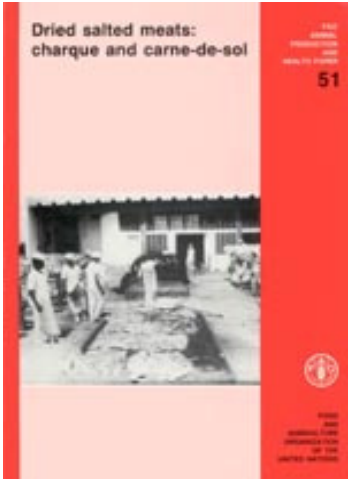

FAO ANIMAL PRODUCTION AND HEALTH PAPER 51

Dried salted meats: charque and carne-de-sol

CONTENTS

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FOREWORD

Meat is a food item which spoils easily unless kept at temperatures in the vicinity of 0.°C. This accounts for the habit in sub-tropical and tropical countries of eating freshly slaughtered meat (warm meat). However, during periods of excessive slaughter (seasonal variations, drought periods) all the available meat cannot be consumed as fresh meat and much of it is consequently lost.

In developed countries the seasonal variations in meat supply are

nowadays overcome by freezing and cold storage, but in earlier days it was achieved by processing the meat into various products of extended keepability such as sausages, bacon, ham, canned beef etc.

In developing countries the main process for the preservation of meat is drying with or without salt and sometimes combined with smoking. Processes for a number of traditional local varieties have been developed over hundreds of years, but there is no consistent technique which would ensure that the product will always be of an acceptable quality. In particular, the handling of the raw material is sometimes unsatisfactory which may result in a spoiled product.

The present publication sets out guidelines for the preparation of two dried meat products from Latin America - charque and carne-de-sol. The intention is to give information which would assist in constructing simple facilities for the manufacturing of the

products, to establish a proper raw material selection and handling and to work out a reliable process for the products.

The publication fits well into FAO's activities to reduce food losses particularly in drought stricken countries. Manufacturing of dried meat products will also be a useful activity in programmes aiming at promoting rural development. It may increase cash flow into the rural community and increase employment possibilities including that for women.

CARNE-DE-SOL, also known as:

“carne-de-sertao, carne serenada, carne-de-viagem, carne-de pacoca, carne-mole, cacina ou carne acacinado.:

CHARQUE, also known as:

“carne seca, carne-do-sertao, xergao, tasajo, chalona, charqui, xarque.”

1. INTRODUCTION

Despite the recent advances in refrigeration and packaging technology, more traditional methods of meat preservation, such as salting and drying, continue to play an important role in the meat marketing structure of many of the world's less developed countries.

Controlled moisture products, prepared either directly by dehydration or indirectly by increasing extracellular osmotic pressure, as in the case of curing, may assume a renewed importance in coming years through the cumulative demands placed upon traditional commercial meat sales systems by an increasingly sophisticated and centralised industrial sector. The rapid turnover, within 24 hours, of fresh, unchilled meat supplied

by municipal abattoirs for local consumption is not realisable where slaughter facilities are dislocated away from the individual centres of consumption to centralised or regional sites.

The problem becomes particularly acute where cold storage facilities in the retail sector are absent or deficient. Salted and semi-dried meat products which are popular in their own right, stand up better to the abuses of these distribution networks than their chilled or fresh meat, counterparts.

With careful control of the manufacturing process, a lightly salted and semi-dried product, with characteristics not dissimilar to that of fresh meat, might be expected to have a shelf life of 72–96 hours at ambient temperatures. Under similar conditions a salted and more fully dried product with specific textural and eating quality characteristics could be expected to have a useable life of 3–4 months without noticeable deterioration.

It is the flexibility in marketing which has made these products so valuable, particularly in those regions inaccesible for periods of the year because of communication difficulties; climatic abberations, where irregular slaughter patterns cause peaks and troughts in supply; where meat has to be transported from one region or village to another in abused conditions or where meat has to be supplied to regions lacking the basic infra structure to market a chilled or frozen product. The only alternative to the manufacture of controlled moisture meat is often the establishment of cold chains or animal stock routes which are costly and difficult to maintain. The present manual presents manufacturing procedures for the fabrication of two traditional Brazilian controlled moisture meat products, carne-de-sol and charque which are consumed in large quantities in the remoter and more impoverished regions of the country.

Although produced using similar procedures, the two products are quite different in terms of keeping qualities and are

manufactured under diverse conditions. In the case of carne-de-sol, at the artesenal level with output levels seldom in excess of 1 000 kg per day. Whereas in the case of charque, at the industrial scale in factories capable of sustained daily volumes between 3–30 tonnes. Because of its limited keeping quality carne-de-sol is manufactured where it is consumed, whereas charque is produced in regions having an abundant supply of raw materials and transported to where it is needed. Historical and strategic reasons have led to these patterns of production but there is no reason why these two products should not be produced in the same premises and this publication explores that possibility.

In the case of a community or region having difficulty in securing regular supplies of fresh meat or where slaughter by necessity is seasonal, the establishment of a plant to manufacture charque and carne-de-sol would offer distinct commercial and marketing benefits.

It is envisaged that a "controlled moisture" meat plant would be furnished with raw materials from local slaughter establishments or from sources further afield should supply become limited.

The plant could be considered as a supply post; distributing fresh, lightly and fully dried meats according to the demand for these products and the day to day availability of raw materials. Since lightly salted products could be manufactured quickly according to projected needs, they might be used as a rapidly disposable stock in times of intermittent slaughter. Stocks of charque could be built up during periods of excess to cover those times when supply is curtailed.

In many respects, carne-de-sol and charque serve the same community needs in terms of retail sales flexibility as chilled and frozen meat. In the case of controlled moisture meats, however, the capital and energy costs involved in their fabrication and storage are far lower and hence their use, in less developed

countries, more widespread.

Because lightly salted products such as carne-de-sol have almost identical characteristics after cooking to similarly prepared fresh meats, their acceptance presents few problems. Fully preserved meats such as charque, although distinctive in appearance and organoleptic characteristics, may be semi-reconstituted when properly prepared before cooking. In regions where they have been introduced because of the shortage of fresh meat, these dried products are demanded for their intrinsic qualities per se.

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2. PRODUCT CHARACTERISTICS

2.1 Carne-de-sol

Carne-de-sol (meat of the sun) is a lightly salted and partially dehydrated meat product of limited shelf-life (3–4 days at ambient temperatures), which is consumed in large quantities in the north-east of Brazil. Typically made from beef or goat meat, carne-de-sol is characterised by its distinctive shape ("mantas") and appearance (dark brown surface colour). It is used as a substitute for fresh meat in areas lacking retailing infrastructure and maintains most of the eating characteristics of the raw material when properly processed and prepared for cooking.

The name carne-de-sol belies the means by which it is usually manufactured since it is rarely exposed directly to the sun during dehydration. A more apt name, and one by which the product was earlier known, is carne-de-vento (meat of the wind) since

drying is generally accomplished in covered, well ventilated areas allowing for gradual and controlled desication of the surface tissues.

Conservation of meat by salt, sun and wind dates back to ancient times and has only relatively recently been overtaken by such preservative methods as refrigeration and freezing. In terms of shelf life, carne-de-sol may be considered as being comparable to fresh meat held at refrigerated temperatures. In most tropical and subtropical countries it is possible to find records describing the importance of lightly salted, semi-dried meats in the local diet. The product assumed a particular importance in areas where work forces had to be maintained close to normal centres of population and points of slaughter. The landed gentry who owned the cotton and sugar cane plantations in Brazil during the 17th century might well have consumed meat prepared this way. Indeed, Francois Pirard de Laval who visited Salvador in 1610, recorded seeing large quantities of carne-de-sol exposed for

sale. The great success of the product, and the reason for its continued manufacture today, may in part be contributed to the abundant supply of marine salt in the north-east of Brazil, and to the peculiar climatic and social-economic conditions that persist in the region. High ambient temperatures and Lack of refrigeration at the commercial and domestic level have necessitated the production of meat products having an extended shelf-life. These same precarious socialeconomic conditions have also restricted the development of its industrial production. Although consumed in greater quantities than charque, carne-de-sol is still manufactured at the artesenal level in inadequate facilities and without proper control of processing procedures. Consequently the physico-chemical characteristics of the product vary considerably from one region to another and one town to the next.

Carne-de-sol is usually prepared from the whole carcass. Subcutaneous and intermuscular fat deposits vary considerably

between manufacturing cuts and these differences affect salt penetration and subsequent water loss during processing. The product is characterised by salt levels between 5 and 6% and total muscle water levels between 64 and 70%. Increases in mean muscle pH of 0.4 pH units and reduction in water activity (a_W) of 0.04 (resulting in a final a_W of approximately 0.94) units usually accompany processing. The physico-chemical changes during processing that result in a reduction of free water in the meat tissue, lead to a concomitant rise in the proportion of other tissue components, in particular salt.

The manner in which carne-de-sol is prepared for cooking is an important factor in maintaining its appeal as a fresh meat substitute. Since it is lightly and quickly salted, much of the salt remains in the superficial outer tissues. This excess salt can be removed by soaking for one to two hours in cold water prior to cooking, thus producing a cooked meat virtually

indistinguishable from corresponding fresh meat.

2.2 Charque

Charque is a meat product obtained by the salting and drying of deboned beef under conditions which permit its conservation for extended periods at ambient temperatures. Unlike carne-de-sol, which may be considered only for local consumption, charque is often transported over long distances and consumed in regions distant from the point of its manufacture. It is not considered as a substitute for fresh meat but rather as an alternative in regions where supplies are limited.

Footnote:

Water activity (a_W) - regarded as a measure of the availability of water for microbial growth and defined as the ratio of the vapour pressure of the food to the vapour pressure of pure water at the

same temperature.

CATEGORY	CRITERIA	STORAGE TEMPERATURE	EXAMPLE
a) Easily perishable	a_w 0.95	+ 5°C	fresh meat
b) Perishable	a_w 0.91–0.95	+ 10°C	carne-de-sol
c) Shelf stable	a_w 0.91	No refrigeration required	charque

Charque is subjected to a rigorous processing resulting in a distinctive appearance, often considered unattractive. Prepared in large flat pieces ("mantas"), charque is characteristically fully dehydrated on its outer surfaces and has a typical strong odour and taste. In more recent times, charque or carne-seca has been packaged in retail sized vacuum packs giving it an even longer shelf-life and a much improved appearance.

Basically, charque processing consists of the preparation of manufacturing cuts of uniform thickness which are subjected to wet and dry salting, washing, drying and packing. Drying is normally carried out in the sun but where environmental conditions are unfavourable, a process of "winter pillage" is used.

Sun drying, where practised, is controlled to avoid rapid dessication of the surface tissues.

It is generally believed that charque was developed to extend the shelf life of lightly salted, conserved meats such as carne-de-sol. Indeed, early records from charqueadas (plants for the processing of dried meat products) describe manufacturing procedures for carne-de-sertao a name also used to describe carne-de-sol. The first recorded charqueada was established in Pelotas in Rio Grande do Sul in 1780 by Joao Pinto Martins. Thereafter numerous establishments were built and large

quantities of charque were exported to the north-east of the country. This movement of dried meat from beef cattle production areas in the south to the northeast has remained at elevated levels, between 60 000 – 120 000 tonnes per year, up to the present time.

Because of the nature and volume of the trade in charque, industrial production has tended to be mechanized and on a large-scale. Plants producing 30 tonnes per day are not uncommon. In general, they are hygienically operated and subject to rigorous inspection by the federal authorities. As a consequence, the characteristics of the product differ mostly in respect to raw material quality and only marginally between sites of production.

Unlike carne-de-sol which is manufactured from whole carcasses, charque is usually made from the flank and forequarter regions removed upon division of the carcass using

the "PISTOLA" cutting method. There is no reason, other than the one of cost and competitiveness, why the whole carcass should not be used for the manufacture of charque. Carcass division in these cases would follow similar procedures to that of carne-de-sol.

The water loss during salting and drying is much more pronounced than in the case of carne-de-sol and is achieved over a much longer period, resulting in a product of low total water content (44–45%), relatively low water activitiy (a_W 0.87 – 0.91), and high salt content (12–15%). Increase in pH of 0.6–0.8 units usually accompany processing. Enzymic fermentations also occur to give the meat its typical flavour.

The physico-chemical changes that occur during the processing, and result in a drastic reduction of the free water content of the muscle, lead to a concomitant rise in the proportion of other components more especially salt and protein.

Although greatly affected by the nature of the raw materials used, average product yield is in the order of 550 g for every 1 kg of meat and 100 g of salt consumed.

The extent to which dried meat can be rehydrated prior to consumption depends upon the surviving water holding capacity of the muscle proteins. Full rehydration of charque is not possible even with prolonged soaking, but excess salt may be removed by scalding the meat in boiling water for several minutes. The “de-salted” product is usually cut up into small pieces and cooked with rice or beans in dishes such as “feijao”, typical of the region.

3. DESCRIPTION OF PREMISES AND EQUIPMENT

The fabrication of carne-de-sol and charque requires a minimum of plant and equipment, but careful consideration should be given to the layout of the premises to facilitate product flow and to reduce the risk of contamination during processing (see Figure 1). Suitable premises would have sufficient ground area to house the following sectors.

- **Reception for raw materials and deboning room**
- **Wet and dry salting room**
- **Washing area**
- **Covered drying area**
- **Open drying area - varales**

- **Packaging and despatch room**

It would be advisable to include a cold store for the reception and storage of raw materials but such a feature could only be economically justified in the case of large deliveries which cannot be processed immediately or where there is an identified supply of frozen carcass meat.

The reception area is usually raised to accommodate off-loading of delivered carcass meat. In the case of alinked abattoir/processing plant, direct access from the carcass holding area to the deboning room could be considered without the need for an intervening reception platform. Provision should be made for the installation of a carcass rail to suspend quarters in order to facilitate off-loading and subsequent deboning.

The deboning room should be large enough to handle maximum possible throughputs and equipped with deboning tables of

galvanised steel, finished with a top of stainless steel or high density plastic. The use of wooden tables is not recommended.

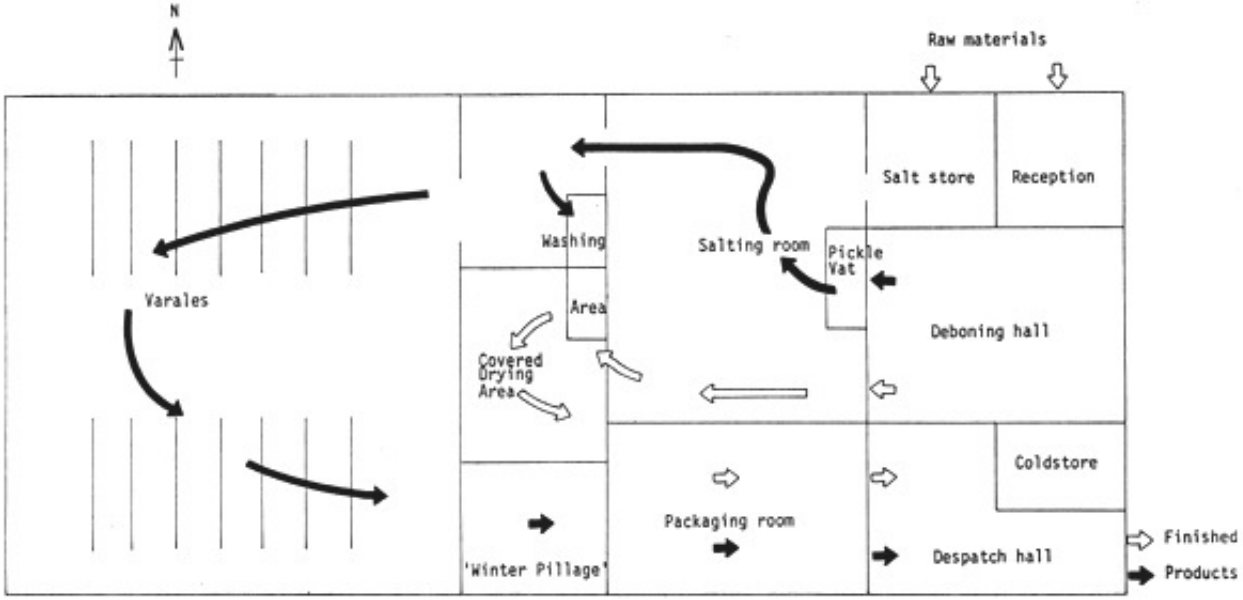


Figure 1. Schematised layout of charque and carne-de-sol plant, showing flow.

In most charqueadas it is usual to find the deboning tables aligned directly with openings in the wall through which the deboned "mantas" pass into the salting room. In the case of charque, the "mantas" fall directly into a brine tank. Pieces of carne-de-sol, which are not usually subject to a wet salting, should be manipulated on to a table placed immediately behind or beneath the wall opening.

The salting room should be large and kept cool by reducing window area and allowing a good air circulation, preferably through roof spaces covered with netting to prevent the entry of birds and insects. The floor should be screened concrete with adequate surface drainage to remove meat juices expressed during salting and pressing. The use of fat traps is recommended. Access into this area from the outside should be restricted and via foot dips. A dry salt store would usually be positioned adjacent to the salting room. Care should be taken to keep the salt sacks off the floor to prevent hardening. Wooden

pallet boards may be used for this purpose. The washing tanks, made of concrete and preferably lined with high quality glazed tiles, should be located immediately outside the salting room. An abundant supply of good quality treated water is essential.

Figure 2. Covered area for the drying of carne-de-sol.

In the case of carne-de-sol, drying is usually carried out in well ventilated areas, protected from insects and birds by netting (see Figure 2). The concrete plinths for "winter pillage" may also be positioned within this covered area.

Drying of charque is usually achieved by suspending "mantas" over wooden rails (varales) in direct sun light (see Figure 3). The rails should be aligned in a north-south direction to maximise solar cover and kept a minimum of 0.80 m apart to facilitate loading and off-loading with hand-pulled trollies. Upper and lower rails should be placed 0.70 m apart to ensure adequate separation of the meat pieces.

The inclusion of a packaging and storage area in the plant layout is strongly recommended. Where charque is likely to be transported over long distances, it would be advisable to install

some form of meat press to produce packets of uniform size and weight. The most common form of packaging for these products is in jute sacks but nylon substitutes are acceptable.

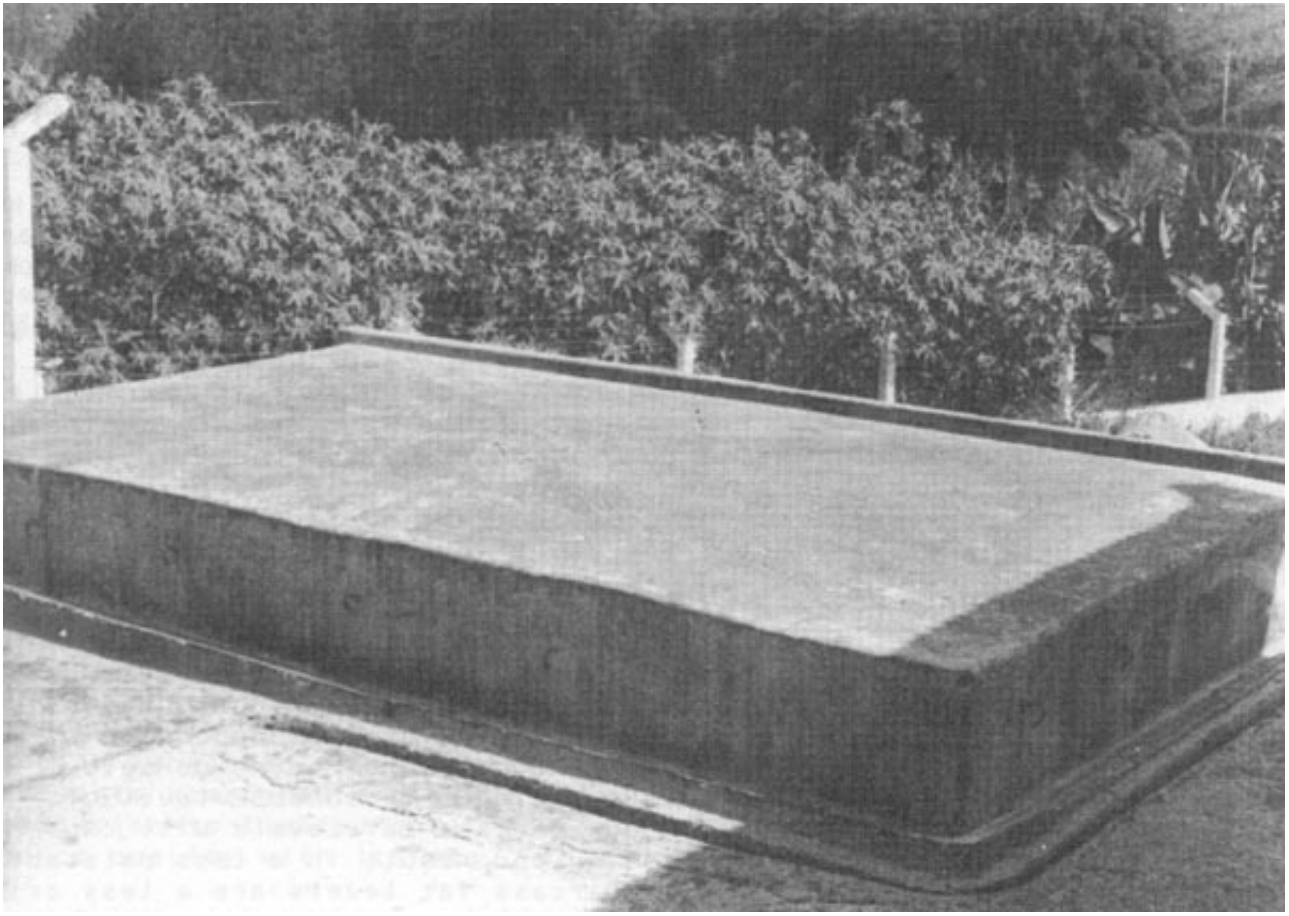


Figure 3. Area for the drying of charque, showing varales and concrete plinths.

Care should be taken to locate the plant in a pollution free area open to natural ventilation and exposure to the sun. Surrounding trees and vegetation should be cleared and the whole area cordoned off with a post and wire fence to prevent entry of domestic and wild animals. Areas not covered in concrete should be planted with grass to limit soil erosion and prevent the formation of dust bowls which are likely to complicate good sanitation practices. This applies both to the plant and the area immediately surrounding it. Care should be taken to maintain the compound and surrounding area free of debris and rubbish which could act as a focus point for insects and rodents.

4. RAW MATERIALS

A careful selection of raw materials is essential to guarantee the manufacture of good quality products. A certain lack of confidence in the quality of dried meat has grown over the years from the unscrupulous practice of using spoiled meat in their manufacture. Such practices should be strongly discouraged. Dried meats, like other processed products, are highly susceptible to manufacturing defects resulting from the use of inferior quality raw materials and ingredients.

To safeguard against the production of unsound unwholesome products, it is recommended that only carcass meat from recognized and reputable sources is used. In countries where meat inspection services are well established and enforced, raw

materials should carry official stamps indicating that the carcasses have been inspected and passed for human consumption. In regions where such infrastructure is not available, the carcass meat should be carefully examined and rejected if suspected of being unsound. Regardless of the presence or absence of official markings, all raw materials should be inspected routinely upon reception for evidence of insect lavae, slime, off-odours, discolouration or adulteration with chemicals, pesticides, dirt, etc. Bruises should be trimmed off, or at least opened, and the clotted blood scrubbed out. All unsuitable materials should be rejected. Frozen meat should be carefully monitored during the period it is defrosting for signs of surface contamination and off-odours. It should be remembered that defrosting of whole frozen beef quarters may take up to 7 days, during which time surface deterioration is inevitable unless the ambient temperature is kept around 2° to 5°C.

4.1 Selection and Preparation of Meat

Charque and carne-de-sol are traditionally manufactured from bovine muscle although sheep and goat meats are also suitable. Pork, which is rich in unsaturated fatty acids is not suitable for the production of charque, although it can be used in the production of carne-de-sol. charque is best produced from carcasses having a reasonable level of subcutaneous and intramuscular fat. Low carcass fat levels will cause an enhanced weight loss during processing and result in a less palatable more excessively dehydrated product. Carcass fat levels are a less critical factor in the manufacture of carne-de-sol because the drying period is much shorter.

Butchery practices have to be carefully chosen to ensure the separation of manufacturing cuts of uniform thickness (2–4 cm). In the north-east of Brazil unique carcass division and deboning procedures are used for the processing of carne-de-sol. Similar procedures were once employed in the south of the country for charque manufacture at a time when whole carcasses were cut

up for this product but with the increasing demand for high quality cuts, new butchery procedures were introduced.

The traditional procedures of deboning, using whole carcasses, are described in more detail below.

Butchers usually allow carcasses to "cool" for several hours post slaughter to allow fat deposits to firm and to facilitate the separation of manufacturing cuts. Separation of the carcass longitudinally into sides and horizontally into quarters is followed or proceeded by the removal of renal and channel fat deposits, the uterus in the case of the females and the reproductive muscles and organs in the case of males.

The hindquarter separated between the 12 and 13th ribs is subdivided into five primal regions; inside round (cha de dentro), outside round (cha de fora), knuckle (patinho), rump (alcatra) and hindshank (largarto posterior). The points of anatomical

separation of these cuts are shown in Figure 4. The forequarter is in turn subdivided into five primal regions; clod and rib cap (posta gorda), brisket (peito), chuck and neck (acem), rib eye (contra file) and shank (lagarto anterior). This system of quartering and primal division results in the separation of 10 cuts of similar weight and with a more satisfactory distribution of first and second quality meat than is possible using the customary "pistola" cutting practices. Variations in these butchery practices are recommended in countries where there is a demand for cuts differing in quality and price.

A further division into secondary manufacturing cuts is usually necessary to separate the filet (file mignon) from the rest of the inside round (cha de dentro) and to remove the distal muscles of the hind leg from the outside round (cha de fora). In sheep and goats this secondary division is not usually carried out.

The twelve manufacturing cuts are made ready for further

processing by a series of incisions which permit the opening of the muscle blocks into flaps or "mantas" of equal thickness. These "mantas" are further scored with a knife across the direction of the fibres to facilitate salt penetration.

4.2 Salt

The salt used in the processing of carne-de-sol and charque falls into two categories. Coarse marine salt, which has not been processed and has crystals between 2 to 7 mm in size; and ground marine salt the crystals of which pass totally through a 2 mm seive. Refined salt which has been subjected to the removal of all organic impurities, magnesium and calcium is sometimes employed in the manufacture of carne-de-sol but its application is limited and there is no information suggesting improved product quality with its use.

Salts with total insoluble solid contents greater than 0.3% and

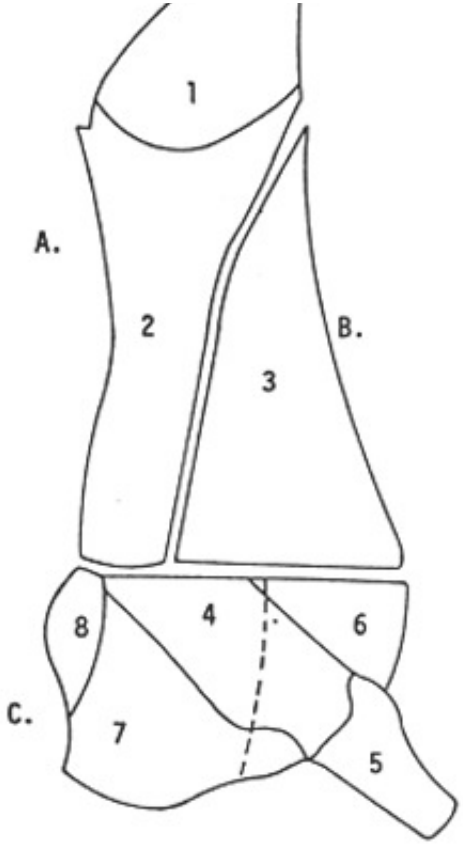
with turbidity levels higher than 50% are not recommended.

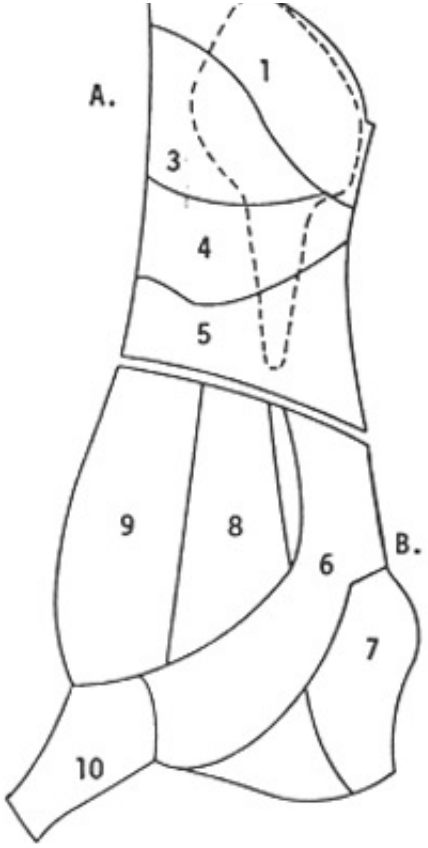
Contamination of marine salt by facultative aerobic halophilic bacteria can lead to a loss of product quality and in some cases to condemnation of the product (sour charque).

In the processing of charque and carne-de-sol a large quantity of brine and used salt is produced during the salting, re-salting and overhauling operations. Where the cost of salt is high, recovery may be advisable using vacuum evaporators. Salt recovered in this way is too fine for many operations but is excellent for reinforcing brines or for covering winter piles of charque.

a) Modern Frigorifico Practices

b) Traditional N/E Brazil Practices





INSIDE

1.	ROUND (Coxao)	20.4	1.	ROUND(Chade dentro)	9.3
2.	RUMP and LOIN (Alcatra completa)	13.8	2.	OUTSIDE ROUND (Cha de fora)	8.6
3.	Ponta de agulha	12.5	3.	HINDSHANK (Legarto posterior)	1.9
4.	SHOULDER (Paleta)	8.7	4.	KNUCKLE (Patinho)	8.8
5.	Shank (Musculo)	1.8	5.	RUMP (Alcatara)	6.4
6.	Brisket (Peito)	4.9	6.	CLOD and RIB CAP (Posta gorda)	8.4
7.	CHUCK and NECK (Acem and Pescoco)	11.2	7.	RIB EYE (Contra file)	4.7
8.	HUMP (Cupim)	1.2	8.	CHUCK and NECK (Acem)	9.1
	CARCASS YIELD		9.	BRISKET (Peito)	10.2
	Manufacturing cuts	70.9	10.	SHANK (Lagarto anterior)	3.5

Bones and Trimmings	29.1	CARCASS YIELD	
Total	100.0	Manufacturing cuts	70.9
		Bones and trimmings	29.1
		Total	100.0

Figure 4. Carcass Division and Separation of Manufacturing Cuts.

4.3 Water Quality

The nature of the water supply determines the extent of the treatment required before it can be considered suitable for use in the manufacture of charque or carne-de-sol. Heavily polluted supplies, containing large quantities of organic material, require full treatment including sedimentation (with or without flocculation), filtration and chlorination. Clean water from deep wells or mains water may not require any treatment prior to use.

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5. PROCESSING PROCEDURES

Manufacturing cuts for charque and carne-de-sol production must be carefully prepared after deboning to produce muscle pieces or uniform thickness. Muscle blocks greater than 5 cm thick are not suitable. Where “pontas de agulha” (flank and rib pieces) are used, little further work is required apart from small incisions to facilitate salt penetration. In the case of hind and forequarter cuts, more extensive opening of the muscle blocks is necessary to ensure uniform salt penetration and consistant drying time.

5.1 Charque (Figure 5)

Wet salting

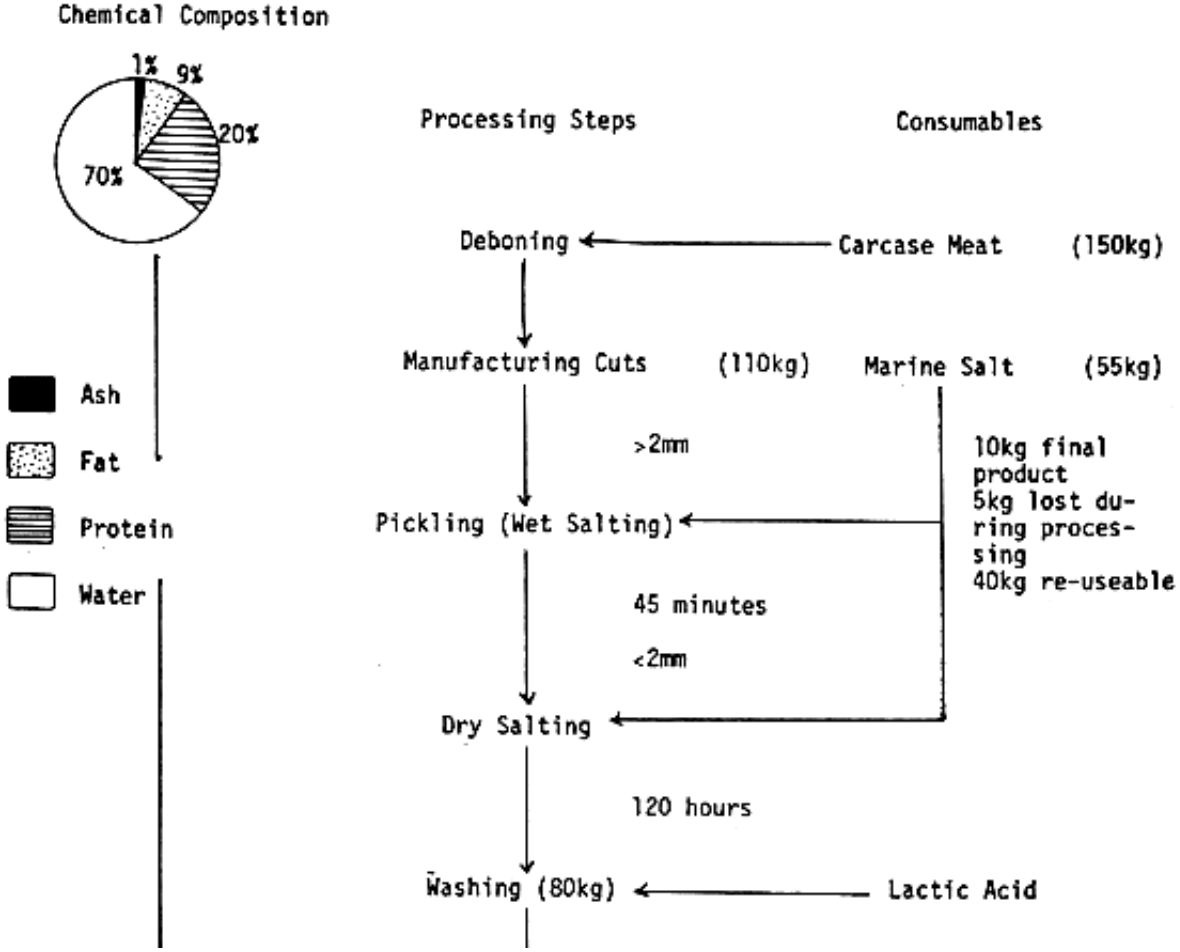
The wet salting or brining operation is carried out in pickle vats of approximately 80 cm depth, of a size depending upon the capacity of the plant. The interior of the tank should be lined with impermeable fine screened concrete or with high quality glazed tiles.

Footnote:

BRINE TABLE

Based on Salometer readings at 15°C.

SALOMETER	BAUME	% BY WEIGHT NaCl	Composition of brine	
			Kg salt	Kg water
100	24.6	26.4	0.358	1.000
95	23.5	25.0	0.355	1.000


Chemical Composition
1%
9%
20%
70%
Ash
Fat
Protein
Water
Processing Steps
Consumables
Deboning
Carcase Meat (150kg)
Manufacturing Cuts (110kg)
Marine Salt (55kg)
>2mm
10kg final product
5kg lost during processing
40kg re-useable
Pickling (Wet Salting)
45 minutes
<2mm
Dry Salting
120 hours
Washing (80kg)
Lactic Acid

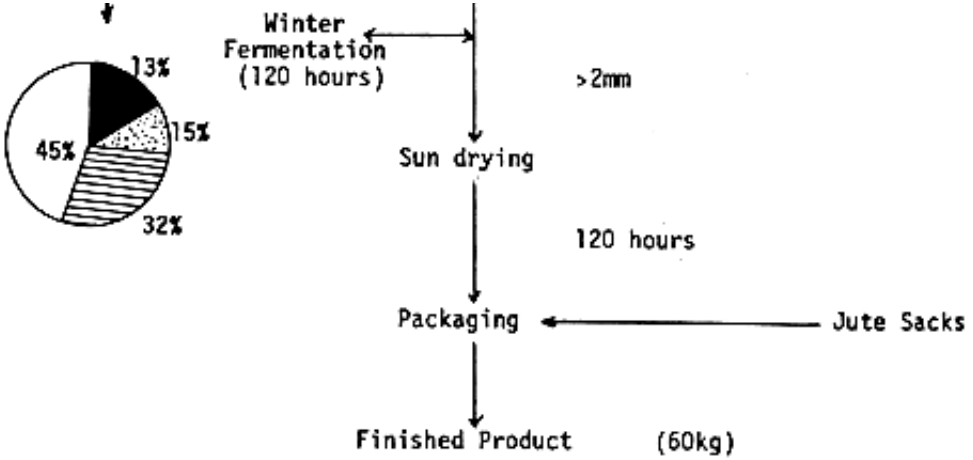


Figure 5. Flow chart, manufacture of charque, showing industrial yield and chemical changes during processing.

A brine strength as near 100° salometer as possible, but never less than 95° (see footnote), should be maintained constantly during the wet salting stage. In larger plants, this may be achieved by pumping the brine continually through a secondary

tank mounted to one side and above the main tank and containing raw salt. The brine, maintained as far as possible at 15–20°C, recirculates into the main tank by gravity. In the case of small throughout plants, readjustment of the brine after each batch should be sufficient for the maintenance of the necessary strength.

The immersed meat pieces are agitated vigorously, by the use of paddles, for a period of 50 minutes after which they are removed from the tank. The meat acquires a blue tone during this phase of the processing.

The brine should be tested every hour for temperature and salinometer strength and replaced each week with sterilized and cooled pickle (see footnote). The brining vats must be thoroughly cleaned before refilling.

Dry salting

Preparation of the piles

Dry salting is initiated, after the meat is removed from the brine tank, on a concrete floor covered with a 1 cm layer of salt. The floor should be slightly inclined, falling away into lateral channels to carry away the meat juices expressed during salting. The meat pieces are stacked into piles (see Figure 6) separated from each other by layers of coarse marine salt (1 mm thick). The salt should be shovelled over the meat as a fine shower from several directions to ensure even penetration into meat cuts and openings. The height and dimension of the pile are likely to be governed by the scale of production but should not be allowed to exceed 1.50 meters for fear of exagerating the pressure on the lower meat Layers thus causing excessive weight loss. Each pile when complete should be capped with a 2 cm covering of salt (see Figure 7).

It is usual to arrange piles initially with the fat layer uppermost

but this orientation is not critical because the piles will be later inverted.

Re-salting

The pile is restacked after 8 hours in order to equalize pressure throughout. Thus, the uppermost meat pieces are repositioned on the bottom of the new piles (see Figure 8). As in the initial salting step, thick layers of coarse salt are placed between each successive meat layer and also on the top of the pile. The meat remains in the second pile for a period of 16 hours before being repositioned into its original order (pilha da volta).

Footnote:

Measurement of Brine Quality

Fill a cylinder of 500 ml with the brine well mixed bring the temperature to 15°C. in a cold store using ice where available.

Place the salometer and thermometer together in the cylinder and record brine strength when temperature reads 15°C.

Figure 6. Preparation of piles during the manufacture of charque.

Figure 7. Finished pile with salt capping.

Figure 8. Restacking of piles during manufacture of charque.

Tumbling

The piles are remade every 24 hours in order to ensure even salt penetration and water loss. The repositioning also reduces the risk of microbial contamination of the pile. The number of "tumbling" varies according to pile size and weather conditions but should be no less than four. If the weather is not suitable to initiate drying, the meat may be kept for a further day or so in the dry salt room. Movement of the meat piles usually follows a set pattern to ease manipulation and help control production flow (see Figure 9).

Weight loss during the dry salting phase ranges between 18% for meat with a high fat content to 20% for very lean meat.

The salt recovered during the various tumbling stages may be re-

used after suitable treatment in selected operations (see 4.2). During the tumbling process nothing other than coarse marine salt with a grain size less than 2mm should be used.

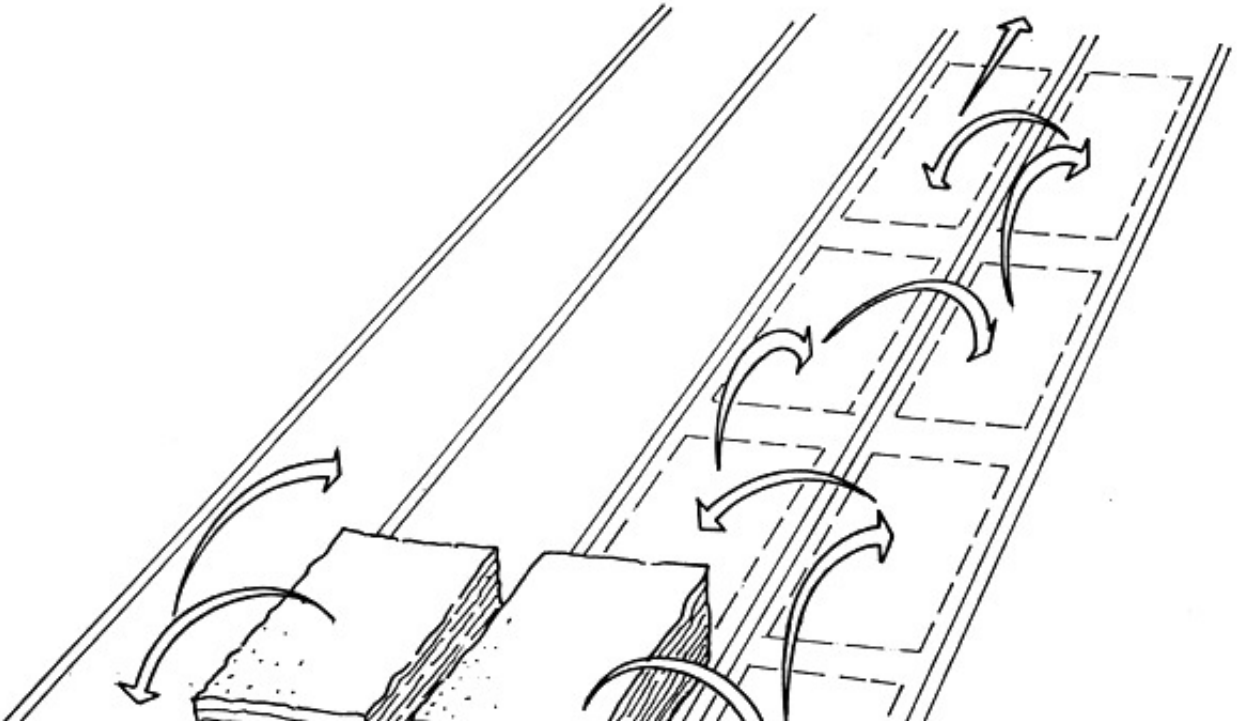


FIGURE 9. Schematised Layout of Salting Room Showing Tumbling of Charque Piles.

Figure 10. Washing of meat pieces to remove excess salt during the manufacture of charque.

Washing

Before initiating drying, the meat pieces are subjected to a rapid washing to remove excess salt adhering to the surface (see Figure 10). This is carried out in rectangular tanks approximately 1 metre wide and 4 metres Long, using running cold water treated with lactic or acetic acid to lower the pH below 5.5.

Drying on varales

If weather conditions are favourable, charque is usually dried directly in the sun on wooden rails (varales) positioned parallel in "runs" oriented north-south (see Figure 11). The distances between these runs should be sufficient to allow movement of barrows used to transport the meat from the washing to the open

drying area.

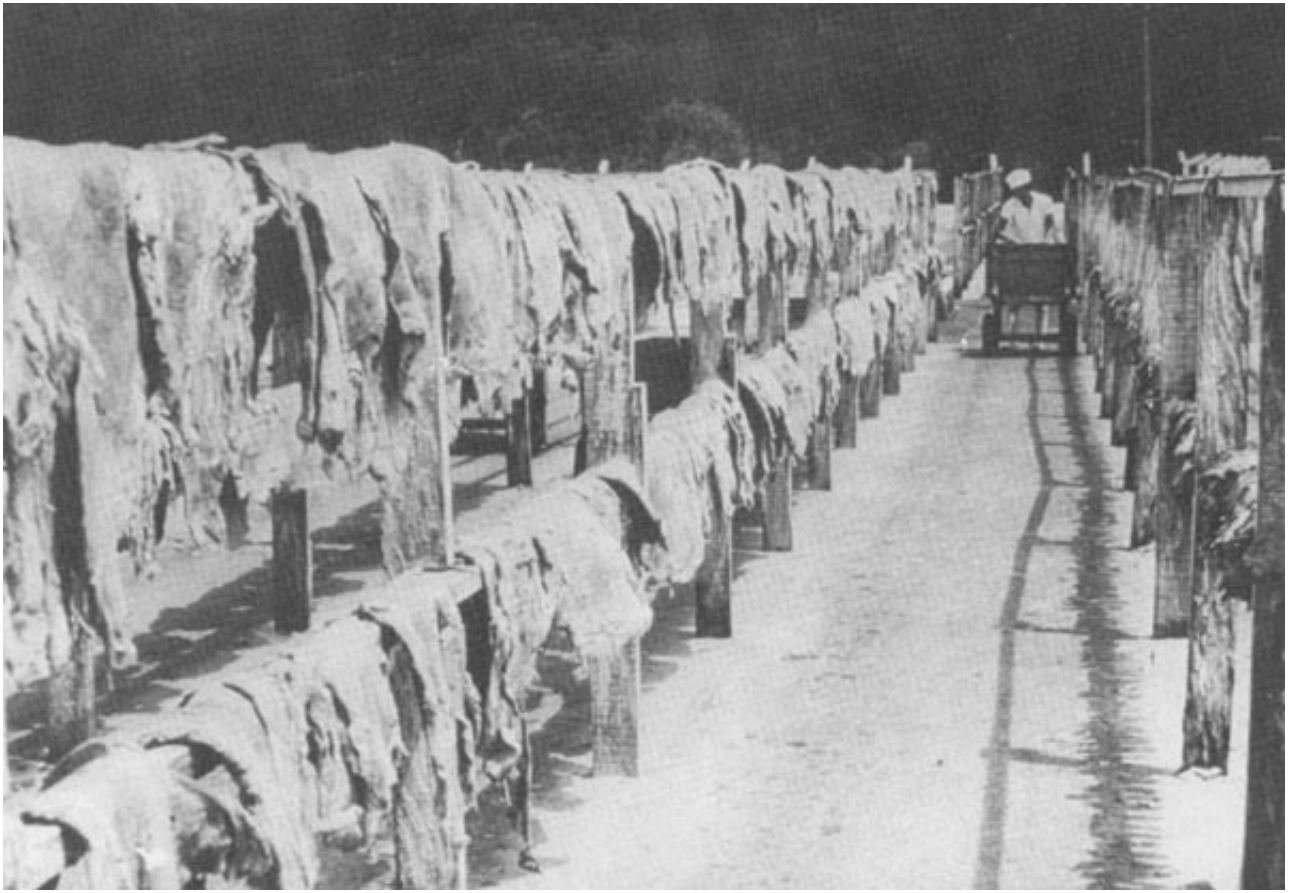


Figure 11. Drying of meat pieces on varales during manufacture of charque.

The meat pieces are extended over the rails with the muscle layer uppermost in order to limit undesirable changes to the fat caused by direct exposure to the solar rays. The initial drying, directly in the sun, is limited to a maximum period of 4–6 hours. This period of exposure may be subsequently lengthened to a maximum 8 hours. Temperatures in excess of 40°C on the meat surface should be avoided.

To ensure an even drying over the extended muscle pieces, the meat is placed on the rails during the morning and removed again in the afternoon. The north-south orientation of the rails permits an even solar coverage.

The meat pieces are exposed to the sun each day over a period of 4 to 5 days. In Brazil this is known as 4 to 5 suns or "sois".

After each period of exposure the pieces are recollected (see Figure 12), stacked in piles on concrete plinths and covered with an impermeable cloth or tarpaulin to protect them against rain and wind and to hold the heat absorbed by the sun. The top of the pile is usually built with a crown to facilitate purging and, in the case of rain, water will run off.

Figure 12. Restacking of piles during during of charque.

Alternative processing - "Winter Piles"

The process of "winter pillage" is used during times of the year when there is constant rain or cloud cover or in regions where weather patterns are uncertain.

Meat pieces are stacked in piles upto 3 metres in height (depending upon availability of material) on special concrete plinths (see Figure 13), immediately after the 3rd or 4th tumbling and without prior washing. Piles should be built with a 10% slope from centre to sides to allow free draining.

The piles may be erected in a covered area adjacent to the dry salting room or in a refrigerated store, if this is available. Fine salt (less than 2mm grain size) should be positioned between layers at the moment of putting into piles.

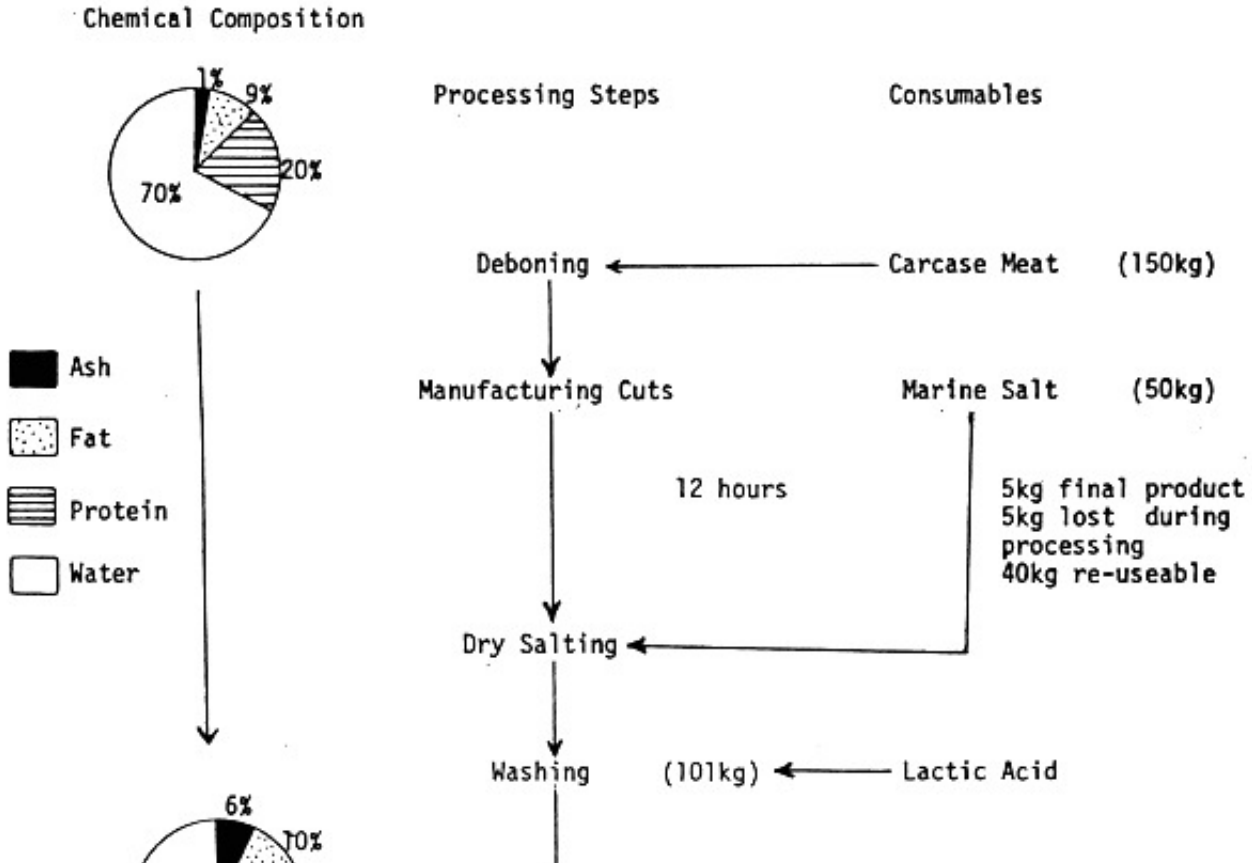
Where piles are kept at ambient temperatures, they must be carefully maintained to obviate microbiological spoilage. This is achieved by covering the whole pile with a thick layer of marine salt, treated with sodium hypochlorite solution (0.4%) up to a thickness of 20–30 cm. Alternatively, salted offals such as lungs, hearts and kidneys may be used to cover the meat pieces. Air penetration into the pile should be prevented as far as possible. A heavy hessian cover moistened with 50% sterilized brine is usually employed to prevant dessication of the upper meat layers. This is tied down using strong cord. The fermentation process takes place under strictly anaerobic conditions.

The piles may be maintained in this state for periods up to 4 months after which the meat is washed using water treated with lactic or acetic acid, and dried in the sun according to the procedures earlier described. "Winter pillage charque" is usually only subjected to sun drying for 2–3 "sois".

5.2 Carne-de-sol (Figure 14)

Processing procedures for carne-de-sol are very similar to those used in the manufacture of charque and both operations may be carried out in the same premises using similar equipment and facilities.

Figure 13. Preparation of charque for "winter pillage"



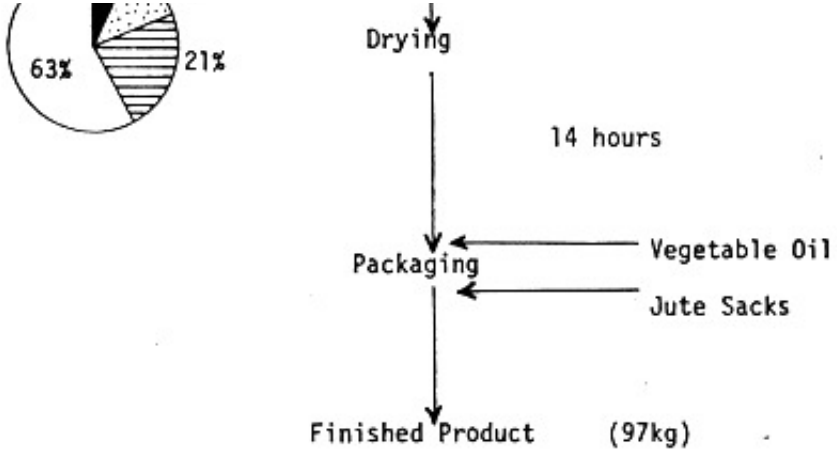


Figure 14. Flow chart, manufacturing of carne-de-sol, showing industrial yield and chemical changes during processing.

Dry salting

The salting operation may be considered as comprising an active and passive phase. During the initial active phase, refined or ground marine salt is rubbed into the meat by hand with the object of ensuring a complete coverage and even distribution.

This operation is best carried out on tables covered with stainless steel or high density plastic.

The passive salting phase is similar to that used for charque. Meat pieces, after hand rubbing, are placed with the fat layer uppermost on a concrete floor covered with a fine layer of coarse marine salt. The pieces are stacked into piles (see Figure 8), separated from each other by 3 mm layers of salt. The height and dimensions of the pile are likely to be governed by operational scale but in any case should not exceed 0.50 metres high.

The stack is remade and inverted 4–6 hours later to permit an even pressure over the mass and to guarantee a uniform salt penetration.

The remade pile is allowed to stand with a 10 cm covering of salt for a further period of 4–6 hours.

Washing

The same tanks used for washing charque may be utilized for carne-de-sol. In the schematised layout in Figure 1, the washing area for carne-de-sol is enclosed within the covered drying area to improve product flow and to minimise contamination. A 1% solution of lactic or acetic acid may be incorporated in the washing water to lower its pH to less than 5.5, thus reducing risks of microbial development. Use of these chemical control measures does not substitute good plant hygiene and careful attention to raw material quality.

The muscle pieces should be washed rapidly to remove excess surface salt and then transferred to the covered drying area for drainage and drying.

Drying

Since carne-de-sol has a limited life and is likely to be produced throughout the year regardless of climatic abberations, it is usually subjected to drying in sheltered, well ventilated areas. The pieces are extended over rails with the fat layer uppermost for a period of between 8–14 hours. During this time the excess meat juices are allowed to drain away. The problem of insect infestation can be minimised by enclosing the whole drying area in fine guage setting.

At the end of the drying phase the meat pieces are collected and taken to the packing room to be wrapped and made ready for sale. In some parts of Brazil, the semi-dried meat is smeared with a fine layer of vegetable oil, such as soya oil, prior to wrapping, in order to remove salt crystals which appear on the product surface during during. This is optional but does result in a significantly improved appearance.

6. PACKAGING, DISTRIBUTION AND PLANT HYGIENE

6.1 Packaging and Transport

The type of packaging used for charque and carne-de-sol depends on the consumer market to which the products are destined, the transport mode employed and the distances carried.

In the less sophisticated and often less demanding markets of the north and north-east of Brazil, carne-de-sol and charque are usually sold without prior packaging. This facilitates customer judgement of product which is usually sensorial (touch and

smell).

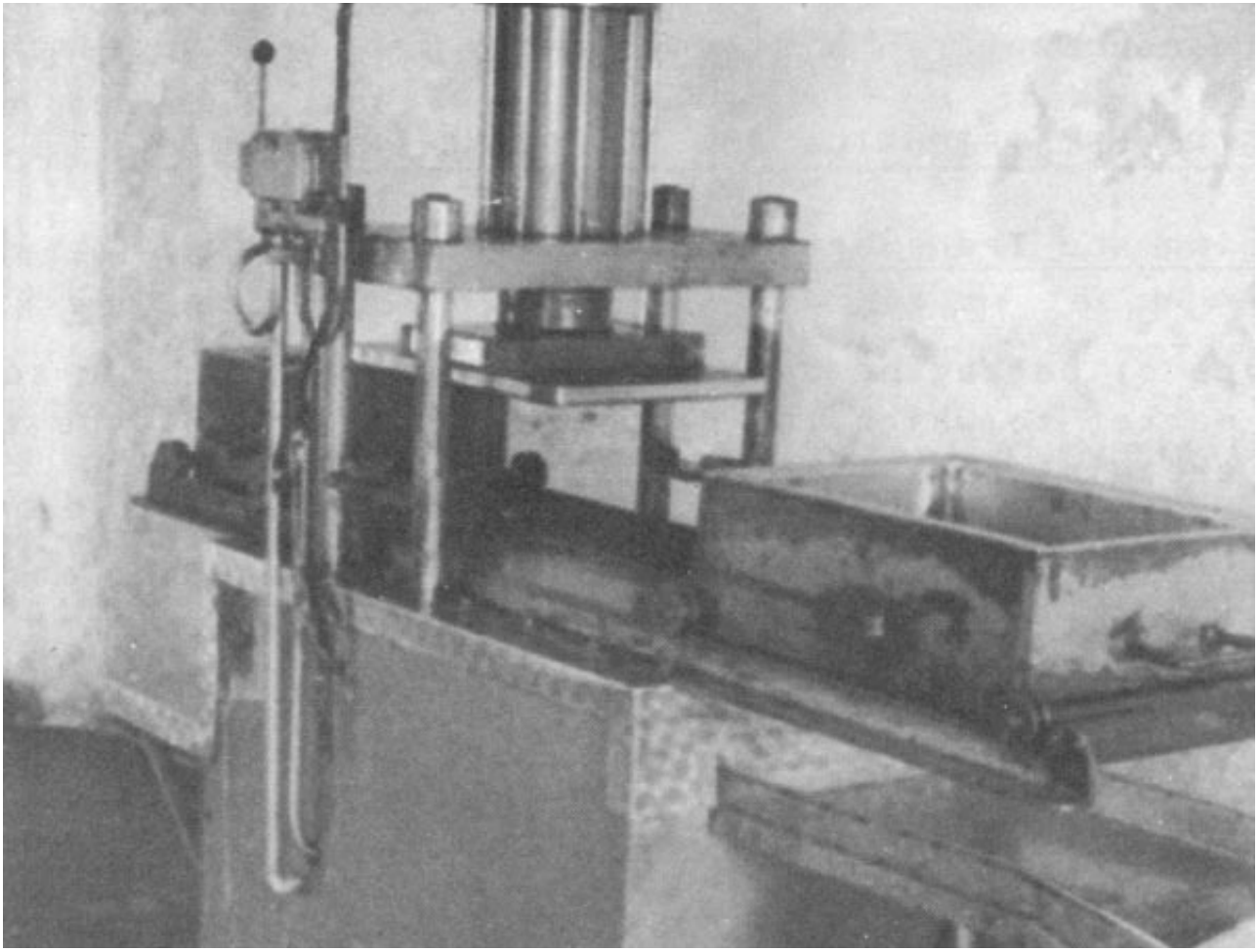
Carne-de-sol is normally distributed to market sites in 30–50 kg loads wrapped in jute sacks and trussed tightly using strong cord. Because the product still contains a high proportion of its original water content, some drip loss will occur during distribution and this must be allowed to drain freely from the product. For this reason plastic sacks are not suitable.

Upon arrival at the market the meat is removed from its wrapping and displayed uncovered.

Charque is usually transported to market sites in open lorries in the form of 50–60 kg bales packaged in sackcloth of jute. The bales are protected with a covering of waterproof canvas. As in the case of carne-de-sol, charque is usually removed from its wrapping and displayed uncovered in the meat markets.

Increasing use is being made of meat presses to prepare charque for transport (see Figure 15). The pressed form is more attractive and can be easily stored and loaded, thus reducing storage space and lowering transport costs. In large throughput plants, the 20–50 kg pressed pieces are vacuum packed in nylon/polythene laminate film to further extend shelf life and protect the product from chemical changes and physical damage during distribution. The combination of pressing and packing in air and water-proof film effectively reduces oxidative changes in the product greatly improving appearance and sensorial quality.

The lipolytic changes which occur in the presence of oxygen are particularly severe at high storage temperatures.



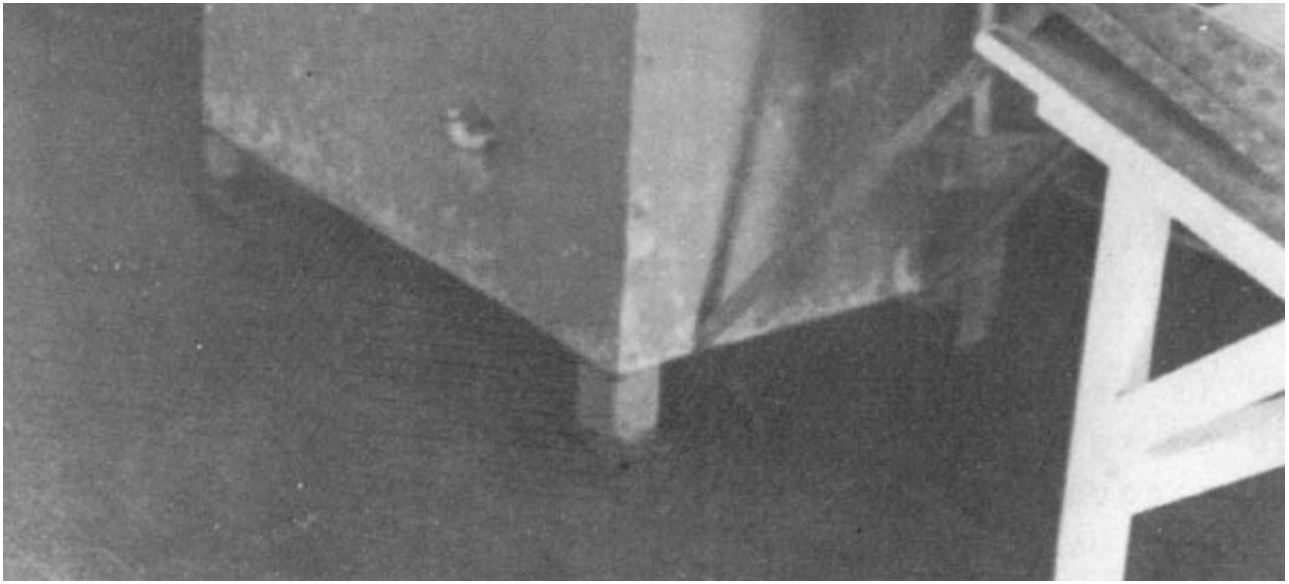


Figure 15. Press used to prepare charque for transport.

The practice of packaging retail sized portions of charque in vacuum pouch packages of 500 g or 1 kilogram has been successfully employed but production and investment costs are high. These costs are off-set by improved hygiene, better

appearance and more especially through increased yield since marginally higher product water levels may be envisaged without subsequent loss of shelf life.

Charque should not be packaged in cold or damp rooms which cause water to condense on the meat surface.

6.2 Hygiene Considerations

Carne-de-sol is a highly perishable product which is subject to rapid processing and requires early consumption. The factors effecting quality and shelf life of this product are very similar to those governing fresh meat.

Of major importance is the quality of the raw materials used. Abnormally dark coloured muscle having a high pH is usually associated with meat from stressed animals. This meat does not permit normal salt penetration and will spoil rapidly. It should be

avoided where possible. Meat which is very soft, pale and exudative can be used without fear in the manufacture of carne-de-sol and charque but final product yields are likely to be affected. Other aspects of raw material quality have been considered in an earlier chapter.

Hygiene control in the plant should be primarily aimed at (i) preventing contamination through bacteria that are tolerant of salt and which cause disagreeable changes in the products and (ii) discouraging insect larval infestations.

Each step in the processing deserves particular care but special attention must be given to the brining and drying operations.

Rennovations of the brine must be carried out often to avoid microbial contamination. In many plants the brine is tested daily to verify its redox potential. A high potential is necessary to avoid the build up of microbial growth. Mechanical agitation of

the brine also serves the same purpose. Where it is not possible to verify the brine condition, it is recommended that it is either discarded daily or boiled if this is economically sensible.

The drying racks are another major source of contamination by the nature of the material from which they are constructed. Wood is difficult if not impossible to cleanse thoroughly and must be subject to rigorous disinfection. A daily routine of degreasing with chemicals or hot water should be followed. After the removal of the fat deposits, the rails should be thoroughly washed down using a 0.4% sodium hypochlorite solution. Plant managers should note that since sodium hypochlorite is readily decomposed by organic matter a preliminary wash down with hot water to remove grease is essential. Contact time of the hypochlorite solution should not be less than 10 minutes after which the rails should be once more washed down with acidified water.

All equipment, floors and walls should be subject to a routine washing down and disinfection. Water used for the initial scrubbing down of surfaces to remove fat and other organic material should be maintained at 70–75°C and cleaning cloths should be used once only and then boiled. The most suitable disinfectant for meat plants is sodium hypochlorite.

The control of insects inside the plant can be successfully achieved using netting at all windows, doors and in exposed roof spaces. Air curtains are also effective but the high purchase and running costs exclude their use in small throughout plants. Outside the plant, files can be controlled through periodic removal of all debris and litter and by a daily programme of fumigation with insecticides. Such steps should only be carried out under the direction of experienced officers since public health risks are associated with indiscriminant use of insecticides.

Footnotes:

Preparation of sodium hypochlorate

Mix 50 g chloride and lime and 100 g washing soda with a little water to a thick paste. Dilute, stir well, with water to make up 5 litres. Allow sediment to stand then decant or filter off the clear liquid. This will give a 0.4% solution ready for use.

It is important that charque does not come into contact with alkaline surfaces which provide an excellent medium for the development of red mould (vermelhao). Where alkali detergents are used for the removal of grease it is imperative that these surfaces should later be washed down with a solution (1%) of acetic or lactic acid.

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