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Advances in Science, Technology and Innovation – Relevance for the ACP Meat Industry

Ndlovu, Lindela R

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Introduction

The meat industry in ACP countries ranges from small-scale producers of live animals to large-scale commercial enterprises on the one hand, and simple slaughter poles to sophisticated abattoirs with refrigeration and chilling facilities at the other end of the continuum. The spectrum for meat processing is also similar, ranging from rudimentary operations to sophisticated modern processing plants. At the level of marketing, sales of fresh meat predominate with limited availability of locally processed meats in several ACP countries. Meat mainly comes from ruminant animals (cattle, sheep and goats), and the quality is inextricably linked to the efficiency of the animal production system. However, locally produced pig and poultry meats are on the increase mainly due to growth in smallholder production (Sonaiya, 2007). Improvement in the ACP meat industry requires consideration of the whole chain from conception to consumption (identification and selection of breeds, production, slaughter, processing including new product development, marketing and consumption).

Meat consists of edible muscle, connective tissue and associated fat. It is an important source of high quality protein comprising essential amino acids that can be used to supplement proteins from plant sources, which often lack essential amino acids such as lysine, tryptophan, methionine and threonine (Bender, 1992; Bindraban and Rabbinge, 2004; Wilson et al., 2005). The over-consumption of meat has been associated with some health risks and it is the fatty acids that are of concern (Pisulewski et al., 2005; Webb et al., 1994).

The major attributes of meat are eating quality (appearance, flavour, tenderness, juiciness), nutritional quality (protein, fat, micro-nutrient and mineral content), safety (absence of pathogens and other contaminants), technological quality (water holding capacity, pH-value, protein content and its characteristics, lipid content and its characteristics, connective tissue, anti-oxidant status), storability, and price (Andersen et al., 2005; Webb, 2006). The major challenges for the ACP meat industry are to ensure that meat products meet these attributes. This paper will discuss some of the recent advances in science, technology and innovation (ST&I) and how ACP countries can capitalize on them to address the challenges faced by the industry, especially for those with access to regional and international export markets.

Genetics and animal breeding
Animal breed and genotype contribute to the eating quality of meat (Hopkins et al., 2005) and therefore selection and breeding are important tools in improving this characteristic. Tenderness, an important eating quality, is controlled by a number of loci and it has hitherto been difficult to select for this trait. Advances in molecular biology and gene technologies make it possible to use marker-assisted selection for such traits that are controlled by what is referred to as quantitative trait loci (Cunningham, 2005). Gene technologies can also be used to select for other quality traits such as meat appearance (colour), flavour, juiciness and fat content based on the carcass of offspring. Gene technologies are not widely used in ACP countries because of the limited technological and skills base and the challenge in accessing resources and developing facilities and skills to conduct pioneering research in this field. International organizations such as the Food and Agriculture Organization of the United Nations (FAO) could be useful partners in helping ACP countries to build capacity. Bilateral collaborative research programmes such as that which exists between South Africa and Australia for mapping the genes of South African and Australia indigenous breeds are another route open to ACP countries to acquire the skills and technologies needed for optimizing gene technologies.

**Feeds and feeding**

Meat contains essential fatty acids that cannot be synthesized in the human body (Enser et al., 1998; Singh et al., 2003). Recent advances in animal nutrition have shown that the essential fatty acid profile in meat can be altered through feeding (Dymnicka et al., 2004; Givens, 2005; Pisulewski et al., 2005; Webb, 2006). Thus through the adoption of appropriate feeding strategies, meat can become a functional food. It has been demonstrated that molecular biology and gene technologies have the potential to be used to insert an enzyme that produces the essential fatty acids in livestock (Morimoto et al., 2005). However, meat from gene-modified livestock is a matter that exercises many minds and the international debates regarding this topic are far from disappearing (www.fao.org/biotech/; African Union, 2006).

Feeds from plants that contain tannins produce leaner carcasses and therefore leaner meat (Barry et al., 1986; Nyamambi et al., 2000; Carpenter et al., 2007). In ACP countries, most legumes used for animal feeding such as leueana, cow peas, acacias, are high in tannins. Although abundantly available, they are only used to a limited extent for livestock feeding. The challenge is to increase their utilization, but, this is constrained by the limited research in ACP countries on the effect of these tanniniferous feeds on meat quality (Makgobatlo, 2004; Nyamambi, 2006; Vasta et al., 2007). The emphasis has been on researching anti-nutritional effects of such feeds and the impact on live animal performance (Dube et al., 2001; Hove et al., 2001; Komolong et al., 2001; Halimani et al., 2005). Consequently, there are no systematic research efforts to integrate the legumes into feeding regimes and determine the utility for improving meat quality.

Most meat in the ACP region is marketed in fresh form and it is important that it is kept fresh for a long time. The shelf life or keeping quality of meat is determined by the rate at which its lipids and muscle proteins are oxidized. These oxidative reactions, together with microbial spoilage, are the most important factors in determining the shelf life of meat as they give meat a rancid flavour and an unacceptable colour (Andersen et al, 2005). Dietary supplementation of animals with Vitamin E substantially reduces lipid oxidation (Webb, 2006). Feeds high in tannins also have a potential to greatly reduce the speed of meat spoilage (Carpenter et al., 2007; Vasta et al.,
However, no concerted efforts have been made to take advantage of this evolving scientific knowledge to improve animal production systems to extend the shelf life of fresh meat.

**Pre-slaughter and Slaughtering**

Advances in muscle biology and physiology have demonstrated the role of stress in determining meat quality (Terlouw, 2005). Stress during the pre-slaughter handling and slaughter procedures influence the toughness of meat which is linked to the pH of muscle. The ideal pH of meat is approximately 5.2 to 5.7; depending on species and type of muscle, higher pHs tend to result in dark tough meat with very poor keeping qualities. A fast decline in pH causes toughening of meat and this can be reduced by minimizing stressful conditions such as fighting and poor stunning techniques that cause the animal to struggle and crowding in the slaughter lair. In many ACP countries pre-slaughter animal handling – long distances travelled, slow killing methods, crowding at slaughtering lair - make the animals highly susceptible to stress. Humane handling of animals pre-slaughter and during slaughter is called for in order to improve the quality of meat offered for sale. There is also need to make better use of advances in muscle biology to improve both short-term and long-term stress on animals prior to slaughter.

In most ACP countries slaughtering facilities are generally very rudimentary and need to be improved to meet the minimum food hygiene and safety standards such as those stipulated in Codex Alimentarius. Technological advances in equipment, machinery, facility design and layout and structural construction are beyond the reach of most small-scale meat industries given the high costs and the need for sound technical advice. Local scientists, food technologists and engineers need to improve their technical capacity and provide assistance to meat producers and processors in addressing the requirements for designing and constructing affordable facilities that meet Sanitary and Phytosanitary (SPS) norms that allow local and international trade in safe and hygienic meat.

**Traceability and Food Safety**

The advent of major disease outbreaks (e.g. BSE\(^1\), foot and mouth disease, Avian flu) in recent years has increased pressure on the meat industry to comply with new and stricter standards for animal health and disease control, on the use of drugs and feeds and on the chemical and microbiological profile of meat and meat products. All these present challenges to ACP countries where control or eradication of some diseases such as Foot and Mouth disease would be almost impossible without use of drugs (World Bank, 2005) and where the laboratory infrastructure needs to be upgraded to support the analyses that are needed to ensure compliance of inputs as well as outputs with the international standards. In addition to meeting these food safety standards, animal welfare issues have taken on center stage with some consumers demanding information on how the animal was treated before slaughter. The intensity of the concerns varies across countries and in some this is a minor concern.

These concerns, however, have increased the importance of ensuring the traceability of animal products from farm to plate to ensure compliance with international regulations and avoid destruction of ACP meat exports at the point of entry or loss of high-value markets. Advances in

\(^1\) BSE: Bovine spongiforme encephalopathy or ‘mad cow disease’.
information and communication technologies offer opportunities for transparent and unique tracking, identification and reporting systems (Andersen et al., 2005). However, the costs of implementing traceability and food safety systems such as the Hazard Analysis and Critical Control Point (HACCP) systems put them beyond the means of most producers in ACP countries. Manual systems that identify country of origin, the farm including the genetic stock, feeding and drug regime, processor and distributor including the conditions under which the meat was handled and stored could be instituted at minimal costs. Overcoming the challenges in achieving complete compliance and providing monitoring reports that are in keeping with the standards, requires trained scientists and engineers, skilled human resources, producer and processor awareness training, legislation and certified laboratories.

Conclusion

Advances in ST&I in animal breeding, selection and husbandry, feeds and feeding systems, molecular and muscle biology, gene technology, production and processing equipment, facility design and construction and Information and Communication Technologies provide a basis for the ACP Meat Industry to address concerns that affect the marketability of high quality wholesome meat and meat products. However, the ACP scientific and engineering community must develop the skills base and conduct relevant research and develop technological solutions that address the needs of the meat producers and processors, especially small-holders and small-scale processors to allow them to compete in local, regional and international markets. The ST&I community must also mobilize itself to interact with policymakers to improve understanding of the challenges they face in responding to the needs of the meat industry and lobby for resources to develop the laboratory infrastructure and skills to respond to the challenges. Public-private partnerships and regional and international collaborations also offer hope to the ACP ST&I community to respond to the needs of the meat industry.

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