

Managing Meat Safety at South African Abattoirs

R. Govender, D. Naidoo, and E. M. Buys

Abstract—The importance of ensuring safe meat handling and processing practices has been demonstrated in global reports on food safety scares and related illness and deaths. This necessitated stricter meat safety control strategies. Today, many countries have regulated towards preventative and systematic control over safe meat processing at abattoirs utilizing the Hazard Analysis Critical Control Point (HACCP) principles. HACCP systems have been reported as effective in managing food safety risks, if correctly implemented. South Africa has regulated the Hygiene Management System (HMS) based on HACCP principles applicable to abattoirs. Regulators utilise the Hygiene Assessment System (HAS) to audit compliance at abattoirs. These systems were benchmarked from the United Kingdom (UK). Little research has been done them since inception as of 2004. This paper presents a review of the two systems, its implementation and comparison with HACCP. Recommendations are made for future research to demonstrate the utility of the HMS and HAS in assuring safe meat to consumers.

Keywords—Abattoir, co-regulation, food safety, HACCP, meat hygiene.

I. INTRODUCTION

Escherichia coli 0157:H7 emerged as a significant food-borne related pathogen in the United States (US) in 1982, after two outbreaks occurred that same year [1]. Salmonella outbreaks in the United Kingdom (UK) and Canada in 1980 and 1998 respectively, *E. coli* outbreaks in the US, Japan and Scotland and in 1993, 1996 and 1997 respectively [2] raised consumer concerns [3]. Traditional approaches to control by government were no longer working.

Consumer concerns played an important role in shaping trade standards in order to guarantee the safety of imported and exported food products. Governments legislated towards greater ownership of safe food handling at producer, processor and distributor level [4].

The Hazard Analysis Critical Point (HACCP) System favoured much research attention in the early 1990s during its widespread commercial application. It was deemed an effective food safety management system [5]–[7].

Meat is a high-risk food with studies showing a strong correlation between meat consumption and disease outbreaks necessitating improved control [8]. Contamination of meat occurs during processing at abattoirs particularly during

evisceration where gut contents is likely to contaminate exposed meat if incorrect techniques are applied. Other contamination sources include meat contacts surfaces, equipment and even personnel. Managing and assuring the safety of meat, given all these risk variables, require systematic process control at abattoirs. Most governments adopted HACCP-based systems applicable to the meat industry [1]. As part of a co-regulation of food safety control, governments worldwide regulated the mandatory implementation of HACCP-based systems.

II. SOUTH AFRICAN MEAT SAFETY CONTROL

A. Legislative Environment

South African control over meat safety has been influenced first, by the Animal Slaughter, Meat and Animal Products Hygiene Act, Act No. 87 of 1967 [9] which presented requirements to be met by municipal managers of abattoirs. During this time abattoirs were managed by government that employed health officers to ensure the safe processing of meat. During the late 1980's, abattoirs were privatised. Act No. 87 of 1967 was repealed by the Abattoir Hygiene Act, Act No. 121 of 1992 [10]. Act No. 121 of 1992 set out requirements for safe meat processing, animal welfare and abattoir hygiene management. Veterinary expertise by this time was utilised in both state and private control however, both abattoir ownership and meat inspection functions were privatised. State veterinary departments were concerned over declining hygiene conditions at abattoirs nationally [11]. Government repealed Act 121 of 1992 and enacted the Meat Safety Act, Act No. 40 of 2000 [12] in an attempt improve hygiene conditions at abattoirs.

Improvement of safe meat processing and abattoir hygiene management at abattoirs was addressed by provisions made for *essential national standards* in Act No. 40 of 2000. International trends in food safety control strategies leaned towards co-regulation during the 1990s. This approach resulted in the regulation of food safety systems to be implemented and managed by private operators. Most countries regulated the HACCP-based systems. However, in South Africa, Section 11(1)(e) of the Meat Safety Act, Act 40 of 2000 made provisions for the regulation of the Hygiene Management System (HMS) and Hygiene Assessment System (HAS) that was one of eleven *essential national standards* applicable to abattoirs [12].

Requirements for the HMS were then regulated. The HMS requirements were regulated for red meat abattoirs according to the Red Meat Regulations No. 1072 of 2004 [13] and

R. Govender. Department of Agriculture and Rural Development, Veterinary Services, Pretoria, South Africa, doctorate student at the Tshwane University of Technology (email: reuben.govender@gauteng.gov.za).

D. Naidoo. Tshwane University of Technology, South Africa; (email: NaidooD@tut.ac.za).

E. M. Buys. Department of Food Science, University of Pretoria, South Africa; (email: Elna.Buys@up.ac.za).

poultry abattoirs according to Poultry Regulations R 153 of 2006 [14]. Benchmarking similar approaches then used in the United Kingdom (UK), the HAS audit checklist was adapted. Together, these two systems are central in the management and demonstration of meat safety during handling and processing at South African abattoirs.

III. REGULATORY ROLE-PLAYERS IN THE MEAT INDUSTRY

Safe meat production, processing and distribution are managed by two main regulatory entities, the Department of Agriculture, Forestry & Fisheries (DAFF) and the Department of Health (DoH). Meat inspection at abattoirs is presently a privatized function and not in direct control of the state.

The public and private role-players involved in ensuring production and provision of safe meat in South Africa is represented diagrammatically in Fig. 1.

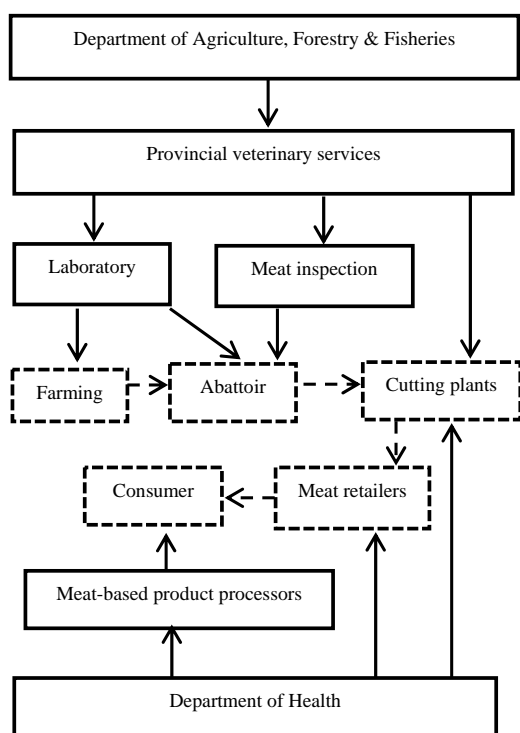


Fig. 1 Meat safety regulatory control in the meat supply chain

The DAFF exercises control over farms and abattoirs. Its primary function is legislation and policy formulation. This is aimed at ensuring standards are developed and consistently implemented in the nine provinces of South Africa. The DAFF is mandate under the Animal Diseases Act, Act No. 35 of 1984 [15] and the Meat Safety Act, Act No. 40 of 2000.

Act No. 35 of 1984 attempts to identify and exclude animals with zoonotic diseases from the food-chain. It also makes provisions for the management of diseases in order to safeguard livestock and is primarily applied at producer level.

Act No. 40 of 2000 mandates the state veterinary services and compels abattoir owners to protect public health in the

safe processing and distribution of meat. Part II, section 1 and sub-paragraph (e) of Act No. 40 of 2000 provides for essential national standards that are to be abided by, implemented and maintained at abattoirs. The powers to legally enforce both Acts and related regulation are given by the DAFF to each of the nine provincial veterinary services branches in each of the nine provinces in South Africa.

Meat inspection and abattoir hygiene management is a contracted function where abattoirs utilize the services of a private contractor. Contractors however, do not have the authority to enforce Act 40 of 2000. Adhering to national standards at abattoirs is the responsibility of the owner. Compliance is verified by inspections and/or audits done by provincial veterinary services personnel.

Once transport vehicles leave the abattoir premises, the DoH thereafter is legally mandated to ensure the safety of meat. This includes transportation between the abattoir and cutting plants or other retail recipient. The Foodstuffs, Cosmetics and Disinfectants Amendment Act, No. 39 of 2007 exercises control over the sale, manufacture, importation and exportation of foodstuffs [16].

Mandated by Act 39 of 2007, the National DoH is responsible for the safety of food. District and metros municipalities enforce the Act for food that is manufactured and sold locally, while the provincial level deals with imported foodstuffs [17].

The DoH presented HACCP regulations in 2003 [18]. The approach was to make these regulations applicable to specific food sectors over time. Presently however, HACCP regulations are legally enforceable at only peanut sorting/grading facilities and peanut butter manufacturers [19]. Fresh meat handling, transportation and further processing facilities e.g. butcheries are not compelled to implement these regulations. Regulation No R 962 of 2012 "General hygiene requirements for food premises and the transport of food" [20] is applicable to transportation and handling of meat outside of abattoirs. Only facilities that have been granted a "certificate of acceptability" in terms of the regulations are allowed to handle and further process meat.

IV. THE HYGIENE MANAGEMENT SYSTEM

In post-apartheid South Africa, trading opportunities opened as international were sanctions lifted. Meat trade with the UK presented a promising opportunity. Due to food safety scares and related disease out-breaks in the UK during the early 1990s, assurance was required from South African abattoirs regarding the safety of meat intended to be exported. A comprehensive HMS was subsequently developed in the mid-1990s. It was not a regulatory requirement and was only applicable to South African abattoirs that wanted to export to the UK. Export abattoirs worked towards HACCP certification. Concerns regarding poor hygiene conditions at abattoirs in general led to the refining of the HMS initially developed for export abattoirs. A refined HMS was regulated for red meat abattoirs in 2004 and poultry abattoirs in 2006.

The HMS is a basic food safety system designed toward macro-monitoring of operating processes at abattoirs. It presents process standards that relates to infrastructure and operating practices. It also provides for quality control measures through the monitoring of specific activities and processes at the abattoir.

The HMS also requires hazard analysis of all abattoir processing and operations. It requires mitigation measures to be planned and documented as part of hygiene programmes within the HMS.

The HMS does not stipulate requirements for micro-monitoring of the final product in relation to physical, chemical or biological contamination. Therefore it does not require testing of meat related to any physical, chemical or biological parameters. The premise of this type of management system is that if all standards are complied with, the likelihood of unsafe meat being processed at abattoirs is significantly reduced [21]. The HMS requirements may be summarised as follows:

- Hygiene Management System:
 - must be documented;
 - control measures or programmes required to monitor identified control points
 - methods of monitoring/checking control points must be defined;
 - records of observations, checks, measurements or results must be kept;
 - sampling programmes for laboratory analyses must be provided;
 - written accounts of decisions relating to corrective actions when taken must be provided; and
 - assess the hygiene status of the abattoir by means of the HAS.
- Document Management System:
 - to retrieve documents relating to an identified slaughter batch;
 - records pertaining to each slaughter batches;
 - a product recall procedure.
- Schematic Plan of Abattoir
 - Flow Diagram of Slaughter Process
 - Potential Hazards
- prepare a list of all potential biological, chemical or physical hazards that may occur at each step of the process;
- consider unacceptable contamination or recontamination
- consider unacceptable survival or multiplication of pathogenic micro-organisms; and
- consider unacceptable production or persistence of toxins.
- Prevention of Hazards:
 - written hygiene management programmes (HMP);
 - to prevent, eliminate or reduce hazards;
 - management programmes for each hazard is implemented;
 - establish critical limits for control points;
 - establish a monitoring or checking system for each control point; and

- prepare written corrective actions and keep records
 - Hygiene Management Programmes (HMP)

Management Programmes (HMPs) are required for ante-mortem inspection; slaughter and dressing; meat inspection; personal hygiene of workers; medical fitness of workers; temperature of water in sterilizers; availability of liquid soap and soap dispensers, toilet paper, and disposable towels; sanitation and continuous cleaning schedule; availability and quality of water; vermin control; waste disposal, including condemned material; contact wrapping and packing materials; maintenance of all equipment and structures; and thermo control.

The HMS is designed to achieve two main objectives, namely, (1) the safe processing of meat and (2) handling and slaughtering of animals in a humane manner. Fig. 2 depicts the implementation of the HMS and HAS.

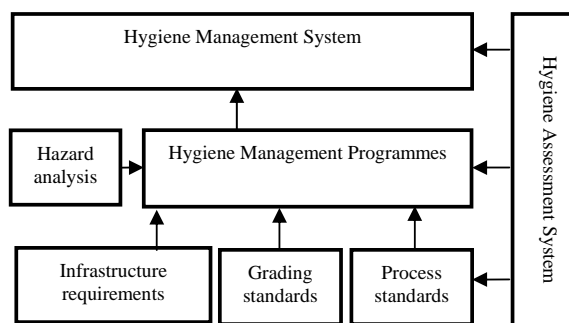


Fig. 2 Implementation of the HMS and HAS

Essentially hazard analysis must be conducted with due consideration process flow and schematic plans. Control measure must be integrated in HMPs. The HMPs themselves are developed with due consideration of grading and infrastructure requirements as well as processing standards. These are documented as part of the HMS. Monitoring must be done based on regulated process measurements as well as monitoring deemed necessary from hazards analysis. The HAS audit may be used to monitor compliance to regulatory requirements including the HMS.

V. THE HYGIENE ASSESSMENT SYSTEM

In 1995, the UK introduced the HAS to monitor abattoirs. It was used to assess the overall hygiene status of abattoirs to see whether they were improving or failing to maintain previously high standards. The HAS provided a final percentage score. A facility complying with all legal requirements would score at least 70 points. The HAS was based on risk assessment but was also subjective in nature. It sought to recognise and promote good hygiene practices at abattoirs and to focus on poor practices towards mitigation (Hudson and Hinton, 1996). Scores were also awarded for the implementation of best practice. This served as a mechanism to encourage owners to exceed compliance to only regulated requirements. The UK HAS was based on five audit

categories namely (1) ante-mortem, (2) slaughter and dressing, (3) personnel and practices, (4) maintenance and (5) hygiene of premises.

Validation studies were conducted on the HAS as a predictor of hygiene conditions at abattoirs in the UK. Research demonstrated that HAS scores were relevant and related to subsequent meat quality [22]. Slaughter and dressing and personnel were strongly correlated to microbiological meat quality [23].

The results of microbiological testing however, were not an established approach when scores were assigned to abattoirs using the HAS.

In January 2006, the HAS was replaced by a scheme that audited hygienic practices and HACCP-based procedures at abattoirs.

TABLE I
HAS CATEGORIES

Category	Weighting	
	Red meat	Poultry
Ante-mortem	0.07	0.05
Slaughter and processing	0.15	0.15
Meat inspection	0.15	0.12
Chilling, portioning, packaging	Not applicable	0.10
Cold storage and dispatch	0.15	0.10
Offal processing	0.03	0.03
Sanitation and pest control	0.10	0.10
Personnel	0.07	0.07
General conditions	0.08	0.08
Structure and maintenance	0.10	0.10
Hygiene Management System	0.10	0.10

The South African HAS was benchmarked from the UK and released in 1999. However, it was not a regulatory requirement and was used by state veterinary departments country-wide to assess abattoirs. The internal assessment of abattoirs using the HAS was regulated in 2004 and 2006 applicable to red and poultry abattoirs respectively. The HAS checklist itself has changed since 1999.

Presently, there are ten weighted categories in the checklist used for red meat abattoirs and eleven for poultry abattoirs. This can be seen in table I. The rationale for weightings assigned to each category is based on the risk that the particular category poses to the contamination of the product. Each category is made up of sub-categories and further assessment criteria. These criteria are based on regulated requirements. An audit of an abattoir using the HAS would yield a conclusion as to the probability of an abattoir producing safe meat.

The HAS is inherently a subjective system that is not informed by microbiological test results on meat. It also does not consider best practices. An abattoir complying with all legal requirements would score at least 100 percent. A sub-category is scored based on compliance to the regulated criteria that it is made up of. Ratings of "excellent", "good", "fair", "poor" and "bad" are associated with specific scores that may differ per sub-category. Each of the eleven categories is given a final percentage rating. Thereafter final percentages are weighted as per table I, to yield a final percentage score.

VI. NATIONAL REGULATORY CONSISTENCY

Veterinary control over abattoirs in the Gauteng province is managed within the IEC/ISO 17020:2012 "conformity assessment – requirements for the operation of various types of bodies performing inspections [24]. Some the objectives of the standard is to facilitate management of inspection work and results such that these results are objective and correct. The standard, in short, makes provision for competence management of inspection personnel, supervision of inspection work and the management of impartiality. Gauteng Veterinary Services has been accredited according to ISO 17020 since 2007 [25].

The DAFF benchmarked technical procedures used within Gauteng's accredited system to develop a national procedure. This was done to facilitate standardization of inspections performed at abattoirs by state veterinary office in the nine provinces, which includes HAS assessments.

The National Abattoir Rating System committee was established in 2008 to develop and facilitate implementation of these procedures. In January 2011 a refined procedure "national abattoir hygiene rating scheme" was implemented. The purpose of this procedure is to standardize the procedures for rating all high and low throughput abattoirs in the country based on the results of the HAS [26]. The NARS procedure also makes provision for a national scheme to award abattoir with high HAS scores. It also makes provisions for branding of the scheme in order to make the public aware of rated abattoirs. It essentially is an attempt towards risk communication to the public. This scheme however is not presently active nationally however; Gauteng organizes a provincial event annually. There is presently little published information pertaining to the work of the NARS committee. The NARS procedure set out requirements to facilitate objectivity of inspection which include:

- conducting HAS audits according to internationally accepted auditing principles;
- holding an opening meeting with owners;
- inviting a representative from the abattoir to witness the audit;
- holding a closing meeting to discuss findings;
- finalize HAS checklists and corrective action reports;
- plan for follow-up audits to verify closure of findings, if necessary.

Scores are based on conditions prevailing on the day of the audit but also taking into account previous inspection findings, as well as documents and records pertaining to the Hygiene Management System.

Non-conformances or findings raised by veterinary officials during audit are categorized as minor, major or critical. A critical non-conformance is defined as a non-conformance with the requirements of the Act or Regulations that will directly influence the safety of the product and therefore cause a serious or imminent risk to public health. Immediate action must be taken and production may be stopped until the problem is rectified. A major non-conformance is defined as a

non-conformance with a high potential to directly influence the safety of the product and where the potential impact is likely to compromise food safety if no remedial action is taken. In this case, the corrective action report at the end of the HAS checklist is completed where a description of the problem is given as well as stipulated completion dates. A minor non-conformance is defined as a low risk situation where there is a non-conformance with the requirements of the Act or Regulations but the potential impact of the non-conformance is not likely to be a serious or imminent risk to the safety of the product.

In the event of progressive non-compliance, a veterinary instruction may be issued for the problem to be corrected within a stipulated period of time. Provisions made by section 9 of the Meat Safety Act provides for legal sanctions in the event of failure to comply with an instruction. The abattoir's registration certificate could also be withdrawn or government could refuse to renew the certificate once expired in the event of non-compliance to instructions.

VII. HMS vs HACCP

The HACCP system is comprised of seven fundamental principles namely, (1) list all hazards, (2) identify critical control points, (3) establish critical limits, (4) establish a monitoring system for each CCP, (5) establish a corrective action system if deviation from critical limits set are identified during monitoring, (6) establish a verification and (7) keep records.

The pre-requisite programmes (PRPs) are developed by an organization as a foundation upon which HACCP plans are developed on. These PRPs include (1) building structure, ablutions, production, distribution, storage, (2) staff and production flow (3) construction of equipment, (4) maintenance programme, (5) cleaning and disinfection/sanitation, (6) pest control, (7) waste management, (8) services needed for production air, water, (9) personnel hygiene programme, (10) product recall and traceability, control of suppliers and (11) training programmes [27]. Therefore implementers of HACCP may use the ISO published ISO/IEC 10330: 2007 standard [28] to develop HACCP plans and the ISO/IEC 10049: 2011 [27] standard to develop PRPs.

Meat regulations provide very specific standards pertaining to *infrastructure*. These help facilitate animal welfare and safe meat processing practices. Depending on the abattoir grade, either high or low throughput, specific *grading standards* are provided. *Process standards* are also provided that apply to abattoirs generally. These three types of standards may be integrated into HMPs that must be developed by owners as part of the HMS. Further, hazard analysis is necessary. Inherent risks to a specific facility must be considered and mitigation measures planned for. These may be addressed in HMPs as well. These hazards and control measures may not necessarily be regulated requirements but have been identified as part of the HMS plan for control. Compliance to standards

set here are part of internal control necessary to ensure the safe processing of meat. The regulated HMPs also contain specific requirements that must be implemented. Process measurements are also stipulated in certain HMP e.g. temperature control. Implementation of HMPs is a similar approach to implementation of PRPs in that they both form a foundation that facilitate safe meat handling and processing practices. The HMS provides for important measures such as control point identification, a documented system, a corrective action system and internal audits using the HAS [29].

The HMS adopts HACCP principles 1, 3, 5, 6 and 7 of HACCP. It does not require the identification of critical control points (CCPs) [principle 2]. In HACCP, we utilise the decision tree to identify CCPs. In the HMS, control points have not been defined. However, critical limits must be identified [principle 4] monitoring is required by the HMS of control points [principle 5].

The five steps to develop a HACCP plan involves (1) assembling a HACCP team, (2) describing the product, (3) identifying the intended use of the product, (4) constructing and confirming a process flow diagram, and (5) on-site confirmation of the process flow diagram. The HMS only provides for the construction of a flow diagram and schematic plans. These are important requirements they serve as input requirements during hazard analysis.

The fundamental difference between HACCP and the HMS is the level of assurance provided in controlling hazards. Control points must have critical limits set and aim to provide more specific control over hazards, which differentiates it from PRPs. However, it is differentiated from a CCP in that it is not necessarily the last step of control to reduce or eliminate a hazard. It therefore provides a subjective "likelihood" assurance on the safety of meat, similar to HACCP-based systems. There appears to be consistency with HACCP and the HMS where integration may possible. Such integration may be useful to those abattoirs who may want to implement HACCP for certification purposes due to consumer pressure.

VIII. STRENGTHENING REGULATORY CONTROL

Co-regulation at farms is not presently followed. Good Agricultural Practices (GAP) used internationally usually incorporate animal husbandry, animal health, animal nutrition, animal traceability – identification, sourcing and records, (5) housing, transport and environmental care as part of fundamental requirements. A well-established voluntary farm quality assurance scheme (Pork360) is administered by the South African Pig Producers Organisation (SAPPO) and contains most of the elements. However, schemes such as these are voluntary and usually applied by well-resourced facilities. Suppliers for the local market are therefore not sufficiently regulated. Holistic control over meat safety is also constrained if adequate control is not managed on farm. In turn it is difficult for segments lower down the supply chain e.g. abattoirs to provide assurances to segments further down e.g. butcheries.

Independence of meat inspection at abattoirs is presently being addressed by the DAFF. It is hoped that one organisation assigned to do inspection nationally would allow independence where certain enforcement powers may be given to inspectors. However, it is important to ensure that clear standards are demarcated for such an entity and where competency management is a key element that must be demonstrated and is auditable.

Meat safety control is a shared responsibility between two government departments. Approaches to meat safety control appear to be streamlining towards farm to fork control with the publication of HACCP regulations. However, the gap to co-regulatory control of meat safety is outside abattoirs is the mandatory implementation of HACCP regulations.

IX. FURTHER RESEARCH

Reference [29] reported that the framework of the HMS and meat safety regulations applicable to abattoirs provides for preventative and systematic control of hazards. Further research is necessary to validate the HMS and HAS through for example microbiological correlation of meat samples with the HMS as a control system and HAS as an accurate predictor of abattoir hygiene.

Studies to demonstrate integration of the HMS and HACCP would greatly assist owners in efficiently and effectively implementing both systems to meet both regulatory and certification obligations.

ACKNOWLEDGMENT

The authors would like to thank the Veterinary Services units at DAFF and Gauteng for their continued support towards research and development in the meat industry. Acknowledgement is made to the Tshwane University of Technology for research funding.

REFERENCES

- [1] G. L. Armstrong, J. Hollingsworth and J. M. Morris, "Emerging foodborne pathogens: Escherichia coli 0157:H7 as a model of entry of a new pathogen into the food supply of the developed world", *Epidemiologic review*, vol. 18, no. 1: 29-51. 1996.
- [2] R. Loader and J. E. Hobbs, "Strategic responses to food safety legislation", *Food Policy*, vol. 24, pp. 685-706. 1999.
- [3] B. M. Hutter, and T. Amodu, "Risk Regulation and Compliance- Food Safety in the UK", United Kingdom: LSE. 2008.
- [4] T. Knowles, R. Moody, M. G. McEachern, "European food scares and their impact on EU food policy", *British Food Journal*, vol. 109 iss: 1 pp. 43 - 67. 2007.
- [5] M. M. Brashears, D. D. Burson, E. S. Dormedy, L. Vavak, S. R. Mcke, W. Fluckey and M. Sanchez, "HACCP Implementation and Validation in Small and very small Meat and Poultry Processing Plants in Nebraska", *Dairy, Food and Environmental Sanitation*, vol. 21, no. 1, pp. 20-28. 2001.
- [6] P. Desmarchelier, N. Fegan, N. Smale, A. Small, "Managing safety and quality in the red meat chain", *Meat Science*, vol. 77, pp. 28-35. 2007.
- [7] J. E. Ehiri, G. P. Morris, and J. McEwen, "A survey Of HACCP Implementation In Glasgow", *International Journal of Environmental Health Research*, vol.7, no. 7, pp. 71-84. 1997.
- [8] J. Hilton, "Reducing food-borne disease: meeting the food standards agency's targets", *Nutrition & Food Science*, vol. 32, no. 2, pp. 46-50. 2002.
- [9] South Africa, "Animal Slaughter, Meat and Animal Products Hygiene Act No. 87 of 1967", Government Printer, Pretoria. 1967.
- [10] South Africa, "Abattoir Hygiene Act, Act No. 121 of 1992", Government Printer, Pretoria. 1992.
- [11] Independent Online, "Just how safe is South African meat?", 14 October 2003, available at: www.iol.co.za/news/south-africa/just-how-safe-is-south-africanmeat-1.113454?ot/4inmsa.ArticlePrintPageLayout.ot# (accessed 5 June 2012).
- [12] South Africa, "Meat Safety Act, Act No. 40 of 2000", Government Printer, Pretoria. 2000.
- [13] South Africa, "Red Meat Regulations, Regulation No. 8056", Government Printer, Pretoria. 2004.
- [14] South Africa, "Poultry Regulations, Regulation No. R 153", Government Printer, Pretoria. 2006.
- [15] South Africa, "Animal Diseases Act, Act No. 34 of 1984", Government Printer, Pretoria. 1984.
- [16] South Africa, "Foodstuffs, Cosmetics and Disinfectants Amendment Act, No. 39 of 2007", Government Printer, Pretoria. 2007.
- [17] Health System Trust, "South African Health Review 2008", Health Systems Trust: Durban.
- [18] South Africa, Regulations relating to the application of the Hazard Analysis and Critical Control Point System (HACCP)", Regulation No. R. 908, Government Printer, Pretoria. 2003.
- [19] South Africa, Regulations relating to the application of the Hazard Analysis and Critical Control Point System (HACCP)", Regulation No. R. 1060, Government Printer, Pretoria. 2009.
- [20] South Africa, "General hygiene requirements for food premises and the transport of food", Regulation No. R. 962, Government Printer, Pretoria. 2012.
- [21] R. Govender and E.M. Genis, "Advancing the Hygiene Management System at red meat abattoirs in Gauteng", *Journal of New Generation Sciences*, vol. 8, no. 1 pp. 64-79. 2010.
- [22] W. R. Hudson, G. C. Mead and M. N. Hinton, "Relevance of abattoir hygiene assessment to microbial contamination of British beef carcasses", *The Veterinary Record*, vol. 139 pp. 587-589. 1996.
- [23] L. V. Alegre and S. Buncic, "Potential for use of hide-carcass microbial counts relationship as an indicator of process hygiene performance of cattle abattoirs", *Food Protection Trends*, vol. 24, no. 11, pp. 814-821. 2004.
- [24] ISO 17020:2012, "General criteria for the operation of various types of bodies performing inspection". 2012.
- [25] R. Govender and T.C. Katsande, "ISO/IEC 17020 accreditation of Gauteng Veterinary Services: a systems approach towards managing food safety in South Africa", *Int. J. Food Safety, Nutrition and Public Health*, vol. 4, nos. 2/3/4, pp.175-195. 2011.
- [26] South Africa, DAFF, "Procedures Manual: National Abattoir Rating Scheme, 1st January 2011", Unpublished. 2011.
- [27] ISO/IEC 10049:2011, "Food Safety Management- requirements for Pre-requisite programmes". 2011.
- [28] ISO 10330:2007, "Requirements for a Hazard Analysis Critical Control Point (HACCP) system". 2007.
- [29] R. Govender, "Continual improvement within South African abattoir Hygiene Management Systems", *The TQM Journal*, vol. 24, iss: 4, pp. 310-325. 2012.