A CRITICAL REVIEW ON THE IMPORTANCE OF THE REQUIREMENT FOR TRACEABILITY IN EU FOOD LEGISLATION (FROM THE PERSPECTIVE OF ADULTERATION OF BEEF MINCED MEAT DURING PROCESSING)

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Abstract
Traceability is the ability to 'track' or 'trace' any food or feed or ingredients used in food production through all stages of processing and distribution. Traceability is a combined system of procedures to trace, follow and identify individual raw materials, product unit or batch through all or part of the steps of production, processing and distribution. It is of great importance to the food supply chain system and plays a major role in the protection of consumer interest, prevents fraud and improves the efficiency of food safety management for the supply chain. Requirement for traceability has been enforced by the EU law and require food producers and retailers to have the system in place as part of their food safety programme. The recent horse meat scandal has put to test the capability and limits of the traceability system that has been in used and suggests the need for a more critical system which will remain effective despite the complexity of the supply chain. Traceability has been considered to be a prerequisite programme that supports building of a strong foundation for the widely known food safety management programme; hazards analysis and critical control system (HACCP). Detailed past, current and future studies and assessments for food traceability in the EU food supply chain has been presented and with particular attention to the control of meat adulteration (intentional or incidental) in the food supply chain.

Keywords: Minced meat, Traceability, Adulteration, Authenticity, Clean-in-place

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1.INTRODUCTION

Protection of consumer rights and the prevention of fraudulent practices, as well as monitoring the adulteration of food are important challenging issues facing the global food chain. The need to safeguard the food chain in the European Union (EU) results for traceability of feed and food which has become a legal requirement for the past decade [Wilhelmsen 2004; European Commission (EC) 2007; Syntesa 2013].
The recent horsemeat adulteration scandal has drawn the attention of the food producers, processors and retailers in the food chain system for the past ten (10) months and this put to test the traceability system of the EU; and an effective traceability was employed to expose the recent adulteration scandal. Article 18 of Regulation (EC) 178 of 2002 makes traceability legal, and it constitutes five major issues. Also, from 1st July 2012, the provisions set out in Regulation (EU) No. 931/2011 regarding the traceability requirements of Regulation (EC) No. 178/2002 in respect to food of animal origin, has become a law. This Regulation gives legal effect to the rapid alert system for feed and food (RASFF) as indicated by the study of Syntesa (2013).
The main objective of this review was to provide an updated review on the importance of the requirement for food traceability in EU food legislation specifically from the perspective of meat adulteration during processing operations; also to suggest how to curb meat adulteration (intentional or incidental) in the food supply chain.

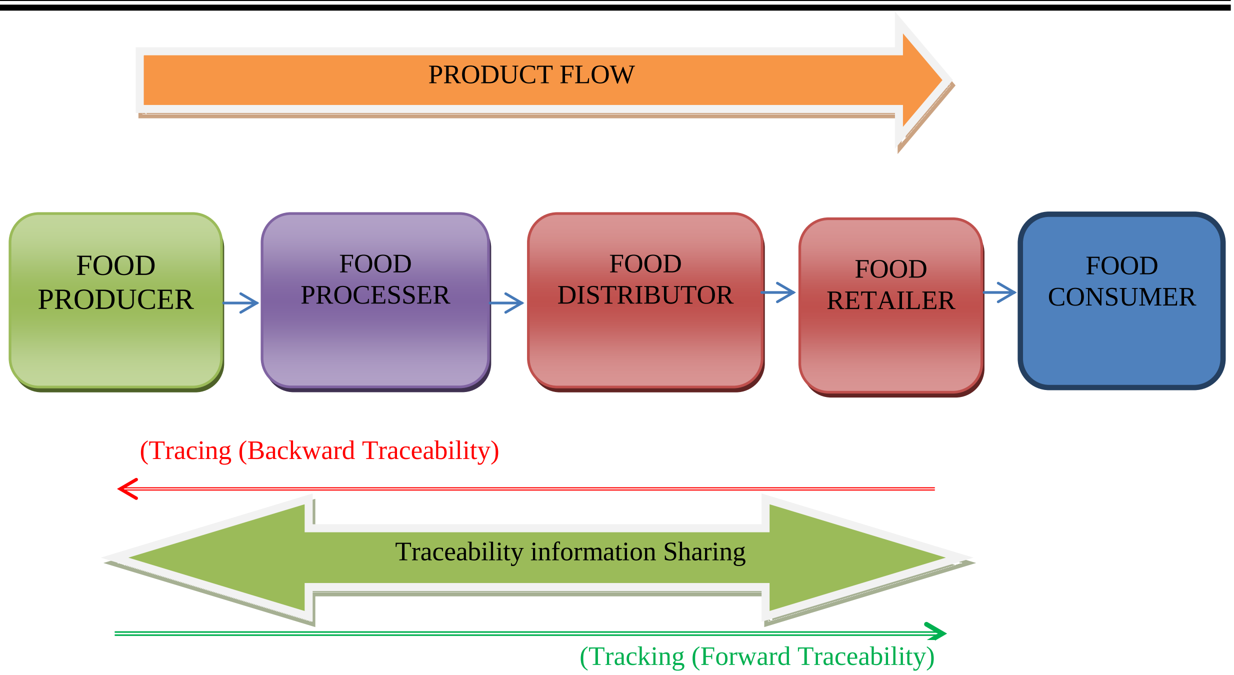

Figure 1: Proposed Model System for Traceability for Food Supply Chain

2. Definition of traceability system

Available definitions by many authors struggled to define traceability as the capability to follow the movement of food or feed of ingredients throughout the supply chain. The two words 'trace' and 'track' had been used haphazardly by some authors. There is the need for a better definition for traceability which should be comprehensive and clear as indicated in Figure 1 (Bosona and Gebresenbet 2013).

The above model in figure 1 clearly defined 'tracing' and 'tracking' as two independent variables that are of significance in the traceability of food, feed or ingredient when the need arises; indicating that traceability could be backward (i.e. ability to trace foods along the chain of distribution on a batch number) or forward (i.e. tracking the source and destination of food products and constituents) (Bosona and Gebresenbet 2013).

2.1 Importance of Traceability

Traceability is an important tool for risk management; it as well plays an excellent role in the protection of consumer and it enhances the efficiency of food supply chain (Bosona and Gebresenbet 2013). Traceability is equally important to identify and verify any risks in the food chain; the food producers can trace food 'one step backward' or 'one step forward' to its origin in order to take immediate and necessary action to prevent the food identified (e.g. a food poisoning case) with such a risk of reaching the final consumers. It also helps to identify and verify food when incident of food-fraud as the case of horsemeat scandal in order to ensure '**Due Diligence Defense**' (NSW Food Authority 2003; Schwagele 2005; Syntesa 2013). 'Due Diligence' can be defined as an act with a certain standard of caution. It can also be defined as the diligence reasonably expected from, and ordinarily exercised by, a person who seeks to satisfy a legal requirement or to discharge an obligation. In a simple term, 'Due Diligence' is the reasonable steps taken by an individual, or an organization to avoid committing an offence against the end-user of a product (Canadian Employment Safety and Health Guide 2012).

The key functions of traceability include assessment of risk in the food chain, verification and control of food origin, effective management of food supply chain, quality control and assurance of food products, and effective communication to the consumers (Coff *et al.* 2008). This which was exhibited by the government and its agencies in the EU during the horsemeat scandal, which was believed to be intentional adulteration to defraud innocent consumers.

2.2 Adulteration of Food and the Recent Horsemeat Scandal

Food adulteration is the addition of substances to food or substitution of food ingredients with inferior substances, with the intent of decreasing the quality and cost of food production and deceiving the purchaser. Adulteration of food could be deliberate (i.e. intentional) or non-deliberate (i.e. incidental). The former refers to the addition of a substance known into food, and the latter implies the introduction of an adulterant into foods without an intention (Wilhelmsen 2004; Dictionary of Food Science and Technology 2005).

The recent horsemeat scandal could be classified as either incidental or intentional adulteration. Adulteration of meat products can occur during unit operations such as the mincing stage, whereby a certain percentage of horsemeat can be added into the mincing machine. The presence of horsemeat DNA in a beef product, such as minced meat (i.e. finely chopped meat) and meat burgers could be considered as intentional adulteration. Also, it could be an incidental adulteration if meats from different animals are processed in the same meat processing plants.

2.3 Authenticity, Traceability and Quality Monitoring of Meat and Meat Products

Meat suppliers and processors should have a vigorous traceability and an authenticity system in place, which is part of the legal requirement in the EU (Syntesa 2013). Several methods to trace meat and meat products include methods such as Protein based, Lipid based, DNA based, Nuclear Magnetic Resonance Spectroscopy (NMR), Mass Spectrometry (MS) based, Infrared Spectroscopy and Near Infrared Spectroscopy (Grundy *et al.* 2012; Bosona and Gebresenbet 2013; Syntesa 2013). Another method used for meat traceability is the stable isotope ratio analysis (Vinci *et al.* 2012).

Also, Sahilah *et al.* (2012) reported that Polymer Chain Reaction amplification of mitochondrial DNA could be used to identify raw horsemeat. Vinci *et al.* (2012) argued that stable-isotope ratio technique could be used to define the 'geographical origin' of food and the production method used in its processing. However, Scotter (1990) reports that Near Infrared Spectroscopy can be used to monitor meat quality production during processing.

2.4 Practical Approach to Prevent Adulteration during Meat Processing

The following practical approach should be put in place during the processing of meat to prevent adulteration:

a) There should be automatic inspection of meat after receipt by computerized checking of the traceability code that was supplied along with to show the origin of the meat including; where the animal was born, fed and slaughtered prior to the mincing operation, and inclusion of tagging and ID technology in the processing and packaging machines to ensure automatic detection and communication during the mincing operation. The system would comprise of printers and barcode scanners using radio frequency identification (RFID); hence Hui (2012) communicates that meat appearance during processing can be determined by computer vision and image processing, which in combination can characterise texture, colour and geometrical properties of meat product.

b) Close-Circuit Television (CCTV) cameras should be mounted in strategic positions within the meat production line and monitored by trained staff; this could help in tracing possible intentional adulteration and a source of reliable information in case of incidence.

c) The meat processing plant would design effective clean-in-place (CIP) system to ensure that incidental adulteration is controlled during processing. See figure 3.

d) The meat processing factory should have separate processing lines for different meat especially where different meats from different animals are processed, and various meat products are produced.

e) A computer aid programme for sampling and testing of meat and meat products should be incorporated into the mincing machine to track adulteration during processing as indicated in figure 2.

2.5 Proposed Model for an Adulteration Prevention and Control Mincing Operation System

There is the need to design a workable model for the prevention of meat adulteration during the mincing process of meat, which should begin immediately after the receipt of meat for processing because Damez and Clerjon (2008) opined that the meat processing plants need reliable meat quality information including tenderness, aroma, juiciness and colour to guarantee high quality meat products for consumers.

Figure 2 presents a simple and practical model that can be employed to ensure the production of 100% minced meat from beef.

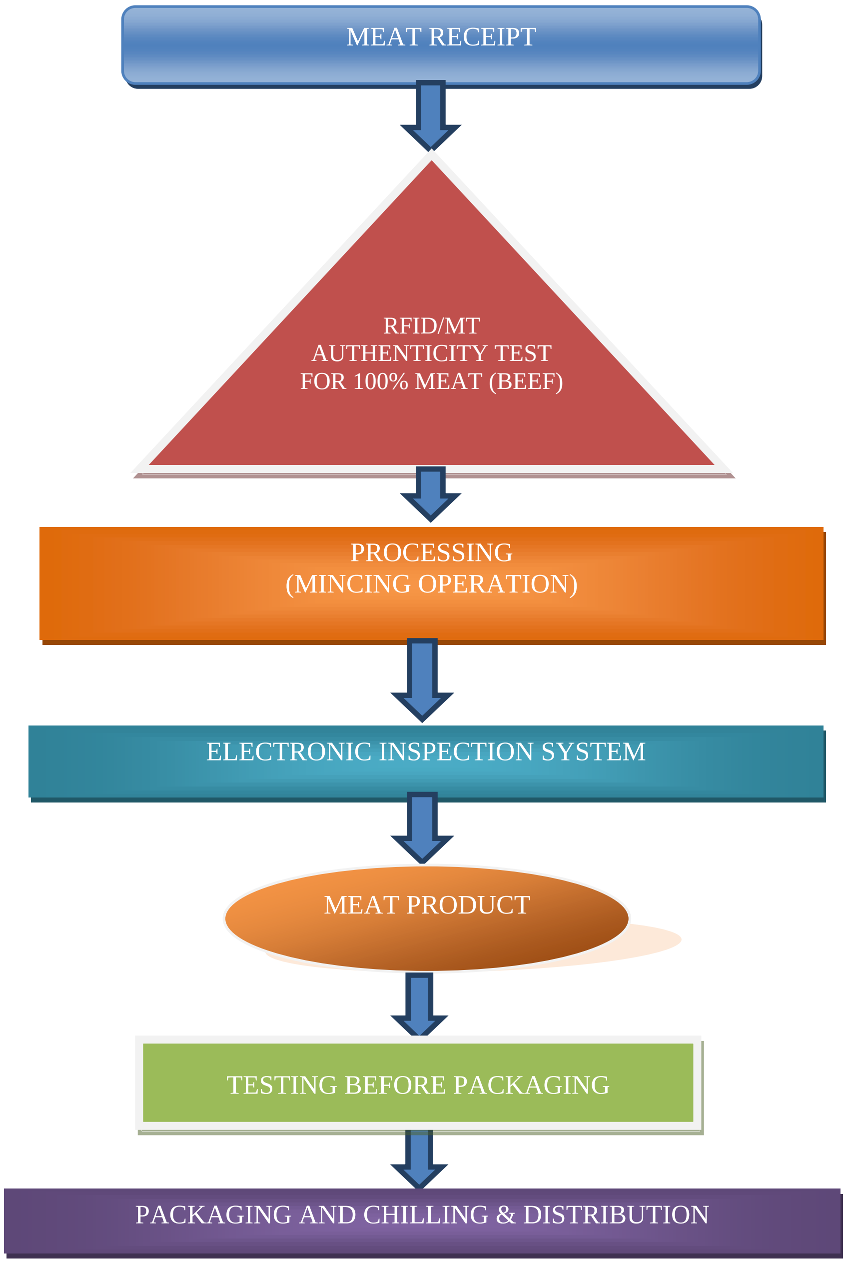

Figure 2: A Practicable Approach for the prevention of Adulteration of meat in Process

Figure 2 shows the receipt of raw meat by the Production Manager (PM). The meat is expected to be verified by the use of RFID and MT (i.e. Molecular Tagging), to ensure authenticity of the supplied Scottish meat showing where the animal was born, fattened and slaughtered. RFID and MT provide verification tagging technology inserted in the meat supplied and receipt with traceability provide by an external label (Hobbs *et al.* 2012). The data would be documented by the PM for record purposes and future referencing.
Also, during the mincing operation an in-built electronic system would be used to monitor incidental adulteration by showing a red light to a process technical monitoring officer (PTMO) whose responsibility is to monitor or stop the process and inform the PM if the red light appears because reliable information about meat quality can be provided during processing by a number of different meat structure assessments either by optical, mechanical, electrical probing or using ultrasonic measurements, electromagnetic waves and Near Infrared (Damez and Clerjon 2008; Damez and Clerjon 2013).
In addition, the possibilities of biosensor-based techniques, such as microarray-based and electronic nose techniques are potential systems for detecting the authenticity of meat products (Kesman and Yetim 2012). Further, before packaging, post rapid testing, as pointed in figure 2, should be conducted on each batch before chilling and distribution, because commercial kit-based detection systems could be used to detect meat adulteration during processing (Kesman and Yetim 2012). This is to ensure that the minced meat is 100% from beef.
However, a situation whereby a meat processing plant uses only one processing line to produce different meat products from different animal flesh, clean-in-place (CIP) system would be the best approach and an alternative to avoid incidental adulteration. This could be assured by thorough cleaning of the line after the production of one product before the start of another.

2.6 CIP System Model for a Meat Processing Plant

Effective and systematic CIP for meat processing plants are essential, especially if it is not possible to use the separate processing production line for different types of meat. Such equipment should be cleaned, sanitised and thoroughly dried between each fresh mincing operation so that incidental adulteration can be prevented and controlled. In other words, each mincing operation should commence after thorough CIP operation is achieved as demonstrated in figure 3. The CIP constitutes of six steps as described by Scurrah (2010) and modified by the authors.

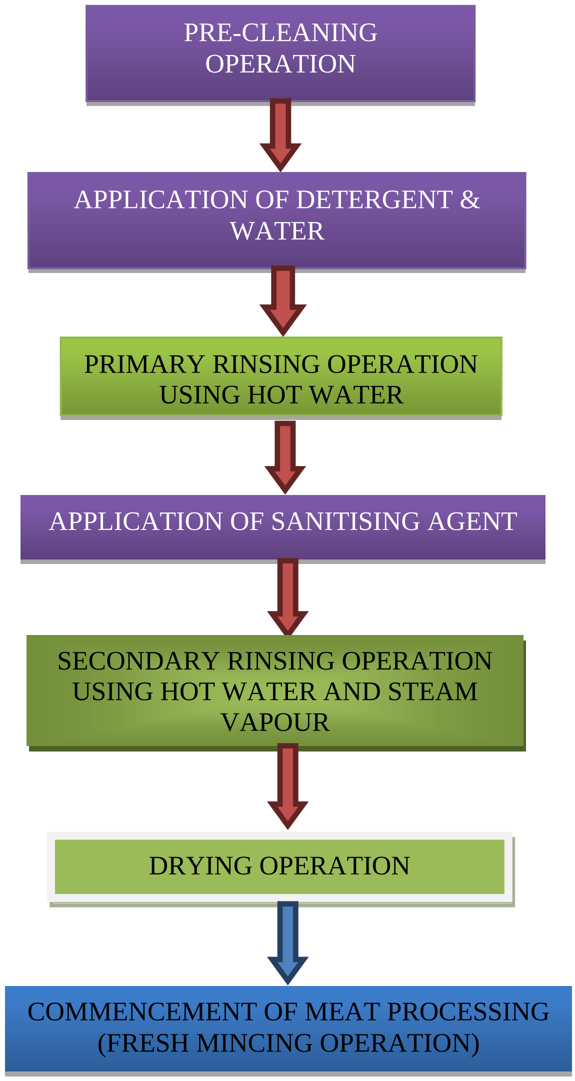

Figure 3: A Model for a Routine CIP Operation between Meat Mincing Operations

Figure 3 presents cleaning operation for meat processing plant to avoid incidental adulteration. Step one of the CIP prepares the surfaces of the equipment for cleaning.

This could be achieved by stopping the mincing machine in preparation for effective cleaning. Step two is the stage that hot water of 82°C and detergent would be used to remove meat pieces, fats and other residues. Step three would be the rinsing stage to flush out meat pieces, fats, other residues and the detergent using hot water as described in step two. This is to provide a dirt-free surface for the sanitiser application. Step four is the stage for the application of disinfectant with a minimum contact time (MCT) of 30-60 seconds.

Furthermore, at step four, application of steam vapour directly onto surfaces of the mincing machine is essential because of the hard-to-reach spots. Step five is the stage for the application of sanitiser such as the Sodium hypochlorite. 100 parts per million chlorine is effective for sanitizing machines in 10 minutes MCT. Step six is the final stage whereby the mincer would be dried by draining and leaving to the air. Hot air would be passed through the mincer for quicker and better drying operation. After achieving the cleaning operation, then fresh meat mincing operation should commence.

3. CONCLUSION

Adulteration of meat products during mincing operation can be controlled by having separate processing lines, and as well as the use of effective CIP schedule could play a positive role in control and prevention of adulteration during meat processing. Staff training is essential to provide the necessary expertise during the mincing and cleaning operations.

The study suggests that sensory quality evaluation method should be developed by the food sensory experts for Beef meat because aroma (i.e. smell) and colour are important attributes for meat identification (Cassens 1994). Trained staff should be responsible to examine batches supplied prior to further processing because Muchenje *et al.* (2008) reported the importance sensory analysis in the evaluation of meat quality; although Jackman *et al.* (2011) argued that experts sensory grading of meat and meat products have essential errors that can be mitigated effectively with computer vision technology that is simple and affordable, although requires some expertise.

There should be the incorporation of fraud risk analysis into HACCP plan. Although this may not necessarily predict fraud, but it would ease handling it; the research of Knaflewska and Pospiech (2007) supported the same view. The provided suggestions and recommendations require further research.

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