



## **INDIGENOUS TECHNOLOGIES FOR MEAT PROCESSING AND PRESERVATION IN NIGERIA - A REVIEW**

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### **ABSTRACT**

Nigeria is confronted with food security challenges despite the fact that Nigeria is a country with greater arable land and numerous animals to feed its growing population. However, the country remains the most impoverished in food security as millions of people in Nigeria lack adequate food, especially animal protein for a healthy and active life. There is consequently an urgent need to look for more practical ways to confront these challenges. One of such ways is the promotion and utilization of indigenous knowledge of food processing, preservation and storage. Nigeria is blessed with various types of food produce and animal species. It also possesses diverse indigenous technological systems for processing and preservation of these food products. This article reviewed meat processing methods and efficiency of meat preservation technologies, quality and safety of processed meat products and possible improvement. The meat which is not freely exposed to the sun, and better handling practices would help in developing a fresh meat export trade toward the larger towns in the North and South. Several studies revealed that meat drying, smoking and salting still remains the main methods of meat preservation in Nigeria as over 70% of meats are dried, smoked and salted. The quality of smoked meat from Nigeria has been found to be within acceptable quality limits specific by various regulatory agencies. Meat handling, processing and preservation are reviewed in this article to provide information for improvement of cultured meats management and practices in Nigeria. Consumer protection in this review was considered the major priority before any other consideration.

**Keywords:** Indigenous, Meat, Preservation, Processing, Technologies.

### **INTRODUCTION**

Meat is animal's flesh that is used as food. Meat is considered as the most important and readily available source of animal protein consumed by humans. However, meat is the most perishable of all staple foods since it contains sufficient nutrient needed to support the growth of microorganisms (Okaiyeto *et al.*, 2010). For highly perishable foodstuffs such as fresh red meat, the threat of food poisoning is particularly high (Oluwafemi and Edugbo, 2004). Thus, if food is not immediately utilized or preserved after processing, it spoils. Most often, this means the skeletal muscle and associated fat and other tissues, but it may also affect other edible tissues such as organs. The muscle tissue of healthy living animals is free from micro-organisms (Khumalo, 2017).

#### **Sources of Meat**

In the tropics, the bulk of meat consumed is derived from sheep, cattle, goat, pig, deer, antelope, rabbit, squirrel, rat, elephant, camel and other mammalian animals both domesticated and wild. It is also obtained from poultry, including chickens, turkey, ducks, guinea fowl, geese and meat from other avian and reptilian animals; fish, Cray fish, crabs, lobster and other sea foods; snails and other mollusks and insects. In most developing countries, including Nigeria, fresh meat forms a significant proportion of meat intake (Olaoye and Onilude, 2010). It is either eaten cooked or processed into other forms to avoid associated spoilage. The main causative factor of such spoilage has been linked to unavailability of necessary storage facilities and favourable ambient temperature that usually prevail in developing countries that are in tropical regions (Olaoye *et al.*, 2010).



### **Nutritional Quality of Meat**

Meat is highly nutritious because it contains high biological value protein (Apata *et al.*, 2013). This favours the growth and multiplication of micro-organisms by so doing, making it highly perishable, poisonous and unfit for human consumption when contaminated with microbes (Okonko *et al.*, 2013). To prevent meat loss and ensure its stability and shelf life during the periods of drought when there is excessive slaughter and other periods, traditional methods of meat preservation such as drying of lean meat in natural conditions are often employed to give rise to traditional dried meat products like kilishi, tsire and others that have long shelf life (Igene, 2009; Isah and Okubanjo, 2012). In view of the increasing demand on meat supply it is essential to assess production pattern, problems and the prospect of meat processors using traditional processing methods. There is a demand to improve the processing, preservation and overall quality of Nigerian traditional meat products (Iheagwara and Okonkwo, 2016).

### **Processing and Preservation of Meat in Nigeria**

Preservation and processing methods explore ways by which spoilage are stopped or slowed down to give product a longer shelf life. Processing methods usually change the texture, taste, and physical appearance of the meat (Horner, 2002). FAO (1986) gave three main meat processing methods as drying, salting and smoking. Many meat species have very good preservation qualities after salting, sun drying and even smoking (Singh and Heldman, 2013; Pigott, 2015). Abiodun *et al.*, (2021) reported that the processing of meat by smoking, salting or drying enhances the nutritive value and promotes digestibility of protein reported that meat quality and safety associated with meat products will differ from region to region and habitat to habitat and will vary according to the method of production and processing. Some of the traditional meat processing methods are associated with contamination which may be injurious to consumers. Many researchers have worked on traditional meat processing in Nigeria, Davies (2005) suggested the adoption of appropriate processing technologies that give satisfaction to consumers and equally preserve economical balance. Hama (2023) analyzed the various advantages of adopting solar energy as a means of drying meat traditionally. Akinola *et al.* (2006) also reported different types of meat preservation and processing methods. It has been observed that the most prominent meat preservation method in Nigeria is smoking and drying. This could be as a result of the fact that most of the communities have no access to electricity to preserve and process their products. Bolaji (2005) reported that despite the rudimentary nature of traditional processing methods, the lack of control over the drying rate, sometimes results to under drying or over drying and expose meat to wind, dust, dirt, insect infestation and contaminants such as flies. These methods still remain predominant in Nigeria. Nigeria's high temperature, lack of processing and storage facilities can be responsible for the susceptibility of meat to damage and spoilage. There is therefore enormous waste through spoilage of both fresh and dried meat (Yola and Timothy, 2012). This article aims at reviewing the major traditional methods of meat processing and preservation in Nigeria.

### **BACKGROUND OF MEAT PROCESSING AND PRESERVATION**

Developing countries, including Nigeria, have limited access to meat and meat products because of its high cost (Ito, 2005). This is due to the fact that production and rearing of animals is far below demand and the preservative technology is grossly inadequate, resulting in high perishability of meat and meat products. Due to rapid population within the rural and urban sectors in Nigeria and also due to changes in dietary habit of most Nigerians, the demand for meat is on a constant increase. Meat, however, is a highly perishable food item due to abundance of a number of nutrients that favour the establishment, growth and multiplication of microorganisms. The presence of some of these organisms may render it poisonous and unfit for human consumption (Fonkem *et al.*, 2010). As meat deteriorates very rapidly, man has over the decades developed a number of meat preservation techniques that can maintain its stability and increase its shelf-life while at the same time possessing adequate nutritive value and desirable flavour (Ogbonnaya and Imodiboh, 2009; Apata *et al.*, 2013). One of the ways of preserving meat is postharvest processing. Processed meat is that in which its fresh properties are modified by the use of one or more seasoning, heat treatment or drying (FAO, 2007). Generally, meat is excellent in supplying high quality protein, vitamins and mineral salts (Adeyeye, 2016). Similarly, it has been reported as ideal for the growth of a wide range of spoilage bacteria (May *et al.*, 2003), accounting to a



great extent why it is perishable. In the world today, traditionally processed meat products are consumed in Nigeria, amongst which is the meat delicacy called Tsire, Kundi, e.t.c (Vilar *et al.*, 2000).

### **The Needs for Meat Processing in Nigeria**

Meat is highly susceptible to deterioration without any preservative or processing measures (Okonta and Ekelemu, 2005). Dave and Ghaly (2011) reported that immediately after the meat dies, a number of physiological and microbial deterioration set in and thereby degrade the meat. Meat is a major source of protein and its handling, processing and distribution provide livelihood for millions of people. Appropriate processing of meat enables maximal use of raw material and production of value-added products which is obviously the basis of meat processing, like the processing of the other food raw materials should assure best possible market quality, provide a proper form of semi-processed final product, assure health safety of products, apply the most appropriate processing method and reduce wastes to the barest possible extent. The need to mechanize meat processing techniques has drawn the attention of national agricultural research to devote utmost interest and resources to engineering research in operation, to minimize the drudgery, reduce labour operation and unsanitary and inherent unhygienic handling that are mostly involved in the traditional manual operations. The rationale for meat preservation is primarily two-fold: to prevent or minimize the growth of pathogenic and spoilage microorganisms and to preserve the quality attributes of the meat.

## **MEAT PROCESSING TECHNIQUES IN NIGERIA**

### **Pre-processing**

Pre-processing of meat prepares the raw material for final processing. It is often performed in abattoir and includes such operations as exsanguination, shanking, evisceration, fabrication and washing of the meat (Luten *et al.*, 2006).

### **Final Processing of Meat**

The three basic procedures used in the final processing of meat products are heating, cooking and controlling water activity (by drying). All these procedures increase the shelf life of the meat by inhibiting the mechanisms that promote spoilage and degradation. Each of these procedures also has an effect on the nutritional properties of the final product (FAO, 2005; Luten *et al.*, 2006; Pigott, 2015).

### **Heating**

Heat treatment can significantly alter the quality and nutritional value of meat. Meat is exposed to heat during both the cooking process and the smoking process. Heating meat to an internal temperature above 66°C or 150°F (i.e. pasteurization conditions) is sufficient to kill the most resistant microorganisms (FAO, 2005; Luten *et al.*, 2006; Pigott, 2015).

### **Wet Heating (Cooking)**

Meat is cooked to produce changes in the texture and flavor of the product and to kill pathogenic microorganisms. Its targets the microorganism by killing them at high temperature. The cooking time must be closely regulated to prevent excessive loss of nutrients by heat degradation, oxidation or leaching (the loss of water-soluble nutrients into the cooking liquid) (FAO, 2005; Luten *et al.*, 2006; Pigott, 2015). There are two ways of cooking, Pasteurization and Sterilization. Pasteurization is cooking done between 72°C for 15 seconds though not all microorganisms are killed. In this part elimination of microorganisms is done. Sterilization is divided into dry heat and moist heat sterilization. The products are cooked under pressure at 121°C for 15 minute or 134°C for 3 minutes this eliminates all microorganisms. All the above methods have a danger of re-infestation with the same microorganisms (Montville and Matthews, 2005; Al-Baali, 2006).

### **Controlling Water Activity (by drying)**

Reducing the water activity of meat inhibits the growth of micro-organisms and slows the chemical reactions that may be detrimental to the quality of the meat product. The control of water activity in meat is accomplished by drying methods. The principal methods of drying meat are by air drying and sun drying (FAO, 2005; Luten *et al.*, 2006; Singh and Heldman, 2013; Pigott, 2015). Each of these methods involves adding heat to aid in the removal of water from the meat product. During the initial stages of drying, known as the constant-rate period, water is evaporated from the surface of the product, and the temperature of the product remains constant. In the final stages of drying, known as the falling-rate period, the temperature of the product increases, causing water to move from the interior to



the surface for evaporation (FAO, 2005; Luten *et al.*, 2006; Singh and Heldman, 2013; Pigott, 2015). All meat following slaughter or manufacture loose quality at some rate which is dependent on the initial microbial profile, meat type and composition; formulation (for processed meat), preservation conditions. However, quality loss may be accelerated or minimized at any of the stages and the total perseveration strategy is therefore often multicomponent since one factor/approach is often inadequate (Jay, 1996). Several authors (Okonta and Ekelemu, 2005; Bolaji, 2005; Akinola *et al.*, 2006; Tawari, 2006) reported different types of preservation methods: drying, smoking, freezing, chilling, salting and brining. But the most prominent meat preservation in Nigeria is smoking, drying and salting. According to Ito (2005), preservation is carried out for the purpose of extending the self-life of meat. The major preservation methods are discussed below.

## **MEAT PRESERVATION TECHNIQUES IN NIGERIA**

### **Smoking**

Smoking is commonest traditional method of meat preservation in Nigeria. It combines the effect of the destruction of bacteria by compounds in the smoke, such as phenols and the cooking of the meat, since, high temperatures will be generated. Smoked meat products have long shelf life, which has been attributed to the drying and cooking effects. When wood and charcoal are burnt, smoke is produced as a result of incomplete combustion. The smoke produced depends on the amount of air available (Ibrahim, 2017). As it is frequently seen in meat markets, properly smoked meat products are dark brown in color and are mostly near perfectly dried. This ensures that the shelf life is prolonged, and the products get to the consumer in relatively good state (Tawari and Abowei, 2011). According to Ajewole *et al.*, (2021) in the process of drying and smoking, much of the water content of the meat is extracted through heat thus inhibiting the action of micro-organism and prolonging the shelf life. Smoke therefore combines three main effects; drying, cooking and preservation.

### **Salting**

Salting involves addition of salt to the meat to be preserved. There are four standard methods for salting meat. These are brine, dry, kench and pickle salting methods. In brine salting, the meats are immersed in a solution of salt in water. Where granular salt is rubbed into the surface of meat, the process is referred to as dry salting. Granular salt is also used in kench salting. In this process, the salt is rubbed into the surface of split meat, and the meats are stored with salt placed between each layer of meat. The liquid formed is not allowed to drain off the meat, which will eventually become covered with the liquid. In pickle salting, the meats are packed in watertight containers with salt between each layer of meat. If the pickle formed does not cover the meat within 4 hours, saturated brine is added to the meat so that it becomes immersed by the pickle. Otherwise, the meat may spoil (Tawari and Abowei, 2011; Adeyeye, 2016). In dry and kench salting, the meat is packed, surrounded by dry granular salt. The salt dissolves on the meat surface. The liquid, which exudes from the meat, does not cover the meat thereby exposing surface of the meat to air. It is therefore the practice to keep meat in saturated brine until salt has been rubbed into meat. Otherwise, fat oxidation, discoloration of meat flesh and the development of rancidity ensure (Adeyeye *et al.* 2015). During pickle curing of meat, the large quantity of salt used ensures that the salt is available in sufficient quantity to form the pickle in which the meat is eventually immersed. The meat flesh which now contains blood as well as other compounds in solution reduces fat oxidation and the development of rancidity (FAO, 2002; Tawari and Abowei, 2011; Abowei and Tawari, 2011).

### **Drying**

Drying is defined as the removal of water by evaporation. When applied to meat, drying is the removal of water by any method as a means of meat preservation to prolong the shelf life. The main method of meat preservation transferred by the medieval Arabic sources to West Africa was that of sun drying (Alonge *et al.*, 1981). In areas where sun drying is used traditionally, the effects of wind and weather conditions are important. Basically, the drying effect of the sun depends on the emission of heat from the sun. This is transferred to the meat and it is accompanied by heat transfer within the meat. During drying, the meat shrinks and undergoes irreversible changes. Water is removed from the surface in the following sequence. Firstly, water on the surface of meat evaporates. Water migrates to the surface of the meat from within meat tissues and evaporates. The air surrounding the meat then experiences a drop in temperature. This is accompanied by cooling of the surface of the meat. The energy required to





drive the moisture from the surface of the meat can be obtained from a variety of sources including smoking, sun drying and mechanical driers (Davies *et al.*, 2008). During drying, water is removed from the surface of the meat. As the surface water is removed, it is replaced by water drawn up from the meat tissue, which leaves the meat surface. The rate of drying, consequently, the rate of removal of water is dependent on the air speed, relative humidity and temperature of the surrounding air (Delgade *et al.*, 2003). The surrounding air conditions remain constant. The rate of drying will also remain constant. This stage of the process of drying is referred to as the “constant rate drying”. As the removal of moisture from the meat continues, the drying effect continues. Eventually, the concentration of the moisture at the meat surface falls consequently, the movement of moisture to the surface also drops and the drying rate slows down. This stage is referred to as the “falling rate drying” (Chisomo *et al.*, 2016) and both rates drying are under the influence of numerous factors notably is the relative humidity of the air. If the air is fully saturated with water vapor, drying will not take place. The relative humidity must be less than 100% for drying to occur. It is obvious therefore that the lower the relative humidity, the faster the drying rate. Increased air speed results in faster drying rates (Adeyeye and Oyewole, 2016). Accelerated drying rates may be achieved to increase the surface area. If the environmental conditions, air speed and temperature are conducive, drying is achieved faster (Putra and Ajiwiguna, 2017).

#### **Quality and safety of traditional processed meat in Nigeria**

Several studies (Akhter *et al.*, 2009; Olayemi *et al.*, 2011; Oparaku and Mgbenka, 2012; Aliya *et al.*, 2012) observed that smoking or drying increases crude protein, crude lipid, crude fiber and ash content of meat and meat products, It was also observed that smoking contains pyrolygneous acid which may have an added preservative effect on smoked dried meat. (Akhter *et al.*, 2009).

Omojowo *et al.* (2010) reported that, 5 per cent concentration salt was able to keep the meat to ICMSF (1986) standard good quality till the sixth week by reducing the microbial load. Hence, they agreed that 5 per cent Sodium chloride (edible Salt) may be used as a preservative in smoked meat without adversely affecting quality in terms of color and organoleptic quality for a period of six weeks.

#### **Prospects for Quality and Safety Improvement of Traditionally Processed Meat in Nigeria: Opportunities and Constraints**

Like most developing countries around the world, those of Nigeria are at the crossroads between many strategic choices regarding food policies aiming at the improvement of food safety while adapting to the advent of globalization. Nonetheless, regardless of the strategy to be adopted, Nigeria should necessarily upgrade the safety of their local foods to take advantage of the opportunities of globalization and to promote the trading of such foods either internationally or in domestic markets in face of the increasingly competitive global trade (FAO, 2004). To this end, Nigeria should take into account, in addition to the national constraints, the regional and global economic environment characterized by a multiplicity of bilateral, multilateral, sub-regional, regional and international agreements. The most significant of these agreements are undoubtedly the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade agreements of the World Trade Organization (WTO), which raised the food safety to the forefront of the international trade requirements (FAO, 2008). Although, it is believed that the application of SPS measures and the consequent strengthening of food safety regulations would progressively lead developing countries, including Nigeria, to improve safety and quality control practices in agriculture and food technology. Such improvements would ultimately result in new forms of competitive benefits for developing countries and contribute to more sustainable and profitable trade in the long run (FAO, 2004). Therefore, efforts to produce traditional foods that meet the standards of the Codex Alimentations would increase their safety, and consequently, their local and international market share, as has been reported for traditional Greek foods (Wieck and Grant, 2021).

#### **Incentives to Meat Processors and Infrastructure Improvements as means of Improving the Quality and Safety of Traditionally Processed Meat Products**

To improve the quality and safety of traditional processed meat products in Nigeria, it is necessary to adopt certain measures that would encourage meat processors, usually rural, including the provision of financial and technical incentives to help them upgrade the hygienic quality of their products and be aware of the benefits of such an approach in the medium and long term. Some of these incentives may be:



### **Preferential Rates of Water and Electricity Fees**

The prices of water and electricity are relatively high in Nigeria due to the water shortage and limited capacity in the production of electricity, a situation that deters rural meat processors from using water and electric urban facilities to prepare traditional meat processors. Instead, they use wells or open surface water as available; they thus expose the final product to various chemical and microbiological contaminants originating from a polluted water supply. Also, the provision of electricity at a reduced rate would encourage rural meat processors to use electric machines (dryers, churning machines, heated vats, meat cutters, refrigerators and so on) for better control of the technological processes or for storage of the finished product before sale.

### **Provision of Technical Assistance at the Farm Level**

Rural meat processors are usually not aware of the critical steps in traditional processes that may lead to defective final products or inconsistent gustatory quality if not adequately controlled. Therefore, technical assistance by trained persons would draw the attention of rural food producers to the critical steps of the traditional processes, and help them ensure the production of foods with consistent quality. For example, the relevance of cleaning/sanitation, as well as personal hygiene, to the quality and safety of the final products is overlooked or even ignored by rural food producers. The organization of adequate training sessions would contribute to the sensitization of meat processors to the impact of these practices on the quality of the finished food products.

### **Facilitating Technology**

Facilitating technology transfer from the household level to small or medium industrial scale for traditional meat products when such transfer is deemed viable and economically feasible in the long run. To this end, the government could simplify the administrative routine, reduce taxes and provide technical assistance to design a business plan and later implement it.

### **Facilitating Loans**

Facilitating loans at reduced rates for the acquisition of small equipment and machinery, rural meat processors usually lack the basic capital to start producing meat for trade, and small or medium loans with reduced rates would help them start a business either individually or within associations or cooperatives.

### **Subsidizing Traditional Meat Products**

Subsidizing traditional meat products, especially those produced in cooperatives or professional associations as an encouragement during a limited period.

### **Encouraging Women Associations**

Encouraging women associations to produce traditional meat products, it is of paramount importance for women in Nigeria to know that the meat produced at the household level have financial value and constitute a significant source of income for their own autonomy and financial independence. This also represents a means to support the gender policies now being recognized as a limiting factor to balanced economic growth in developing countries; this is usually better achieved by a group of women within associations.

### **Organizing Training Sessions**

Organizing training sessions for all the personnel involved in the production process including technicians and meat handlers on a regular basis under the supervision of official agencies or Nigeria Government Officials (NGOs), and at no fees for targeted participants.

### **Organizing Yearly Award and Prizes**

Organizing yearly prizes for individuals or associations producing the most competitive traditional food products that also meet the safety standards. It is worth mentioning, however, that these measures can only be effective if the other basic requirements for such technology transfer (infrastructure, transportation vehicles, electricity, potable water, and so on) are met, and this is a matter of sustainable development of the country as a whole.

## **CONCLUSION AND RECOMMENDATIONS**

Although meat has been processed in Nigeria for a long time, traditionally processed meat products may pose high level of potential risk because the meat are been exposed to the environment and microbial contamination of the traditionally processed meat products. Considering the important role of



meat and meat products to food and nutrition security as well as economic development of any Nation, Government agencies and other stakeholders should ensure strict compliance with policies and procedures that will provide safe and high-quality meat for consumers. Proper hygienic slaughtering, transportation and handling practices should be encouraged to ensure that the consumer get meat of the right quality. If the incentives to meat processors and infrastructure improvements are carried out, these would serve as means of improving the quality and safety of traditional processed meat products from Nigeria. However, modern processing methods result in better quality and safer processed meat products.

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