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# Salting in the preparation of jerked beef meat with pork

Victor Hugo de Luna DIAS[1], Terezinha Domiciano DANTAS[1], Valquiria Cardoso da Silva FERREIRA[1], Solange de SOUSA[1], Jorge Luiz Santos de ALMEIDA[1], Maria Monique Tavares SARAIVA[2], Rerisson do Nascimento ALVES[1], Caio Franklin Vieira de FIGUEIREDO[2], Airton Gonçalves de OLIVEIRA[2], John Edson CHIODI[2], Francisco Fabrício Damião de OLIVEIRA[2], Neila Lidiany RIBEIRO[3]*

**Abstract**

Food processing allows a wide variation in the final quality of the product, which directly depends on the quality of the raw material used, the processing conditions, storage and commercialization. Salting, for example, is one of the oldest methods used to preserve meat. In the meat industry, the incorporation of salts into products is commonly used to improve dietary functionality and ensure food safety. Thus, the objective of this review was to understand that the discarded matrix meat can be used to make jerky meat, adding value to the final product. The processing of jerked beef is based on the osmotic dehydration process in counter flow, promoted by the penetration of salt with consequent exit of water from the inter and extra fibrillar compartments to the surface, with subsequent drying. At the same time, myosin denaturation occurs as a result of high temperatures, as well as myoglobin oxidation, promoted by salt, increasing the susceptibility to protein oxidation. The use of discarded animal meat to make jerky adds value to the by-product, improving sensory quality.

**Keywords:** product; salt; sensory; TBARs.

**Practical Application:** The use of discarded matrix meat for the manufacture of jerked beef can be an alternative for a better use, because in addition to helping to improve the flavor and tenderness, it can add value to this raw material.

## 1 Introduction

Food processing allows a wide variation in the final quality of the product, which directly depends on the quality of the raw material used, the processing conditions, storage and commercialization (Silva et al., 2013). Salting is one of the oldest methods used to preserve meat (Inguglia et al., 2017). In the meat industry, the incorporation of salts into meat products is generally used to improve dietary functionality and ensure food safety. Adding salts to meat improves gelling, water binding ability, fat retention and cooking loss (Desmond, 2006). However, in order to improve health, strategies have been researched to reduce the sodium content of foods, among them, the replacement of sodium chloride (NaCl) with other types of salts or by more recent processing techniques (Inguglia et al., 2017). According to Ruusunen & Puolanne (2005), the use of salt mixture is a good way to reduce the sodium content in meat products. Some of these mixtures may have potassium chloride, magnesium sulfate and L-lysine essential amino acid hydrochloride (Desmond, 2006).

Charque is a salted and sun-dried meat product, typical of Brazil, also known as the meat of the sertão or jabá (Shimokomaki, 2006), almost always produced with beef. Despite being one of the most consumed industrialized meat products in the country, its expansion in the consumer market is far from being fully explored. Its potential goes beyond the domestic market, being a product that does not require the use of the cold chain for its preservation (Abrantes et al., 2014).

The use of salting in the meat of sows for disposal can be an alternative to improve its use, because, in addition to incorporating a specific desirable flavor, it can add value to the raw material, which is difficult to market in the meat chain (Pelegrini et al., 2008). Thus, the objective of this review was to understand that the discarded matrix meat can be used to make jerky meat, adding value to the final product.

## 2 Nutritional value of pork

The composition and quality of pork differ due to several factors, such as: genetics, feeding, handling and transport. The influence of these aspects is observed in both fresh and processed meat, and thus, the products differ in consumer and industry acceptance (Moura et al., 2015).

Meat products contain proteins of high biological value and important micronutrients, and the impact of their consumption on human health has been extensively reviewed by De Smet & Vossen (2016) and Cashman & Hayes (2017). However, even with limitations and restrictions, the demand for meat in the world

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[1] *Programa de Pós-graduação em Tecnologia Agroalimentar, Centro de Ciências Humanas, Sociais e Agrarias, Universidade Federal da Paraíba – UFPB, Bananeiras, PB, Brasil*
[2] *Universidade Federal de Campina Grande – UFCG, Campina Grande, PB, Brasil*
[3] *Instituto Nacional do Semiárido – INSA, Campina Grande, PB, Brasil*
*Corresponding author: neilalr@hotmail.com

should increase, given the demand of the population of developing countries and with their stable economies (Tomovic et al., 2015).

Pork stands out among the main meats consumed in the world. It has adequate protein content of high biological value (because it has all the essential amino acids) and high digestibility (95 to 100%) (Souza et al., 2016). According to Gutiérrez (2008), from the protein content (about 18%) present in the muscles, myofibrillar proteins (10.5%), sarcoplasmic (6%) and associated connective tissue proteins (1.5%) stand out. %). The main myofibrillar (contractile) proteins are myosin, actin, tropomyosin and troponin, titin, nebulin, α-actinin and desmin. Sarcoplasmic proteins (myoglobulins and enzymes) are involved in glycolysis, glycogen synthesis and glycogenesis, most of which act as enzymes. Associated connective tissue proteins are mainly composed of collagen, elastin and mitochondrial enzymes, responsible not only for the protection and support of muscle fibers, but also for the strength (stiffness) and elasticity of the muscle (Sarcinelli et al., 2007).

In addition to proteins, pork also contains some non-protein nitrogenous compounds, such as free amino acids, simple peptides and amines. Such elements, although of little nutritional value, constitute a potential source of nitrogen for amino acids and endogenous protein synthesis (Magnoni & Pimentel, 2007).

Pork is an important source of thiamine (0.8 mg/100 g), niacin (6.3 mg/100 g), pantothenic acid (1.7 mg/100 g) and biotin (4.0 mg/100 g). A small portion of pork loin (85 g of raw meat) provides 66% of the daily needs of thiamine in men and 72% in women, which ends up being of great interest to reach the daily recommendation for this nutrient. In addition to thiamine, pork supplies most of the riboflavin and niacin needs, which are important for growth in children and the metabolism of both carbohydrates and amino acids, as well as the prevention of riboflavinosis and pellagra (niacin deficiency) (Maham & Escott- Stump, 2012).

According to Cashman & Hayes (2017), pork contains important and essential minerals, with average values: sodium (67.9 mg/100 g), sodium chloride (127 mg/100 g), potassium (340.7 mg/100 g, calcium (11.7 mg/100 g), magnesium (22.9 mg/100 g), phosphorus (208 mg/100 g), iron (0.9 mg/100 g), copper (0.8 mg/ 100 g), zinc (2 mg/100 g), selenium (15.7 mg/100 g) and iodine (5 mg/100 g) Compared with beef, it has higher levels of potassium, selenium, calcium, phosphorus and copper, lower levels of sodium, sodium chloride, iron, zinc and iodine, and similar values for magnesium. edible organs, glands and fats (Universidade Estadual de Campinas, 2011). In addition to these, the age of the animal, the type of tissue, the proportion of bone and cartilage, the composition of nutrients in the food, seasonal variations, the physiological state, the maturity and race, are factors that affect the content minerals present in pork (Tomovic et al., 2015).

It is estimated that 40% of the total iron content is in the heme form, whose absorption is more efficient. In addition, some cuts have a higher total amount of iron compared to poultry and fish. Its own heme iron content, the amino acids present in pork facilitate the absorption of non-heme iron. Another particularity lies in the expressive content of selenium, in relation to other meats, whose main function is to participate in the enzymatic antioxidant system that fights the action of free radicals in cells and tissues (Bügel et al., 2004).

In the Brazilian Food Composition Table, there are variations between the analyzed cuts, but the raw pork loin has a good nutritional composition, with 67.7% moisture, 176 kcal, 22.6% protein, 8.85% of lipids, 55 mg of cholesterol, 1.0 mg of ash, 4 mg of calcium, 24 mg of magnesium, 0.01 mg of manganese, 31 mg of phosphorus, 1.4 mg of iron, 616 mg of sodium, 228 mg of potassium, 0.23 mg of copper, 0.6 mg of zinc, 0.07 mg of thiamine and 0.03 mg of riboflavin for 100 g of the product (Universidade Estadual de Campinas, 2011).

### *2.1 Use of meat to produce meat products*

The habit of making sausages emerged as a means of preserving meat and offal, in addition to making full use of slaughtered pigs (Marianski; Marianski & Gebarowski, 2009). The most popular salted and dried meat products at room temperature in Brazil are: jerked beef, jerked beef and jerked beef (Ferreira et al., 2013; Freixo et al., 2022) (Figure 1).

Thus, in addition to meat, blood, offal and viscera are also used to prepare various foods that are known in different countries,

**Figure 1**. Salt meat make with meat pork.

such as the Burgos black pudding in Spain (Santos et al., 2003), the Assar black pudding, the Alentejo chorizo and Mouro chorizo in Portugal (Gokoglu et al., 2010) or Cavourmas, a cooked sausage from Greece (Arvanitoyannis et al., 2000), Dinuguan sarapatel from the Philippines and Haggis from Scotland (Toldrá et al., 2012), between others. These products are responsible for adding value to meat production and reducing the environmental impact caused by the disposal of by-products (Toldrá et al., 2012).

Silveira & Andrade (1991) recommend the use of animal meat and its disposal in the formulation of fermented products because they have a lower moisture content and a more accentuated color. The use of meat from these discarded matrices for the manufacture of sausages, and/or other products such as dried meat and jerked beef, for example, could be an alternative for a better use, as well as helping to improve the flavor and tenderness, can add value to this raw material. Discarded animals can be used in cooked, smoked and/or fermented sausages, such as salami (beef, pork, sheep and goat meat, containing bacon), "krakauer" (sheep/goat and pork sausage), "iyoner " (a product with a composition similar to salami, but without undergoing fermentation), Vienna sausages, ham-type sausages and hamburgers. Another example is the traditional Slovenian sausage "Kranjska klobasa" smoked and cured with pork (Polak et al., 2017).

In Brazil, Normative Instruction No. 6, of February 15, 2001 defines salted meat products, industrialized meat products, obtained from meat from butcher animals, boneless or not, treated with salt, with or without curing salts, spiced or not, cooked or not (Brasil, 2001).

### *2.2 Salt and charque*

Charque meat and jerked beef are salted meat products of intermediate moisture, both have a water activity of up to 0.80 and contain at least 12% salt. In relation to moisture, in jerked beef it is a maximum of 50% and in jerked beef it is a maximum of 60%. However, in the preparation of jerked beef, the use of curing salts is allowed and vacuum packaging is mandatory (Brasil, 2020) (Figure 2).

Since ancient times, curing meat has been a conservation technique widely used to prolong shelf life, and consists of exposing meat to a mixture of NaCl and nitrate/nitrite, giving cured meat products their typical aroma (Shakil et al., 2022). However, Gutiérrez (2008) states that this process means a true transformation of the meat, promoting the stabilization of the raw material, the reduction of water availability, which in turn, develops specific sensory qualities, as a consequence of drying, physicochemical phenomena. and biochemicals, which affect the components of the raw material through transformations of proteins and lipids, with evident repercussions on the flavor, aroma and flavor, resulting in a new food product with high added value.

Due to its low cost, salt is one of the most used additives in the food industry, and salting is one of the main methods of preserving meat products (Inguglia et al., 2017). However, the high consumption of sodium in food has been linked to an increase in blood pressure and, consequently, a higher risk of stroke and premature death from cardiovascular diseases

**Figure 2**. The salting process in meat pork.

(Nilson et al., 2022). The United States Department of Agriculture (DAEU), for example, recommends sodium values of 2000 mg in industrialized or non-industrial meat products, using beef, pork and poultry as raw materials, in order to regulate their consumption in the human diet (The United States Department of Agriculture, 2016).

Even considering the concern with the use of salt in meat products, its technological use has been investigated, due to the properties related to its preservative, antimicrobial and flavor enhancing effects (Albarracín et al., 2011).

According to Weiss et al. (2010), salt provides a number of functional properties in meat products, among which they cite protein activation, increased hydration capacity and water binding, improving texture. It also increases viscosity, facilitating the incorporation of fat to form stable masses. According to the authors, studies related to salt reduction should address the scientific effects it may have on technological functions, such as water retention capacity, texture, sensory, stability and durability, which impact consumer acceptability (Desmond, 2006).

The presence of salt exerts an antimicrobial effect due to the ability to reduce water molecules, a necessary condition for microbial growth. The effects of salt on microorganisms depend on the amount of salt present in the aqueous phase of foods. The addition of sodium causes efflux of water through

the semipermeable membrane of bacteria, leading to osmotic shock that can result in bacterial cell death or serious injury, causing a significant reduction in bacterial growth. Although there have been advances in the development of ingredients (flavor enhancers with different compositions) that replace salt, there is still an associated negative sensory impact element (taste and texture) (Inguglia et al., 2017).

Therefore, although new technologies are promising tools, which aim to reduce the salt content used in industrial meat foods, these effects must be carefully considered, due to the essential functions (taste, texture and shelf life) provided by salt, with emphasis on in ensuring the microbiological safety of low-sodium meat products (Desmond, 2006). Any alternatives not only need to be effective to keep the product safe, but they must be practical, affordable, and new technological tools (ultrasound) need to be further investigated (Inguglia et al., 2017).

In the meat industry, the most used dry salting process is the technique of covering the meat with one or several layers of coarse salt with pre-established temperatures and relative humidity for the batch (Figure 3). Thus, the salt content of pieces of meat in the same batch varies greatly, not only due to the salting process itself, but also to the heterogeneity in weight, shape, and composition of the raw material (Toldrá et al., 2012), associated with the environmental conditions, position of the layers in the salting process, the formation of brine, the size of the salt crystals, among other factors (Freixo et al., 2022).

In Brazil, typical salted meats are sun-dried meat and jerked beef and its substitutes, estimating an average annual production of between 350,000 and 450,000 tons, 95% of which is destined for domestic consumption and only a small percentage for the market. Africa and Central America, with an expected increase of around 5% per year (Associação Nacional das Indústrias de Carne Seca, 2017). From this amount, the production of sun-dried meat and/or other cured products, traditionally made by hand, is excluded. Salted meats are commonly consumed in the geographic regions of the Northeast and North of Brazil, or by northeastern populations settled in other regions of the country (Associação Nacional das Indústrias de Carne Seca, 2017)

Despite the meats being subjected to the dehydration process through salting, what varies between the products is the type of raw material, the ingredients (type and quantity) and the type of processing (time and variations in the drying processes), which end, gives them their own color and flavor (Abrantes et al., 2014).

**Figure 3**. Pile of meat pork salting with temperature and humidity control.

Charque emerged around the 18th century, in the Northeast region, as an alternative to overcome the difficulties arising from the high perishability of meat, aggravated by other factors, such as the seasonality of meat supply and the difficulty of distribution and storage due to the climate. hot and to great extent (Pardi et al., 1996). Due to the prolonged drought period, which decimated the cattle herd in the Northeast, at the end of the 18th century, a Portuguese named José Pinto Martins, emigrating from Ceará, moved to the banks of the São Gonçalo River and took with him the conservation technique of meat, founding the first charqueada in Rio Grande do Sul (Nogueról et al., 2007).

Charque is a typically Brazilian product, widely consumed in Brazil, and this may have been the first industrialized meat product in the country. Its dissemination, popularity and high consumption are due to its easy transport, conservation and durability, as it does not require refrigeration or treatment with high temperatures for ingestion (Brasil, 2000). It is a salty meat product obtained by dehydration, through exposure to the sun for a long time, without refrigeration (Santos & Hentges, 2015).

Charque is classified as an intermediate moisture meat product (IMMP), and has low moisture (40 to 50%), water activity (Aa) between 0.70-0.75, high protein content (> 30%), 10 at 20% salt, and stability from a microbiological point of view (Freixo et al., 2022). It has a darker color, saltier flavor and tends to be more rigid. It also presents a greater "break", has greater loss of muscle portion in its process when compared to jerked beef jerky. Charque meat processing is based on the counter-flow osmotic dehydration process, promoted by the penetration of salt with consequent exit of water from the inter and extra fibrillar compartments to the surface, with subsequent drying (Shimokomaki, 2006). At the same time, myosin denaturation occurs as a result of high temperatures, as well as myoglobin oxidation, promoted by salt, increasing the susceptibility to protein oxidation (Lund et al., 2007).

The artisanal processing of jerked beef remained practically unchanged for many years, until the emergence of jerked beef, a similar meat product, produced from the automatic injection of brine containing sodium nitrite and nitrate (Youssef et al., 2007). Both jerked beef and Jerked beef can be preserved for 4-6 months at room temperature, making them excellent sources of animal protein for those living in regions without refrigeration facilities (Ishihara et al., 2017; Shimokomaki et al., 2016; Vidal et al., 2019). Jerked beef is considered the evolution of jerked beef, with great potential growth in the Brazilian market by integrating the cultural consumption of its precursor to items related to industrialized food products, in addition to being an easily digestible food with high biological value. (Shimokomaki et al., 2016; Zen et al., 2018).

Salting is a common operation in the manufacture of several products, and can influence both lipid oxidation (Silva et al., 2004) and the production of carbonyl compounds from the oxidation of proteins in meat and meat products (Shimizu et al., 2009). The addition of NaCl alters the ionic strength of the medium, affecting the degree of association of myofibrillar proteins,

exposure to pro-oxidants and susceptibility to the production of carbonyl compounds. Considering the range of meat products, in which salt plays an important role, there are few studies related to the effect of NaCl on the production of carbonyl compounds in meat proteins (Shimizu et al., 2009).

According to Correia & Biscontini (2003), desalting and cooking promoted significant changes in the chemical composition of jerked beef and jerked beef, observing losses of moisture, ash, protein and lipids at the end of processing. They also concluded that the retention of protein and lipids found in these products was 71 and 87% and 60 and 65%, respectively.

Charque and jerked beef have moisture values ranging from 45.96 to 46.4% and 51.17 to 52.1%, respectively (Correia & Biscontini, 2003; Youssef et al., 2007), reaching up to 45% for jerked beef and 55% for jerked beef (Brasil, 2000). Youssef et al. (2007), evaluating the relationship between the chemical composition of jerked beef from the Vastus lateralis muscle and its shear force, obtained a value of 9.8 kgf. The authors report that the lower tenderness of beef jerky is linked to its lower humidity (46.4%).

Lara et al. (2003), using obstacles to reduce the growth of Staphylococcus aureus in beef jerky processing, identified that this bacterium does not survive the obstacles imposed by processing, with a considerable decrease in its count during drying, which is not so surprising. when the bacterium develops at high Aa values, above the limits for intermediate moisture foods. The results extracted by the authors showed that the high saline concentration (10 to 20%) and, mainly, the intermediate values of Aa (0.70 to 0.75) are important obstacles placed in the production of jerky, being affective to inhibit the growth of Staphylococcus aureus.

Ferreira et al. (2013) found that the addition of different levels of NaCl caused changes in the physicochemical and microbiological characteristics of pork, and the addition of 5% NaCl provided the highest quality, ensuring safety standards. Yang et al. (2009) studied the differences between pork jerky (produced with pork) and beef jerky (produced with beef), and concluded that pork jerky has a lower moisture content and a low Aa compared to beef jerky. Pork jerky made from sirloin has higher lightness, shear force and TBARS than other jerky samples. As pork has a higher amount of fatty acids than beef, this can cause lipid oxidation to occur rapidly during storage. However, pork jerky is safer considering microbiological growth, as it has lower moisture content and water activity.

### *2.3 Sensory analysis*

Sensory analysis has become a very useful tool to know the opinion of lay people and professionals about certain products that are of interest to the market, this technique consists of a set of practices used to objectively measure the characteristics of a product through the senses, analyzing parameters such as odor, flavor, tenderness and juiciness (Moura et al., 2015).

Temporal Dominance of Sensations (TDS) and Temporal Check-all-that-apply (TCATA) successfully determined the temporal sensory profiling of the reduced salt and fat Bolognas sausages with emulsion gels, with good discrimination and similarity among them. Additionally, results also showed that both methods complement each other. Whereas the multiple selections of attributes during TCATA evaluation provides a more complete description of how the sensory characteristics of products change over time, TDS enable to evaluate the ability of sensory attributes to capture consumers' attention. TDS and TCATA data showed that the texture attributes (firm and soft) were the first dominant perceptions for all samples; however, TCATA would bring additional information where interaction between attributes is required, firm, soft and juicy in our case, and allows re-presenting more than two attributes at any point in time. Saltiness was significant in TDS evaluation only at the end of mastication process, and it was not the most cited attribute in TCATA data. The main driver of liking and disliking were Bologna flavor and fat flavor respectively, suggesting that future studies aiming to mask fat flavor would improve overall linking of reformulated Bologna sausages (Paglarini et al., 2020).

Food characteristics have been important factors for consumers to choose a product. Thus, it becomes necessary to measure, improve and control the physicochemical and sensory properties of foods. The physicochemical (Correia & Biscontini, 2003) and microbiological characteristics of jerked beef have been the object of research, as well as other alternatives to prolong its shelf life. However, innovations capable of promoting an increase in the sensory quality of the product have not yet been evaluated.

The quality parameters of a food can be evaluated by three different techniques: objective methods, instrumental or by subjective methods, through sensory analysis with trained teams or a panel of consumers. Objective methods allow the comparison of different treatments, as well as verify their effects on a particular trait, but do not provide information on consumer acceptability or preference for one type of meat over another (Teixeira, 2009).

The subjective evaluation of quality is not simple, as it involves psychological, physiological, social and economic conditions of the consumer. Therefore, the quality of a product and its components differs from one individual to another. There are five senses of human perception: smell, taste, touch, sight and hearing. External information is captured by the senses and processed in the brain, which determines reactions and behaviors in response to these stimuli (Ramos & Gomide, 2007).

In this sense, Ramos & Gomide (2007) report that the sensory characteristics of foods are grouped into three categories, called sensory acceptability factors: appearance, flavor and texture. The food industry has used sensory evaluation as a "guiding tool" in the areas of product development, quality control and marketing. With the continuous expansion and diversification of the food industry, the field of sensory analysis has implemented techniques that provide valid and reliable data.

Meat texture and tenderness are the most important attributes in determining consumer acceptability and satisfaction (Paglarini et al., 2020). Salt provides a series of functional properties in meat products, such as protein activation, increasing hydration capacity and water binding, improving texture. It increases viscosity, facilitating the incorporation of fat to form stable masses, and that studies related to the reduction of salt should

address the scientific effects that it may have on technological functions, such as water retention capacity, texture, sensory, stability and durability, which have an impact on consumer acceptability (Vidal et al., 2019). Dias et al. (2022) evaluated the addition of different levels of salt in the discarded matrix pork does not change the physicochemical characteristics and the sensory analysis of pork jerky. The microbiological characteristics were within the norms of the legislation. The dry pork has good market acceptability, and those with 30 and 50% of salting are the most appreciated by consumers.

The Q methodology is considered a conceptual methodology, and has been used to characterize perfumes (Brard & Lê, 2018) and to understand meat consumption by environmental advocates (Scott et al., 2019). In the Q methodology, the samples are grouped into two groups, according to a concept previously presented to the participants ; the samples belonging to the concept are placed in the firsts group, while the samples that do not represent the concept should be placed in the other group (Brard & Lê, 2018). However, there are few studies about the Q methodology to characterization of meat products (Vidal et al., 2020)

## 3 Conclusion

The use of discarded animal meat to make jerky adds value to the by-product, improving sensory quality.

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