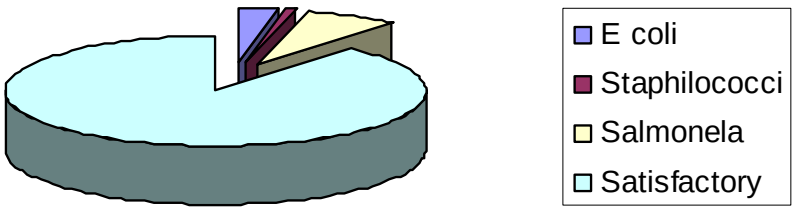

Table I : Microbiological analysis conditions and reference standard

Germs	Medium	Incubation			Normative standard
		Temperature	Time (h)	Atmosphere	
Aerobic bacteria at 30°C	Plate count agar	30°C	48-72	Aerobic	NVF 08-051 (02/1999)
Faecal coliforms	VRBL agar	44°C	24	Aerobic	NVF 08-060(
Escherichia coli	PTX agar	44°C	18-24	Aerobic	NFV 08-053 (12/1993)
Staphylococcus aureus	Baird-parker agar	37°C	48 20/24 24	Aerobic	NFV O8-57 (11/1994)
Clostridium perfringens	Trypticase sulfite neomycin agar	37°C	20 24	Anaerobic	NFXPV 08-61 (10/1993)
Salmonella spp	Rappaport vassiladis agar Selenite-cystine broth Rambach agar Hektoen agar Nnutritive agar	37°C	18-24 48 24	Aerobic	NFV 08-52 (5/1997)

Table II: Effects of the distance between the landfill and poultry farms on microbiological quality of poultry meat

Parameters	Distance between the landfill and poultry farms			
	< 1 km		> 1 km	
	Number	Frequency (%)	Number	Frequency (%)
E. coli				
Satisfactory	50	92.6	44	95.7
Acceptable	2	3.7	1	2.2
Unsatisfactory	2	3.7	1	2.2
Faecal coliforms				
Satisfactory	53	98.1	46	100
Acceptable	1	1.9	0	0
Unsatisfactory	0	0	0	0
Sulfite reducing anaerobe				
Satisfactory	47	87	43	93.5
Acceptable	7	13	3	6.5
Unsatisfactory	0	0	0	0
Total aerobic mesophilic flora				
Satisfactory	42	77.8	36	78.3
Acceptable	12	22.2	10	21.7
Unsatisfactory	0	0	0	0
S. aureus				
Satisfactory	54	100	45	97.8
Acceptable	0	0	0	0
Unsatisfactory	0	0	1	2.2
Salmonela				
Satisfactory	52	96.3	41	89.1
Unsatisfactory	2	3.7	5	10.9

Table III : Effects of the origin of drinking water on poultry microbiological meat quality around the Mbeubeuss landfill

Parameters	Origin of drinking water			
	Well		Urban water supply	
	Number	Frequency (%)	Number	Frequency (%)
E. coli				
Satisfactory	62	93.9	32	94.1
Acceptable	1	1.5	2	5.9
Unsatisfactory	3	4.5	0	0
Faecal coliforms				
Satisfactory	66	100	33	97.1
Acceptable	0	0	1	2.9
Unsatisfactory	0	0	0	0
Sulfite reducing anaerobe				
Satisfactory	65	98.5	25	73.5
Acceptable	1	1.5	9	26.5
Unsatisfactory	0	0	0	0
Total aerobic mesophilic flora				
Satisfactory	59	89.4	19	55.9
Acceptable	07	10.6	15	44.1
Unsatisfactory	0	0	0	0
S. aureus				
Satisfactory	65	98.5	34	100
Acceptable	0	0	0	0
Unsatisfactory	1	1.5	0	0
Salmonela spp				
Satisfactory	62	93.9	31	91.2
Unsatisfactory	4	6.1	3	8.8

Table IV : Effects of the distance between the landfill and poultry farms on chemical quality of poultry meat

Parameters	Distance between the landfill and poultry farms			
	< 1 km		> 1 km	
	Number	Frequency (%)	Number	Frequency (%)
Mercury				
Satisfactory	11	73,3	8	88,9
Unsatisfactory	4	26,7	1	11,1
Lead				
Satisfactory	15	100	9	100
Unsatisfactory	0	0	0	0
Cadmium				
Satisfactory	15	100	9	100
Unsatisfactory	0	0	0	0

Table V : Effects of drinking water origin on chemical meat quality around the Mbeubeuss landfill

Parameters	Origin of drinking water			
	Well		Urban water supply network	
	Number	Frequency (%)	Number	Frequency (%)
Mercury				
Satisfactory	14	73.7	5	100
Unsatisfactory	5	26.3	0	0
Lead				
Satisfactory	15	100	9	100
Unsatisfactory	0	0	0	0
Cadmium				
Satisfactory	15	100	9	100
Unsatisfactory	0	0	0	0