03-080-1
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January 2, 2004

Docket No. 03-080-1
Regulatory Analysis and Development,
PPD, APHIS
Station 3C71
4700 River Road, Unit 118
Riverdale, MD 20737-1238

RE: Docket No. 03-080-1

This submission is in response to a request for public comment on the proposed rule concerning *Bovine Spongiform Encephalopathy; Minimal Risk Regions and Importation of Commodities, (Federal Register Vol. 68, No. 213, Tuesday, November 4, 2003, pgs. 62386-)* on behalf of the North American Natural Casing Association, an association that represents the majority of natural casing producers and brokers in North America. Our members produce, buy, sell and distribute casings worldwide. The US industry processes virtually all available US runners saved by slaughterhouses and also imports and exports significant amounts of casings to meet demand in the US and around the world.

Natural casings, animal intestines that have been cleaned further calibrated (selected) into a neutral container for use primarily in sausages, constitute a significant industry in North America and world wide. There are three primary animal intestines used in natural casings, hog, sheep and beef. (See attached fact pamphlet at **Exhibit 1**). Of these, hog intestines are not an issue in this regulation, as hogs are not ruminants and are not susceptible to BSE.

**Sheep:** The sheep and lamb intestines used for casings are the most valuable of the species used for casings, due to their tenderness and translucent color, and are in great demand. In the US, saved runners supply approximately 20% of the US market, with the rest imported, primarily from Australia and New Zealand. Canada has also been an important market for sheep/lamb casings, before the trade was banned in May.

**Beef:** The market for Beef intestines worldwide has significantly decreased since the finding of BSE in the UK. In the US, currently most beef intestines for use as casings are imported from countries such as Brazil, that are considered free of BSE by the EU and the US. Until the finding of BSE in one animal in Canada, there was important trade in beef casings from Canada. The US has not been able to ship beef casings to the EU for many years due to the BSE issue, although customers in the EU have consistently requested that the restrictions be lifted as the US product was in demand in the EU. There

are thus only limited amounts beef intestines saved for casings in the US, but there has been an important market for beef intestines used as a food product, primarily in exports to Asia. The parts of the beef intestine used as casings are primarily the beef bung caps, beef rounds and beef middles. Beef rounds are derived from the small intestine. Beef middles are derived from the large intestine and bung caps is the section between the round and the middle.

NANCA has participated with the International Association (INSCA) and the European Association (ENSCA) in a joint Scientific Working Group for many years, and other country associations have participated through INSCA in the research and development on casings and their safety. Over this period, the industry has commissioned several studies on the safety, use and processing of natural casings. The industry is committed to providing the safest product possible to the public, and there are no known cases of natural casings being implicated in any disease or food safety event. The industry developed a HACCP program now in use throughout the world by companies, and is constantly monitoring and providing scientific information on issues that might affect the safety and marketability of natural casings.

Our comments on the USDA proposed rule follow:

**A. NANCA Supports the new category in 9 CFR sec. 94.18 (a) (3) for "Minimal Risk Regions".**

We are supportive of actions proposed by the USDA/APHIS that will ensure minimal risk of exposure to BSE from animals or products of regions where BSE has been identified. We also are supportive of the revised policy that will more realistically treat product from minimal risk regions. The OIE has for many years recognized that BSE risk can never be zero and thus must be identified through sound science in a way that will provide continued trade in product from regions at low risk. We believe Canada (and the US) falls into that category. The criteria for such a determination included in the proposed rule for minimal risk regions meets, we believe, international scientific requirements.

**B. NANCA supports the designation of Canada in the new "Minimal Risk Region" Category.**

The actions by the Government of Canada since the finding of a single cow with BSE in Canada on May 20, 2003 have demonstrated that the criteria proposed in the regulation can be effective in reducing the risk of risk material entering the food chain. Further the investigation in Canada verified the low potential of any widespread outbreak of BSE in North America. The level of surveillance, enforcement of the feed ban and risk mitigation, along with restrictions in place in ensure that imported animals do not come from high risk areas.

**C. NANCA supports the proposed removal of the ban on sheep originating in Canada. Sheep casings originating in Canada should be allowed entry into the US.**

Numerous studies have found no natural cases of BSE in sheep. As noted in the proposal (FR, page 62391; *Source Species*), the experimental infections of sheep show that the prion is distributed widely throughout the animal, and thus, if BSE were a concern in sheep, the entire animal would be at risk. As there have been no findings of BSE occurring naturally in sheep, it is appropriate to limit the exclusions to bovine animals and products. We note that while the proposed rule allows the importation of live animals, there was no amendment of 9 CFR Part 96 to provide the same exclusion from restrictions for sheep casings. We assume this was an oversight and that it will be corrected in the final rule. It would make no sense to allow the animal in to go to slaughter, but not allow the casing. Further, there is no greater risk in the casing than in the rest of the ovine derived products. Studies have shown a lesser degree of potential infectivity in cleaned casings than in bone-in joints of muscle meat of lamb/sheep. The cleaning process itself significantly reduces the amount of potential infectivity that may be present in the intestine by removing the mucosa (along with Peyer's patches), muscle and serosa layers.

The industry world wide has done considerable scientific study on the issue of sheep casings and any risk of BSE. As noted in the FR notice, the evidence of all studies so far completed is that the risk of BSE in sheep is miniscule if not nil. Further, to the extent there is concern about the distal ileum in sheep, the distal ileum is removed naturally in sheep during the cleaning process. The definition of the ileum is determined by the World Association of Veterinary Anatomists and specified in *Nomina Anatomica Veterinaria,* its official publication dealing with anatomical terms, as *"ileum—the short terminal part of the small intestine to which the Plica Ileocaecalis (ileocaecal fold) is attached..".* While there is no official definition of "distal ileum" this can unequivocally be determined as the distal (posterior, caudal) half of the ileum, the other (anterior, cranial) half being the proximal ileum – and can be determined by measurement to determine the mid point of the ileum. The international association (INSCA) includes a definition of the distal ileum in its materials distributed to all members and has prepared a video demonstrating cleaning methods that insure the removal of the distal ileum. (See attached statement at **Exhibit 2**).

In its discussions with the European Commission on this subject, the European Association and INSCA have provided scientific information which was accepted by the EU in their most recent decision to allow the trade in sheep casings with the ileum removed. * Further, the US certifies that US product has the distal ileum removed, (See FSIS export requirements for Japan) and Canadian procedures are the same – in short, the distal ileum is removed naturally in the cleaning process. This removal is a simple

* Commission Regulation (EC) 1139/2003, Annex 11, amending Regulation (EC) 999/01 related to classification of sheep and goat ileum as SRM for animals of all ages slaughtered after October 1, 3003. 1(a) (ii)....the ileum of ovine and caprine animals of all ages."

procedure, due to the fact that there is a natural tendency for it to break at its proximal end during the pulling (processing) of the small intestine. This tendency is converted to a certainty by adjustment of the tension on the pulling machine and/or during hand pulling, by the operator. The length of the total ileum (distal and proximal parts) is about 25-40 cm in sheep. In universal practice, this part of the intestine and additionally the first limiting cm of the jejunum are not used for sausage casing manufacture. For further information on this issue, See attached at **Exhibit 3,** *"Histological research on the cleaning efficacy of mechanically versus manually processed sheep intestines"*, P.A. Koolmees, M.H.G Tersteeg, G. Keizer & J. van den Broeck (July 2003).

We recommend, therefore, that 9 CFR 96.2 (b) be amended to read: *"The importation of casings, except stomachs, from bovines that originated in or were processed in any region listed in sec. 94.18 (a) (1) and (2) is prohibited."*

Recognizing that the distal ileum may be a risk material in all species, and recognizing the appropriateness of taking extra precautions in connection with BSE, we recommend that 9 CFR 96.3 be amended to require that certificates for importation to the US include a requirement that the distal ileum of bovine, ovine and caprine animals is removed from any product entering the US from all sources. This requirement would be consistent with what some countries are now requiring and with industry practice and would ensure consistency in import requirements for all casings entering the US.

D. **Specific Beef Products: NANCA recommends that the proposal to require the removal of the ileum from beef at the slaughterhouse be amended to specify that no more than the small intestine be removed and destroyed.**

The Proposed Rule provides a finding on tissue localization risk identifying only the distal ileum as a risk material in cattle less than 30 months of age. However, the rule then requires that the entire intestine be removed and destroyed from animals of all ages. Canada has required that the distal ileum be removed since July, 2003, and the US FSIS has itself recognized and certified that US beef casings destined for export have the distal ileum removed. For example, the Government of Japan has accepted the US certification for export of beef (and sheep) casings on the basis of the removal of the distal ileum. The definition of the distal ileum in beef and the protocol for removal prepared by the US beef industry was accepted by the US government, and we understand that it is policy in all slaughterhouses to remove the distal ileum at the time of slaughter. The same procedure is done in Canadian slaughterhouses. The general removal procedures and the definition of the part removed provide that the break point from the small intestine must be at least 80 inches from the Cecum and Ileum junction. Studies of infectivity of the BSE agent in experimental BSE in cattle have shown infectivity in the distal ileum.

While we believe that the removal of the distal ileum, which is the practice worldwide in the industry, along with the significant cleaning process, would significantly reduce any potential risk in the remaining product originating in minimal risk regions, we understand that the current events in Canada and the US may lead the US to require an extra measure of protection.

The proposed changes to 9 CFR Secs. 93 and 94 should, however, refer to no more than the small intestine, rather than "intestines" when requiring removal. This change would be consistent with the decisions announced by Secretary Veneman on December 30 in connection with actions required in the US as a result of the single case of BSE found in Washington State.

We recommend therefore, that 9 CFR 96.2 (b) be amended to read; *"The importation of casings, except stomachs, from bovines that originated in or were processed in any region listed in 94.18 (a) (1) and (2) of this subchapter is prohibited."*

Changes to reflect new certification requirements on the removal of the small intestine from minimal risk regions should be included in amendments to 9 CFR 96.3 to specifically require the removal of the small intestine of bovine casings originating in any country/region listed in 94.18 (a) (3.

We respectfully request that USDA consider these changes, which we believe fully meets both our desire and the desire of the US Government to ensure a safe animal and food supply in the US, while ensuring that the US industry can continue supplying its products to the sausage industry in the least disruptive manner.

Please contact us if we can provide further information or assistance in connection with issues involving the safety of animal casings.

Sincerely,

Shirley A. Coffield

Shirley A. Coffield
Executive Secretary and Legal Counsel

Attachments: Exhibits 1,2,3

EXHIBIT 2

# STATEMENT ON THE DEFINITION OF ILEUM

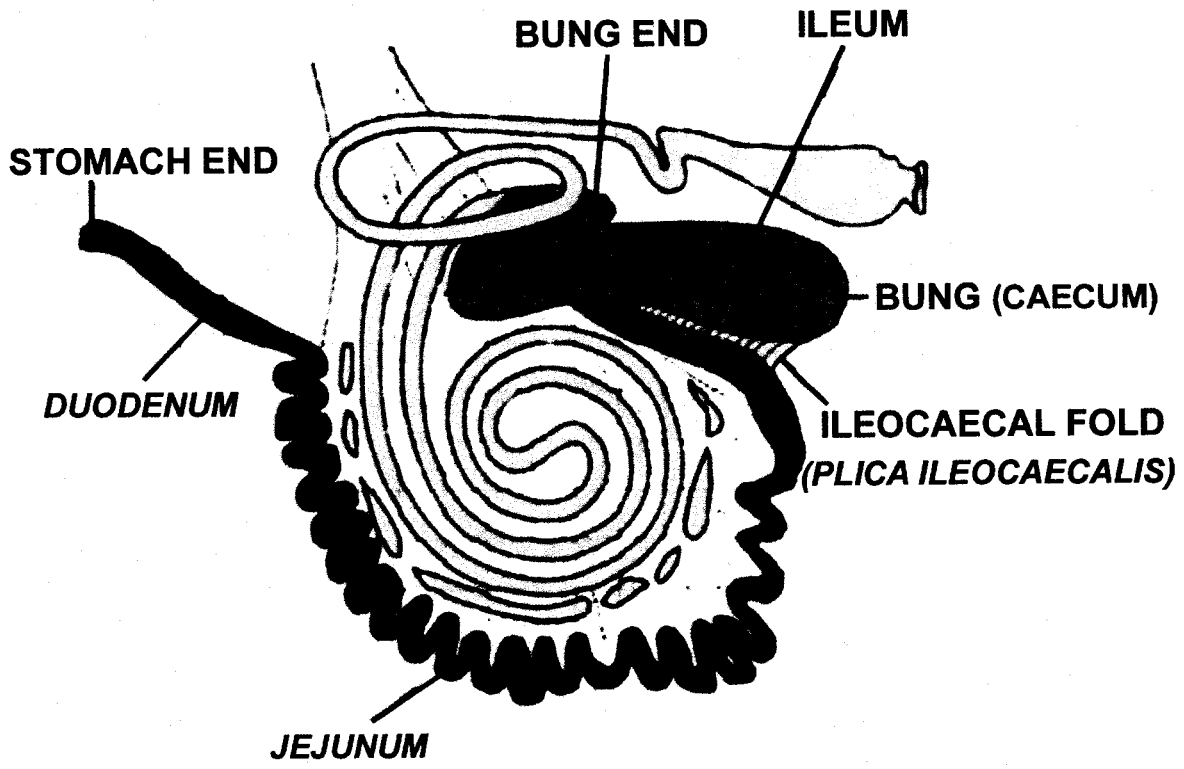
# INSCA • ENSCA • NANCA
# SCIENTIFIC WORKING GROUP

With the implementation on 1 October 2003 of the new Commission Regulation (EC) No 1139/2003 that amends Regulation (EC) No 999/01 related to classification of sheep and goat ileum as SRM for animals of all ages slaughtered on and after 1 October 2003, the following statement is issued in order to clarify a few points for the benefit of the natural casings industry worldwide and those responsible for risk management and enforcement of the Regulations.

## ANATOMICAL DEFINITION

At the request of the natural casing industry, three internationally recognized veterinary anatomists were consulted upon the anatomical definition of the ileum. It has been recommended that the definition in *Nomina Anatomica Veterinaria (NAV)* is used. The official body that authorizes acceptable veterinary anatomical terms is the World Association of Veterinary Anatomists and their list of official terms is published in *NAV.* The *NAV* definition is:

> *"Ileum:* the short terminal part of the small intestine to which the *Plicas ileocaecalis* is attached". This is clearly illustrated in following drawing which is also used in the video programme produced for the industry entitled "The production of natural sheep casings: Removal of the ileum" that shows the methodology for removal in the gut room.



The meat industry in general and the natural casings industry in particular, have adopted a range of terms to describe various parts of the intestine, not all of which correspond with the internationally agreed veterinary anatomical terms. When legislation is adopted (as in the EU from 1 October 2003) it is essential that the industry, regulators and inspectors have a common understanding of the law and how it should be applied. It is the purpose of this statement to assist in achieving a common understanding of some additional terms that have lead to a degree of misunderstanding/confusion.

The following appellations are commonly used in natural casing industry :

*Bell ends: found according to season and age of the animals, such special parts are usually 0.5 to 1.5 m long. Such portion is the distal part of the jejunum just before ileum.

- NZ or Australian Cuts: such specific processing methodology has been widely used in those 2 countries and by extension adopted in many factories.

Here three cuts of the small intestine/casing are defined starting from the distal (bung) end of the small intestine:

1st Cut: From the terminal (distal) jejunum (junction with the ileum) and extending forwards between 7.5 and 12 m.

2nd Cut: The middle part of the jejunum of unspecified length.

3rd Cut: The proximal jejunum (junction with the duodenum) of unspecified length.

INSCA • ENSCA • NANCA SWG

1 October 2003

**INSCA • ENSCA • NANCA**
**Scientific Working Group**
**12100 Sunset Hills Road, Suite 130**
**Reston, VA 20190**
**703-234-4112**

EXHIBIT 1

# THE SYMBOL OF NATURAL CASING SAUSAGE

INSCA

International Natural Sausage Casing Association
12100 Sunset Hills Road, Suite 130
Reston, VA 20190
Phone: 703-234-4112
Fax: 703-435-4390
Internet address: http://www.insca.org
Email: insca@aol.com

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### About INSCA . . .

INSCA is the International Natural Sausage Casing Association—a not-for-profit international trade association of the Natural Casing industry consisting of producers, processors, sausage makers, brokers, industry suppliers, and affiliate and associate members of sausage making industry.

INSCA was established in 1965. Its founding members were predominantly American companies. As the Association evolved, new members from other countries helped mold the representation into a global presence which today includes European, North and South American, Asian, Middle Eastern, African and Australian companies.

INSCA is dedicated to increasing the knowledge and appreciation of quality sausage produced in Natural Casings.

## How to Use this Manual:

This book is intended to serve as a guide for sausage makers, deli managers and students of sausage making.

- The various types of Natural Casings are identified
- Their range of calibration is classified
- Approximate stuffing capacities are given
- Ideal uses are recommended

This information is provided in the charts at the beginning of the "Natural Casing Products" section. Using these charts, you can learn which casing to buy for a particular sausage, what the optimum quality should be for the job, and very importantly, how much you should buy.

In "Handling Casings" you'll find information on buying casings and how to make the most of them through proper storage, handling and processing.

The section called "Drying & Moisturizing" is a brief synopsis about the smoking process. This subject is far too technical to be treated in-depth in the short space provided here, but the overview will at least enable you to recognize some potential concerns and, hopefully, encourage you to further study. Finally, "Making Sausage" provides you with an introductory, step-by-step guide to beginning actual "wurstmaking."

This book is designed to serve as a general reference for selecting, buying, handling and understanding Natural Casings. Many good recipes are available from a variety of excellent sources, among whom are sausage makers, trade publications, industry associations, cookbooks, etc. We hope you find this information beneficial.

For more information, write to:

International Natural Sausage Casing Association
12100 Sunset Hills Road, Suite 130
Reston, VA 20190
Phone: 703-234-4112
Fax: 703-435-4390
Internet address: http://www.insca.org
Email: insca@aol.com

## A BRIEF HISTORY OF NATURAL CASINGS

Sausage is known to be the oldest and most enduring form of processed meat. In some respects, it may even be considered the world's very first "convenience food."

The history of sausage production parallels the recorded history of man and civilization. In fact, for as long as man has been carnivorous, the intestinal tract of meat animals has been used for sausage casings—not to mention a variety of other uses as well.

It's only during the last thousand years, however, that **Sausage Making** has come into its own as a venerable and highly developed craft. The practitioners of this trade have fostered a rich tradition —at once sophisticated and yet personal. In many cases, families handed down their particular sausage making art over several generations and across dozens of nations, with each "wurstmacher" contributing his taste and heritage to the art. Of course, the art was also influenced by the demand of the marketplace and by the availability of the various ingredients which went into the sausage.

The twentieth century brought on the **industrial Revolution**—exploding onto the scene with new technology—and adding billions to the world's population. This "one-two punch" generated a need for **mass production** in virtually all industry segments... especially food! At first, the goals of mass production were primarily "quantity" and "speed." But gradually "quality" struggled toward the forefront of this new technology. The meat processing industry faced its own inherent challenges in slaughter, processing, and food safety. "Efficiency" and "quality" became the norm for those processors who rose to the challenge and managed to withstand the test of time.

Sausage making has now evolved into a highly specialized business, with processors ranging in size from independent "mom & pop" shops producing one-of-a-kind gourmet sausages, to multi-million dollar "mega-processors" producing millions of pounds of product each and every week.

Today there are numerous types of sausage casings including: **Natural** and artificial such as **Collagen, Cellulose** and **Plastic**. Collagen, Cellulose and Plastic casings are relative newcomers to the artificial field, mainly born out of market demand during the technological maelstrom of the early twentieth century. Much information and instruction about these man-made products is available through the major manufacturers of these casings, and it is not our place to delve into them here. As for **Natural Sausage Casings**, however, surprisingly little qualitative or quantitative information is readily available to processors about these products.

INSCA is striving to fill this information gap. The world-wide membership of INSCA generally shares the opinion that too often higher quality sausage which should be made using Natural Casings is passed up by processors who are planning production for the wrong reasons—namely, lack of information. Recent technology has all but eliminated the difficulties and significantly increased the profitability of producing Natural Casing sausage. The challenge then, is to make this knowledge more freely available to decision makers of meat processing enterprises.

This informational brochure and all INSCA education materials are available free or "at cost" to everyone. Our goal is to encourage the production of the highest quality sausage in the most practical, and profitable, method.

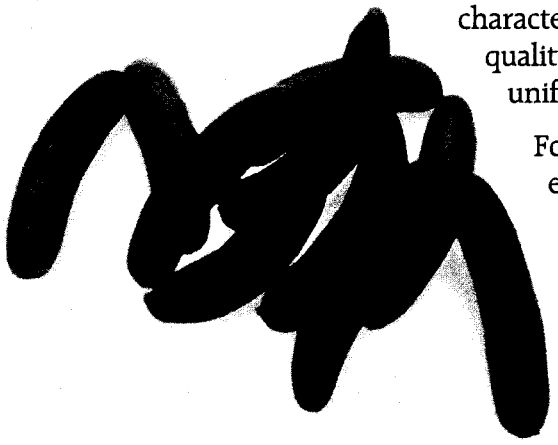
At your service,

**INSCA**

## WHAT ARE THE SPECIAL QUALITIES OF NATURAL CASINGS?

We feel strongly that Natural Casings are the sausage makers' BEST CHOICE because:

- Natural Casings readily permit deep smoke penetration
- Natural Casings have excellent characteristics of elasticity and tensile strength, to allow for high efficiency production and expansion during filling
- Natural Casings protect the fine flavor of sausage, without contributing any conflicting flavorings of their own
- Natural Casing Sausage has that special "snap" and tender bite that's like no other man-made product, and is so highly demanded by today's knowledgeable consumers
- Sausage in Natural Casings stays tender and juicy
- The osmotic quality of Natural Casings permits superb cooking
- The term "Natural" is, and continues to be, one of the most powerful words influencing consumers' buying decisions.



For **Sausage Makers**, these characteristics yield high quality products that are uniform in flavor.

For **Retailers**, the endothermic quality of Natural Casings means that the casing draws heat from the sausage and cools it below the temperature of surrounding air, providing better shelf-life and maintaining a juicier, fresher appearance.

For **Consumers**, the osmotic quality allows an intermingling of flavors inside and outside the sausage while sizzling in the skillet. It also allows the wonderful scent of fine sausage to enhance appetite appeal, whether cooking in a skillet, under a broiler, or over an open flame on the barbecue grill.

Other less well known characteristics of Natural Casings are:

- Superior tensile strength enables maximum yields
- Sausage in Natural Casings has a well-filled appearance
- Natural Casing Sausages have a fine appearance at link ends
- A variety of product shapes contribute to an inviting appearance, and give sausage in Natural Casings strong display appeal

**Natural Casings—a definition:** Natural Casings are made from the submucosa, a largely collagen layer of the intestine. The fat and the inner mucosa lining are removed. Since small intestines are collagen in nature, they have many of the same characteristics common to all types of collagen, particularly the unique characteristic of variable permeability.

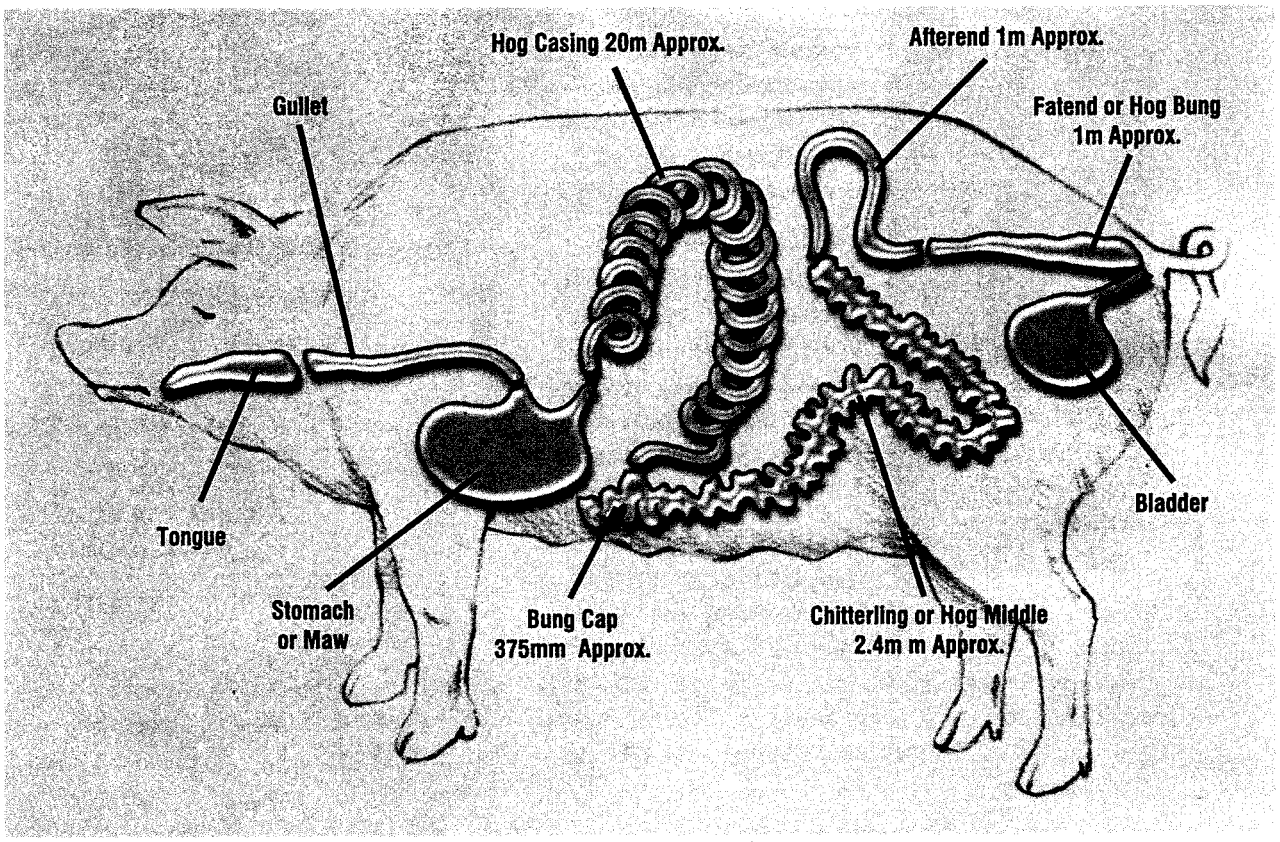
Natural Casings are hardened and rendered less permeable through drying and smoking processes. Moisture and heat make casings more porous and tend to soften them, which explains why smoking, cooking and humidity must be carefully controlled.

Before studying the numerous kinds of Natural Casings, it's important to understand that casings can vary in quality. Better casing suppliers and the sausage manufacturer will determine the specifications required based on the sausage manufacturer's purposes. These variables include:

1) equipment used for filling
2) type(s) of sausage being manufactured
3) coarseness of the grind

Together, the casing supplier and sausage manufacturer can determine the criteria to be used when inspecting the casing.

# NATURAL CASINGS PRODUCTS




## HOG CASING

Hog Casings are used for **Cooked Sausage, Country Style Sausage, Fresh Pork Sausage, Pepperoni, Italian Sausage, large Frankfurters, Kishka, Kielbasa** and **Bratwurst**—to name just some of the best-selling items.

Hog Casings are sold in "bundles" or "hanks." This unit of measure equals approximately 91 meters.

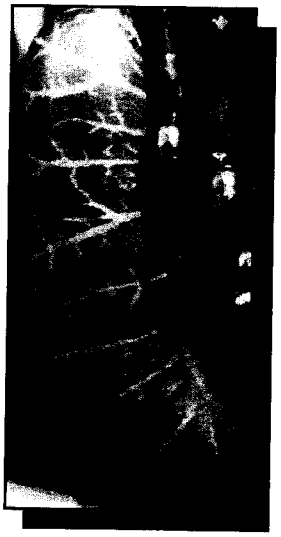
Hog Casings are also sold in bundles called "shorts." Shorts are 1 to 2 meter lengths and usually classified as 35mm and up or 35mm and down. NOTE: "Green Weights" refers to the weight of a stuffed casing, prior to cooking or smoking, per 91 meter lengths.

### HOG CASINGS by bundle or hank

| Range of Diam. | Approx. Capacity/Bundle —Green Wt. | Product Examples |
|---|---|---|
| 30/down | 41 kg/down | Pork Sausage |
| 30-32mm | 41-45 kg | Frankfurters, Italian Sausage |
| 32-35mm | 48-52 kg | Pork Sausage, Bratwurst, Frankfurters, Italian Sausage |
| 35-38mm | 52-57 kg | Smoked Sausage, Pepperoni, Bratwurst, Italian Sausage |
| 38-42mm | 57-61 kg | Smoked Sausage, Kielbasa, Pepperoni, Rope Sausage |
| 42-44mm | 59-64 kg | Smoked Sausage, Kielbasa, Pepperoni |
| 44mm/up | 61-68 kg | Specialty Items |

***Hog Casings**—unstuffed, shown in hanks, tubed, and in tubs; also shown are examples of stuffed hog casings*

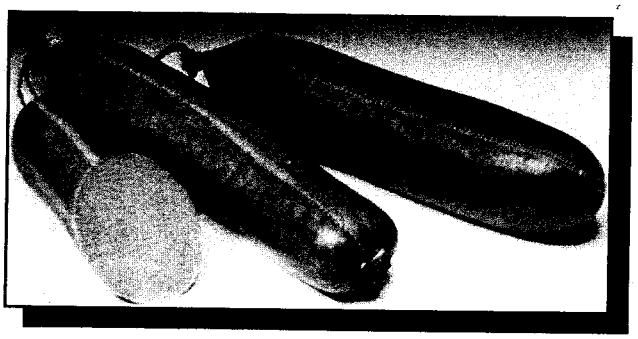
## HOG BUNGS: REGULAR & SEWN HOG BUNGS & HOG BUNG ENDS



"Regular Hog Bungs" are sold as individual pieces and are used primarily for **Liver Sausage** and **Braunschweiger.**

"Sewn (or Sewed) Hog Bungs"—are produced in double-walled and single-walled varieties. All varieties are made by sewing two or more pieces of smaller sizes of regular hog bungs together.

To obtain a larger, more uniform finished product, these casings are custom made and can be purchased in almost any shape or size suitable to the needs of the processors. Most of the products are used exclusively for **Liver Sausage, Braunschweiger, Genoa or Thuringer, Summer Sausage** and **Cervelats.**



### REGULAR HOG BUNGS OR FAT ENDS

| Caliber Size/Grade | Length (cm) | Stuffing Capacity | Product Examples |
|---|---|---|---|
| 50-55mm | 50cm | 600-700g | Braunschweiger |
| 55-60mm | 50cm | 800-900g | Braunschweiger |
| 60-65mm | 50cm | 1000-1100g | Braunschweiger |
| 65-70mm | 55cm | 1200-1300g | Braunschweiger |
| 70-80mm | 60cm | 1500-1800g | Braunschweiger |
| Light Sow—75mm | 60cm | 1800-2200g | Liver Sausage |
| Normal Sow—80mm | 60cm | 2000-2500g | Liver Sausage |
| Heavy Sow—90mm | 60cm | 2500-3000g | Liver Sausage |

## HOG MIDDLES / CHITTERLINGS

"Hog Middles / Chitterlings"—are put up in three calibers: wide, medium, or narrow. The size is determined by the location of the item within the animal. There are normally 9-10 one-meter pieces to a bundle. Hog Middles are easily recognizable by their curly appearance. Chitterlings are also available selected into 5mm calibers.

***Hog Middle** (shown at left)*

### HOG MIDDLES / CHITTERLINGS

| Sizes | Product Examples |
|---|---|
| Wide | Cooked Braunschweiger |
| Medium | Liver Sausage, Dry Salami |
| Narrow | Italian Salami (Frisses) |

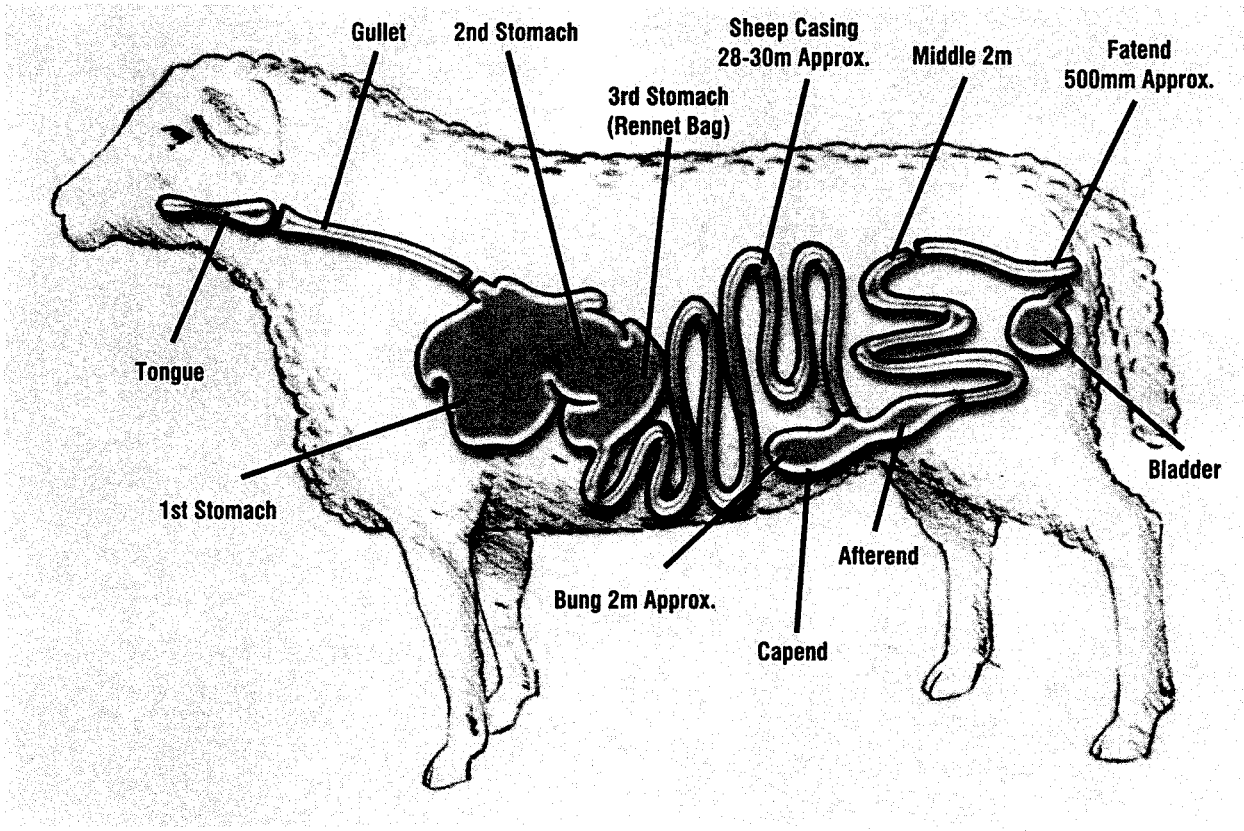
Hog Middles / Chitterlings are also available graded

| Sizes | Product Examples |
|---|---|
| 45 - 50 | Italian Salami (Frisses) |
| 50 - 55 | Liver Sausage, Dry Salami |
| 55 - 60 | Liver Sausage, Dry Salami |
| 60 - 65 | Cooked Braunschweiger |
| 65 - 70 | Cooked Braunschweiger |
| 70 + | Cooked Braunschweiger |

## SEWN HOG BUNGS—Paper Lined, Beef Middle Lined, and Beef Bung End Lined

| Width (mm) | Length (cm) | Approx. Stuffing Capacity | Product Examples |
|---|---|---|---|
| 90mm | 60cm | 3 – 3-1/4 kg | Liver Sausage |
| 100mm | 60cm | 3 – 3-1/4 kg | Liver Sausage |
| 110mm | 60cm | 4 – 4-1/2 kg | Liver Sausage |
| **Double Wall Genoa Sacs** | | | |
| 89-95mm | 25cm | 2-1/4 – 2-1/2 kg | Genoa Salami |
| 83-102mm | 25cm | 2-1/2 – 2-3/4 kg | Genoa Salami |
| **Single Wall / Double Wall Hog Bungs or Beef Middles** | | | |
| 89-102mm | 76-81cm | 4 – 4-1/2 kg | Thuringer, Summer |
| 76-89mm | 76-81cm | 3 – 3-1/2 kg | Thuringer, Summer |
| 64-76mm | 76-81cm | 2-1/2 – 2-3/4 kg | Thuringer, Summer |

# SHEEP CASINGS

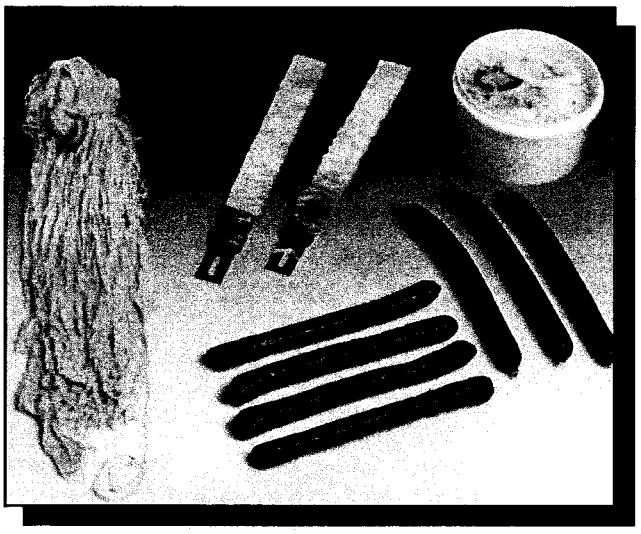



Sheep Casings are the highest quality small-diameter casings used for the finest in sausages such as: **Bockwurst, Frankfurters and Port Sausage.** These casings combine tenderness with sufficient strength to withstand, the filling, cooking and smoking operations. Color varies according to county of origin; color ranges from white to gray, but this variation does not indicate quality, strength, capability of smoke penetration, etc. Check with your casing supplier for the best casing origin that meets your requirements.

NOTE: All weights illustrated in charts are "Green Weights" and represent approximate stuffing capacity before cooking or smoking, per 91 meter lengths.

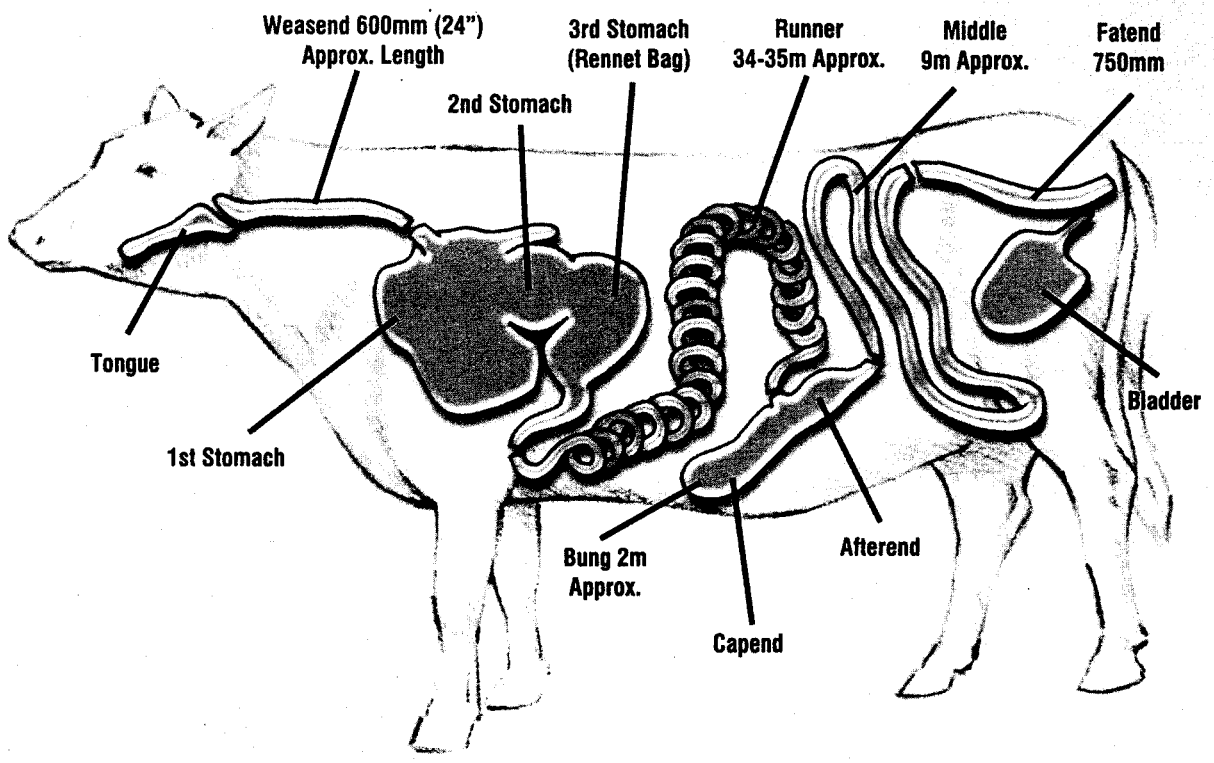
## SHEEP CASINGS

| Caliber | Approx. Stuffing Capacity Before Cooking | Product Examples |
|---|---|---|
| 16-18mm | 15-16 kg | Frankfurters, Beer Stix |
| 18-20mm | 17-18 kg | Fresh Pork Sausages, Frankfurters |
| 20-22mm | 21-23 kg | Fresh Pork Sausages, Frankfurters, Cabanosa |
| 22-24mm | 25-27 kg | Frankfurters, Cabanosa, Chipolata |
| 24-26mm | 27-29 kg | Frankfurters, Bockwurst, Cabanosa |
| 26-28mm | 29-31 kg | Frankfurters, Bockwurst, Cabanosa |
| 28mm/up | 31-34 kg | Frankfurters, Landjaeger |



***Sheep Casings*** *— unstuffed, shown in hanks, tubed, and in tubs; also shown are examples of stuffed sheep casings*

# BEEF CASINGS




The three most used Beef Casings are: **Beef Bung Caps, Beef Rounds** and **Beef Middles.**

Beef Bung Caps — are used for **Capocolla, Veal Sausage, Large Bologna, Lebanon** and **Cooked Salami.**

"Beef Rounds" — these casings derive their name from their characteristic "ring" or "round" shape. Beef Rounds are used for **Ring Bologna, Ring Liver Sausage, Mettwurst, Polish Sausage, Blood Sausage, Kishka** and **Holsteiner.** Stuffing capacities indicated are approximate "Green Weights." Beef Rounds are measured into sets or bundles of 9, 18 and 30 meters.

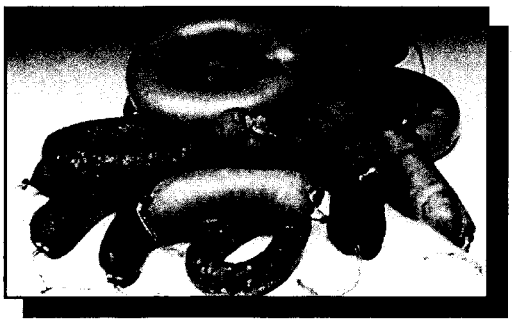
## BEEF BUNG CAPS

| Width | Length | Approx. Stuffing Capacity Before Cooking |
|---|---|---|
| 76-89mm | 46-51cm | 2-1/2 – 2-3/4 kg |
| 89-102mm | 46-51cm | 2-3/4 – 3 kg |
| 102-114mm | 46-51cm | 3-1/4 – 3-1/2 kg |
| 114-127mm | 46-51cm | 3-1/2 – 3-3/4 kg |
| 127mm/up | 46-51cm | 4 kg/up |

## BEEF ROUNDS

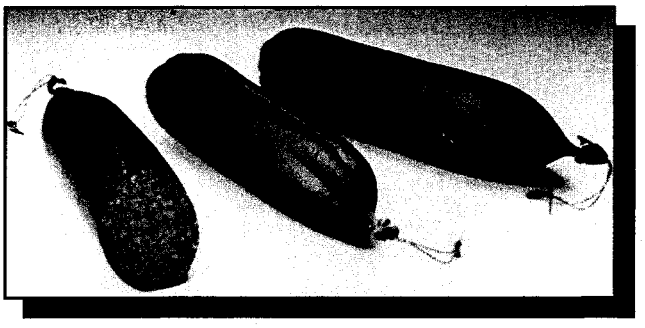
| Average Approx. Diameter | Approx. Stuffing Capacity Capacity Per 30-meter Set |
|---|---|
| 35-38mm | 30 kg |
| 38-40mm | 33-34 kg |
| 40-43mm | 36-37 kg |
| 43-46mm | 39-40 kg |
| 46mm/up | 41 kg/up |

***Beef Rounds***
← *Before... And After Stuffing* →



"Beef Middles" — can be used for **Leona Style Sausage**, all other types of **Bologna, Dry and Semi-dry Cervelats, Dry and Cooked Salami** and **Veal Sausage**. Beef Middles are measured in sets or bundles of 9 and 18 meters (29 - 30 feet and 57 - 60 feet) each.

Beef Middles can be sewn so that they have a uniform diameter and a uniform length, with or without a hanger (stitching loop).



**BEEF MIDDLES**

| Average Approx. Diameter | Average Approx. Stuffing Capacity Per 18-meter Set |
|---|---|
| 45-50mm | 29-32 kg |
| 50-55mm | 32-36 kg |
| 55-60mm | 36-41 kg |
| 60-65mm | 41-45 kg |
| 65mm/up | 45 kg+ |

"Beef Bladders" — are the largest diameter casings from cattle; they are oval in shape, and will hold from 2.5 to 6.5 kg (5 to 14 pounds) of sausage. They are used chiefly for **Minced Specialty Sausage** and **Mortadella...** either in their natural oval form, in square molds for sandwich slices, or in the flat, pear-shaped style. There is no satisfactory substitute for quality Beef Bladders.

Wall thickness is largely determined by the amount of fat left on finished casing. Beef Casings with a heavy textured wall will have some fat on casing wall; casings with thin texture will have virtually no fat.

*Top:* ***Sewn Beef Middles***

*Center:* ***Beef Middles, Beef Bund Caps***

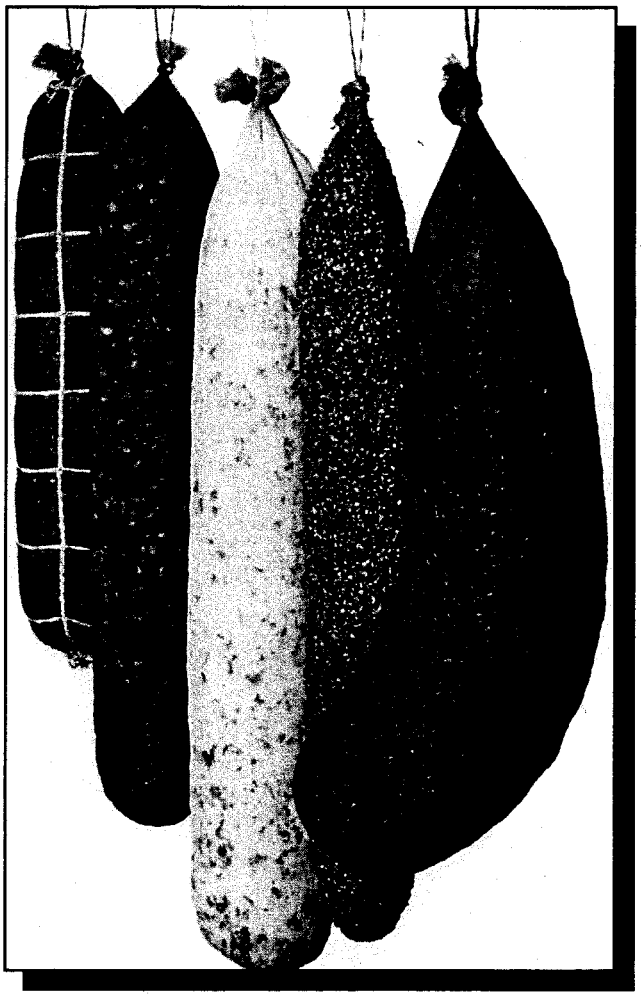
*Above L/R:* ***Beef Bladders***

*Right:* ***Beef Round***

**BEEF BLADDERS**

| Grade | Kind | Approx. Diameter | Approx. Stuffing Capacity Before Cooking |
|---|---|---|---|
| Extra Small—8 / down | Salted | 130mm down Inflated | 2-1/4 kg down |
| Small—8 / 10 | Salted | 130-162mm Inflated | 2-1/4 – 3-1/4 kg |
| Medium—10 / 12 | Salted | 162-194mm Inflated | 3-1/4 – 5kg |
| Large—12 / up | Dried | 194+ Over-Inflated | 5 – 6-1/4 kg |

## LAMINATED CASINGS



If desired, various nettings may be applied on the casings during processing. These tend to enhance appearance and serve to allow the hanging of these sausage products for easy display.

### LAMINATED CASINGS

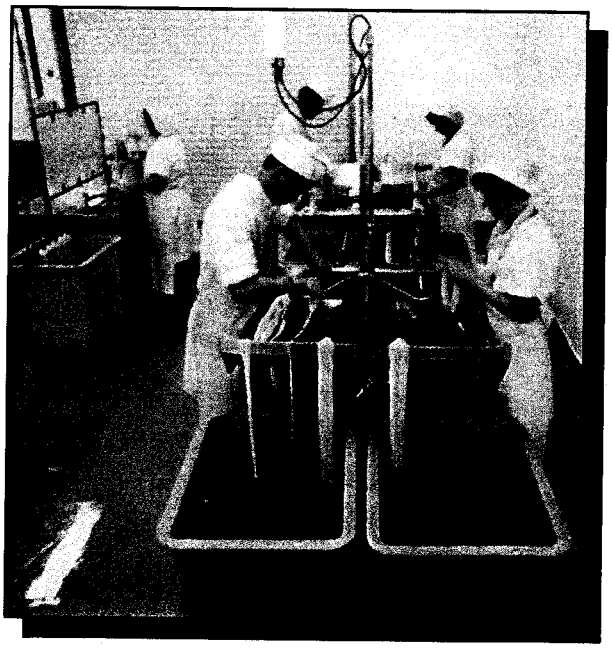
| Diameter (mm) | Max. Length (cm) | Approx. Stuffing Weight (grams) |
|---|---|---|
| 42mm | 30cm | 275 g |
| 45mm | 50cm | 320 g |
| 48mm | 25cm | 410 g |
| 52mm | 50cm | 550 g |
| 58mm | 50cm | 680 g |
| 65mm | 50cm | 1400 g |
| 70mm | 50cm | 1800 g |
| 78mm | 50cm | 1650 g |
| 85mm | 50cm | 2000 g |
| 90mm | 60cm | 2400 g |
| 95mm | 60cm | 2900 g |
| 105mm | 60cm | 3300 g |
| 110mm | 50cm | 4400 g |
| 115mm | 50cm | 4800 g |
| 130mm | 50cm | 5800 g |
| 135mm | 50cm | 6200 g |
| 45 / 62mm | 42cm | 900 g |
| 48 / 82mm | 55cm | 1800 g |
| 65 / 90mm | 60cm | 2700 g |
| 65 / 100mm | 60cm | 3200 g |

Laminated Casings are mainly used for **Dry or Semi-dry Sausage** and may also be used for **Cooked Deli Products.**

Pieces of hog casings or sheep casings are cut open and laminated on a form or mold. This sausage-shaped mold may be made to accommodate a variety of caibers. During the processing operation, high temperatures are used to eliminate any bacterial growth. The natural binding quality of the casing protein causes coagulation. After cooling, the casings are removed from the form or mold.

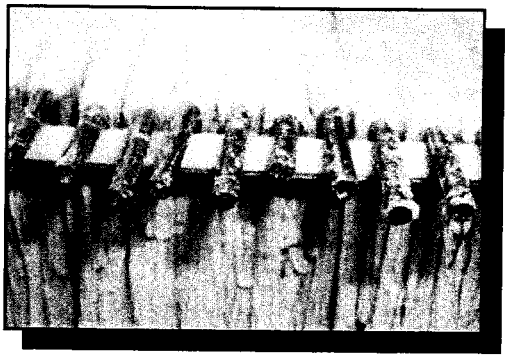
# HANDLING CASINGS

Today, CASING RECOVERY — most often done in large slaughtering facilities — is both a precise science and an elaborate process. It requires high-level expertise, state-of-the-art machinery, and maximum sanitation and quality control procedures.



As the intrinsic value of the raw material represents a large part of the finished casing product, every inch of tract needs to be utilized. In the slaughterhouse, the viscera of each animal is removed, and the various parts of the intestinal tract are separated. This separation of parts is instrumental in creating a variety of products ranging all the way from pig chitterlings to sheep appendixes for pharmaceutical products.

The casings are prepared for the removal of manure, mucosca (raw material for the anticoagulant "heparin") and any undesirable elements such as fat, threads and animal fluids. This removal, facilitated in a series of both hot and cold water soaks, is accomplished by machine crushing under close "hands-on/eyes-on" scrutiny.



The fully cleaned casings are then placed in a saturated salt environment to prepare for further processing. The casings are then sorted into various grades and diameters. The selection process is dictated by such factors as: type of animal, and criteria set by the casing processor and ultimately the sausage producers.

**Measuring Casings.** After selection, all casings are carefully measured, either by machine or by hand. Regardless of measurement method, both must be accurate since the measured unit becomes the sales pricing criterion,

Hog Casings and Sheep Casings are prepared in 91-meter (100-yard) hanks or bundles. Beef Casings, if not sold by the piece, are sold in 18 - 30 meter bundles for Beef Rounds, and 9 - 18 meter sets for Beef Middles.

**Determining Quality.** Qualities are determined in several precise and labor-intensive ways.

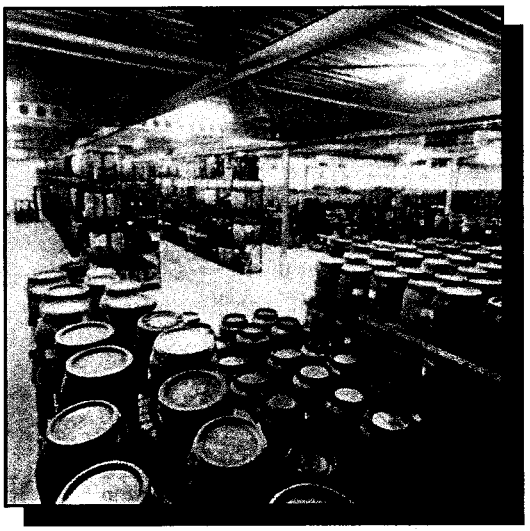
In sheep, for example, an "**A**" quality casing is determined during selection, and is defined as a casing with no holes or weakness. This casing can be used for the finest frankfurter emulsion. "**B**" quality casings are of acceptable strength and quality for coarse ground emulsions such as those used in Pork Sausage.

With Beef Casings the term **"Export Quality"** is sometimes used. This term describes casings as free of nodules (pimples) or scores (windows).

With Hog Casings, there is a single quality standard with several specifications for length. Where the various hog casings originate from taking into consideration factors of species, climate, and diet — will generally determine the different characteristics of the casings. Some will be "white" or virtually transparent / clear; others will be darker and more opaque, and will have more

visible veining. These characteristics also have an effect on the tenderness or "bite" of the casing.

Clear Hog Casings are generally used for fresh products. Thicker and stronger casings such as Chinese Hog Casings are generally best suited for smoked products, because these casings better withstand the smoking process and because casing appearance is not as critical a selling feature, due to the smoking process itself.



**Test Procedures.** The traditional methods for grading and testing Natural Casings are: water testing for Sheep and Hog Casings, and air testing for Beef Casings.

The casings are appropriately filled with water or air and periodically expanded under pressure, to check for size and quality. The casings are then cut to final sizes and quality specifications are confirmed during quality control.

**Shipping Casings.** Casings are prepared and preserved in various forms for shipping to the sausage makers. Some examples include:

- **Dry Salt Pack:** Excess moisture is removed for semi-dry state. This is usually appropriate for long distance travel and/or prolonged storage at ambient temperatures
- **Slush or Preflushed Packed:** in this convenient form, casings are very soft and flexible and do not require flushing prior to use
- **Pre-tubed Casings:** Each strand is shirred on a tube to allow one-step loading of the casing directly on the sausage filling horn—without the need for flushing—by the processor

Casings should be stored in a controlled, cool environment. Special care should be taken to avoid excessive heat. A neutral temperature of 4-10°C (40-50°F) is ideal.

## DRYING AND MOISTURIZING

**Principles of Drying & Moisturizing.** Once the product has been stuffed and moved into the smokehouse, the initial critical steps of drying and smoke application must be monitored very carefully. Before smoke is applied, the casing should be dried to the point where it is tacky:

- If the casing is not sufficiently dried, the smoke will penetrate the casing and will be deposited on the meat surface, thereby permitting casing separation and causing a pale, dull appearance.
- If the sausage casing is overdried, the smoke will essentially be deposited only on the outside surface with very little flavor penetration.

Tenderness of animal casings varies. Sheep Casings which are used for small diameter products are the most tender and should be handled very carefully.

## MAKING SAUSAGE

**Preparing the Casings.** There are four basic steps to preparing casings for stuffing.

SALTED:

1. Rinse salt from casings with fresh water.
2. Soften by soaking in fresh water at room temperature (approximately 21°C [70°F] for 45 minutes to one hour. When hanks are placed in water, gently hand massage them to separate the strands and prevent dry spots which may adversely affect the stuffing process.
3. Take casings to stuffing table. Place in bath of fresh water. This water should be warmer to render a little of the natural fat in the casing. This will help to allow the casing to slide from the stuffing horn more readily.
4. Preflush the casings by introducing water into the casings and allow to run through the casing. This will also facilitate getting the casing onto the filling horn and moving the casing smoothly during the filling process.

PRE-FLUSHED IN SLUSH:

Requires somewhat less labor and time before stuffing, but all four steps should be followed.

PRE-FLUSHED WET PACK:

Goods are packed in a brine with lesser amounts of salt. Requires only steps 3 and 4. Pre-tubed goods (casings on plastic tubes to speed production) usually come this way. Tubed goods may require a charge of water after they are on the stuffing horn; this is done using a horn made specifically for that purpose.

PRE-FLUSHED IN SOLUTION:

Requires no soaking time. Only steps 3 and 4 need to be performed. Casings packed this way are more prone to damage in shipping and/or from temperature changes. These casings should be purchased in smaller amounts — usually a 2 to 3 month supply, although they can be kept longer. Barrels should be carefully inspected, with leakers used first, employing steps 3 and 4.

## MECHANICAL APPLICATIONS

While somewhat more expensive due to up-front labor, Pre-flushed and Pre-tubed Casings (shirred onto a plastic tube and ready for the stuffer) are also available. As with all casings, these should at least be rinsed before use.

It is always a good idea to compare costs involved in preparing a casing for stuffing before you decide whether or not to use pre-flushed or pre-tubed casings. You might also want to explore pre-tubing on reusable stainless pipes in your own casing operation, thereby saving time at the stuffer, and allowing the stuffing process to run more efficiently... which typically results in higher productivity and better return-on-investment.

## A WORD OR TWO ON "WHISKERING"

"Whiskers" are the capillaries that hold the intestine in the fat and provide a flow of blood to the intestine. When removing the intestine with a knife, the capillary is not completely removed, creating a hair-like appearance on the surface of the casing. After cooking, these whiskers generally disappear.

## PREPARING TO STUFF CASINGS

In general, all casings can be handled in essentially the same manner; however, there are a few intrinsic variations. For example, Beef Casings, being more fleshy, can withstand more soaking and warmer water than Sheep Casings.

**Beef Rounds:**
Soak overnight in cold water. Then, thirty minutes before use, put casings in 38°C (100°F) water.

**Hog Casings:**
First rinse with fresh water. Then, soak in 30°- 32°C (85°-90°F) water for at least thirty minutes prior to use; soaking overnight is also quite typical.

**Sheep Casings:**
First rinse with fresh water. Then, soak in 30°-32°C (85°-90°F) water for thirty minutes prior to use.

## GLOSSARY OF TERMS

**Bundles** — A measured unit of casings ready for sale in salted, pre-flushed, or tubed form; bundles will be either hog casings or sheep casings consisting of 91 meters (100 yards). Bundles can also refer to a customer-defined specification.

**Green Weights** — Represents approximate stuffing capacity of casings before cooking or smoking, per 91 meter lengths.

**Hanks** — Another essentially interchangeable term with the same meaning as **Bundles**, applying to hog and sheep casings.

**Nodules** — Pimples that appear on some beef rounds or beef bung caps.

**Sets** — A unit of beef casings ready for sale in salted form, consisting of 18 - 30 meters for beef rounds and 9 - 18 meters for beef middles.

**Shirred** — Refers to the result of applying a casing to a dummy transfer horn or to a flexible plastic sheath to expedite the stuffing process.

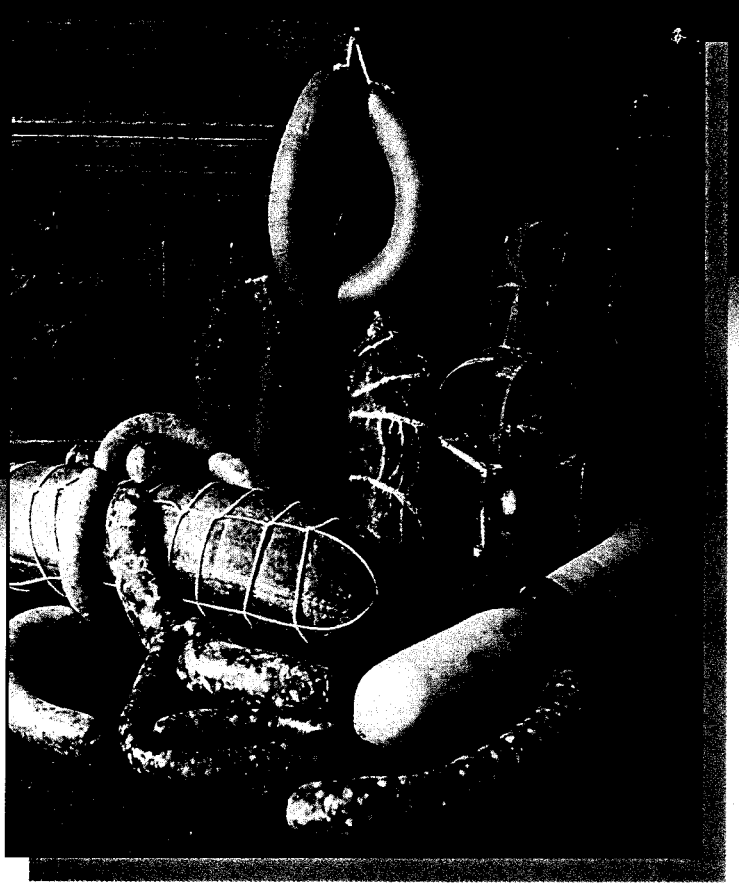
**Tierce** — A shipping container made of plastic with a packing volume to 208 liters (approximately 55 gallons).

**Windows** — Damage to casings caused by overcrushing. Windows result in wall thicknesses being approximately half the thickness of the majority of the casing.

**Whiskers** — The capillary that holds the intestine in the fat and provides a flow of blood to the intestine. When removing the intestine with a knife, the capillary is not completely removed, creating a hair-like appearance on the surface of the casing.

**NOTES:**

**INSCA** wishes to express its heartfelt appreciation to all members who have generously contributed their time and expertise in the development of this booklet, and to those members who have graciously allowed use of their company's photos within this publication.



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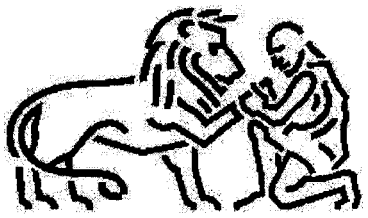
# Histological research on the cleaning efficacy of mechanically versus manually processed sheep intestines

**Research for the Scientific Work Group of ENSCA, INSCA, NANCA**

**V&V Report No. H0301**

P.A. Koolmees*, M.H.G. Tersteeg* G. Keizer* & J. van den Broek**



Utrecht, July 2003

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# Contents

# 1. Introduction

Recently the European Commission (EC) has considered the risk to consumers from natural casings from small ruminants in the event that BSE is found, or becomes probable in these species. The EC has introduced additional measures as a precaution to protect consumers against exposure to potentially BSE infected tissue from small ruminant species used for food. The specific measure is to include the ileum of small ruminants as a specified risk material (SRM). This measure will enter into force in the EU from 1 October 2003. The European natural casings industry has voluntarily removed the ileum from small ruminant intestine as a HACCP measure for some years previously.

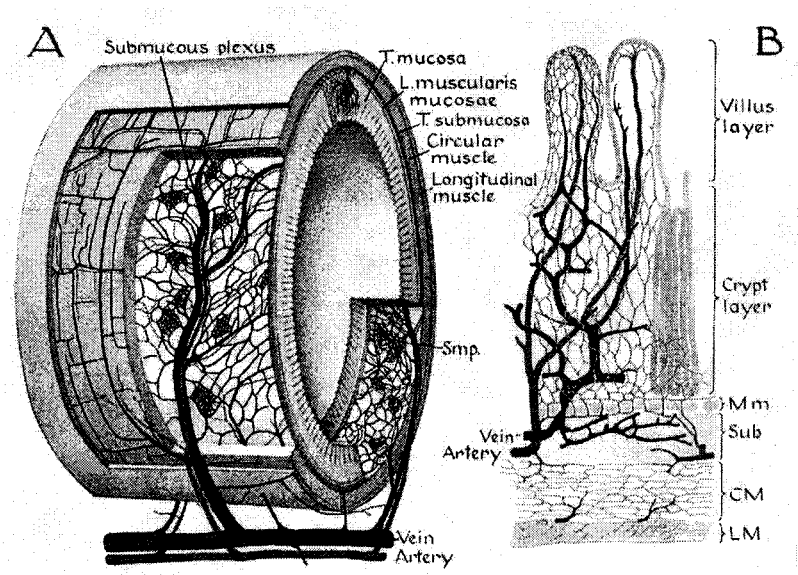
In discussing the afore-mentioned issues, the EC has been informed by the European industry that there are two main methods of cleaning intestines to make natural casings. These are the mechanical method and the manual method. Both result in the removal of various layers of the intestine and lymphatic tissue in Peyer's patches that in a TSE-infected intestine are believed to contain most of the infectivity. However, there is a lack of information on the comparative efficiencies of the two methods. Consequently the EC has requested that the industry undertakes a study to show the relative efficiencies of cleaning the intestine using the two methods as undertaken in commercial conditions. This is a report of those studies.

Historically, research has been carried out to determine the titre of infectivity in different tissues of goats and Suffolk sheep with natural scrapie. These studies included titration of the infectivity in the distal ileum (Hadlow 1980, 1982). More recently and using the historical and more recent data on the distribution of infectivity and PrP-res in sheep with natural and experimental scrapie and experimental BSE an analysis of the potential risk of exposure to consumers from natural casings prepared from sheep small intestine has been reported (Comer, 2002; SSC 1999; SSC 2002).

New research has reported the histology of the intestine after different steps in the production process of natural casings (Koolmees 1997; Koolmees & Houben, 1997). Histological research revealed that during processing the serosa, mucous and muscle layers were for the most part removed from the green intestine (Scheme 1). This means that during processing from green sheep intestines to cleaned sheep casings the thickness was reduced significantly to 7.5 – 8.6% of the original intestine. In recent research it was shown that during processing from green to cleaned casings a weight decrease of 87.5% occurred (Koolmees *et al.*, 2002). In two different histological studies it was demonstrated that during the cleaning process of sheep intestines all aggregated lymphatic nodules (Peyer's patches) were completely removed (Koolmees *et al.*, 2002). With respect to prion diseases this was an important observation since organised lymphoreticular system tissue is believed to be the main residence of TSE infectivity when it occurs (Bradley, 2002).

Data from anatomical, histological and epidemiological research as well as from the scientific literature were used to quantify the TSE risk reduction due to the removal of potentially infectious material during the processing of sausage casings from sheep and leg of lamb. With a per capita annual consumption of 2 kg of sausage in France, the total amount of per capita consumed casing will be approximately 8 meters. The annual per capita consumption of lamb is about 2 kg, i.e. the equivalent of one leg of lamb (AFSS, 2002). The risk analysis revealed that when the consumption of a portion of leg of lamb from a BSE infected animal was compared with the consumption of an equivalent weight of sausage made from the jejunum (largest part of

the small intestine) of this animal, on average the sausage would lead to a 5 times lower exposure to potentially infectious tissue than a portion of leg of lamb (Koolmees *et al*, 2002).




*Scheme 1. Drawing of complete small intestine with the distribution of blood vessels (A) and the different layers (B). The mucous layer (villus and crypt layers) and the muscle layers (CM and LM) are removed by pulling. The natural casing only consists of the submucosa layer (Sub). (Source: W. Bloom and D.W. Fawcett, A text book of Histology, Philadelphia 1969).*

These findings demonstrated that the exposure and thus potential risk, to consumers from infected sheep would be actually greater following consumption of a meal from a leg of lamb than from an equivalent weight of sausages encased in natural casings from the same infected animal. At present, such measures are considered not to be proportional to the theoretical risk. In the mean time, discussion and research on possibilities to increase the risk reduction during processing, removal of the ileum and limitation on the age of the animals continued. In order to further refine the risk analysis regarding the consumption of natural sheep casings, additional data on the presence and quantity of some specific tissues in these casings are necessary. Since a considerable amount of manually processed casings enter the European market, research on the efficacy of manually versus mechanically processing was also needed.

ENSCA commissioned the Department of Public Health and Food Safety of the Faculty of Veterinary Medicine, Utrecht University to carry out research on manual and mechanical processing of sausage casings. The aim of the comparative research reported here was to study the difference in cleaning efficacy between sheep intestines, which are cleaned mechanically or manually. By histological research the efficacy of the removal of the mucosal (lumenal) surface, Peyer's patches, and the outer serosal and muscular layers during the mechanical and the manual desliming process of sheep intestines was determined.

## 2. Materials and Methods

### 2.1 Description of manual processing of sheep intestines

This description is based on a visit to a casing processing plant in Turkey. The plant collects green casings from sheep slaughterhouses in the surrounding districts. Hand pulling of the intestine from the mesentery and manual manure stripping are done in the gut room of these local slaughterhouses. Manure stripping is done from the duodenum side of the intestine to the bung (caecum), hence from the narrow to the wide end. The ileum was broken from the bung by hand at a distance of 1-1.5 meter. The ileum is not used for casing processing by the plant- as it was claimed – because of its different texture. The runners are then tied together, put in barrels and transported to the casing processing plant. The sheep are from the Karaman breed and slaughtered at the age of 12-18 months. The factory has a strong preference for processing casings derived from male sheep. Since the rennet stomach (abomasum) is consumed in Turkey, the proximal duodenum is partly left to this stomach. The distal part remains attached to the jejunum.

From sheep slaughtered in the morning the runners were transported to the processing plant in the afternoon. In more remote slaughterhouses the runners were stored overnight in water of 10-15°C before transportation. It was avoided to apply longer soaking periods in a chilled room than 2 days since that would make the casings weaker. Green casings were frozen and stored if processing was not foreseen within two days (weekends). On the other hand a certain soaking (fermentation) period is necessary to facilitate the removal of the different tissue layers from the casing. Unfortunately, there was no opportunity to visit one of the local slaughterhouses.

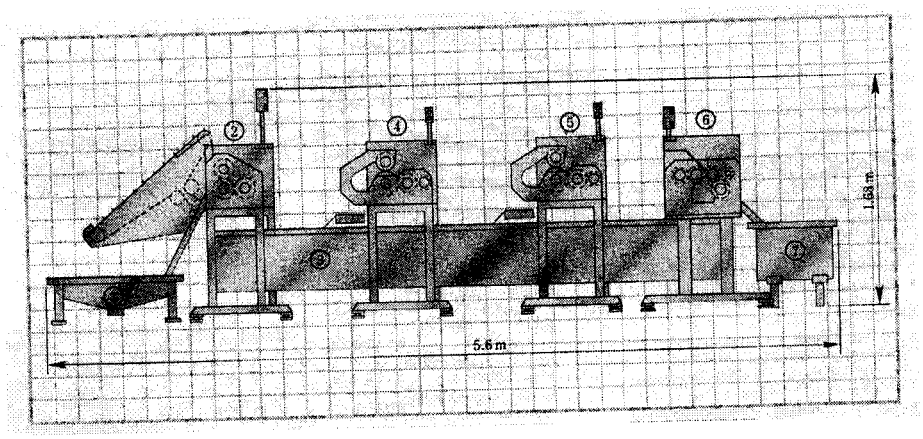
Apart from the Karaman breed, runners from Australian sheep were processed in the plant. Manure stripping of these intestines was done in Australia. The green casings were obtained by frozen transport from Australia. Runners from Australian sheep were thawed, rinsed in tap water and subsequently manually cleaned and stripped. The casings were cleaned under good hygienic conditions. HACCP guidelines are followed, although no HACCP certificate has been obtained yet.

Before manual cleaning and stripping the stored runners with a typical length of 25-27 meters are put in water of 15-20°C. During the summer time ice is added to this water to maintain this temperature. This water is poured into the runners by means of a funnel to facilitate the removal of mucous and the inner layer (Fig. 1). Cleaning and stripping was done according to the so-called Kamişh or bamboo stick method. A small, cleaved bamboo stick (approximately 8 cm long, diameter 4-5 mm) bent into two sides and which is surrounded by synthetic tube is used. The spherical sides of the flexible stick are bent together (Fig. 2). The operators keep these sticks in their hands while pulling and squeezing the runners through this stick (Fig 3).

As with manure stripping the cleaning and stripping of the runners in the plant is done from the duodenum side to the bung side. The stripped runners are put in another container with water. Stripping of the complete runner in this manner was done twice. In between the two runs again water is poured into the runner by means of a funnel to facilitate the removal of the inner layer. Although this could not be observed macroscopically, it was claimed that during the first run the mucous layer is removed, while the serosa and muscle layers are removed during the second run. The casings thus cleaned were rinsed in water again and subsequently salted and stored.

## 2.2 Description of mechanical processing of sheep casings

This description is based on a visit to two abattoirs and one casing processing plant in Britain. The plant collects green casings from sheep slaughterhouses all over the United Kingdom. The casings predominantly originate from sheep of Suffolk and Texel breeds, which are slaughtered predominantly at an age of 6-12 months. Both abattoirs visited deliver green sheep casings to the casing processing plant. The processing plant as well as both slaughterhouses are EC approved. In both slaughterhouses pulling was done mechanically in the gut room. After removal of the stomach the operator broke the distal end of the intestine by hand, by ensuring that the break was proximal to the start of the plica ileocaecalis (ileo-caecal fold) thus ensuring that no ileum was processed. Instead it was left attached to the large intestine for disposal once pulling was complete. These procedures form together a critical control point throughout the European industry. The intestines were hung on a set of hooks. The middle of the jejunum was threaded on to the first pair of rollers of the pulling machine; this was done with 5 intestines at the same time in one abattoir and 10 intestines at the same time in the other. The runners are then pulled away from the mesentery. After passing the pulling machine the runners are dipped into a water bath and subsequently threaded through a set of rollers for manure stripping (Fig. 4). Again this was done from the middle of the jejunum onwards. Then the runners are tied together in sets by a knot in the middle, put in barrels with water, stored at 0-4°C and transported to the processing plant.




*Scheme 2. Equipment for mechanical cleaning and stripping with 4 sets of rollers and water baths.*

The barrels with sets of runners are stored in a cold room (0-4°C) until processing. A soaking time of approximately 2 days is common. The processing room had four processing machines (Bitterling). The sets of runners were taken out of the barrels and put in a container with warm water (30-40°C). Then the operator threaded the runners onto the first set of rollers (Scheme 2) of the processing machine from the middle part of the jejunum onwards. In total the runners are pulled through three sets of rollers (two sets with crushing/stripping rolls and a third set of rollers [the 'finisher']) with water baths between each. The temperature of the water baths was kept at 30-40°C by adding water through sprinklers located above the sets of rollers. The sets of rollers sequentially crush and remove the serosa, mucous and muscle layers of the green casing as described and illustrated by Koolmees & Houben (1997).

As with manure stripping the whole cleaning and stripping process removed mucous, mucosa, serosa, and muscle layers from the middle part of the jejunum onwards evenly down to both the duodenum and bung end. In this way there is generally an even length of material on both sides reducing pressure on the casing. In addition this handling is also quicker on the machinery, reducing any long trailing ends. The whole cleaning and stripping process by the machine took about 4 minutes. After the finisher the cleaned casings are put in a tank with running tap water to cool down. Then they are tied into a hank and allowed to drain before salting.

From these observations it can be concluded that there are remarkable differences between the manual and mechanical methods to process sheep casings, which may explain possible differences in efficacy of desliming. Of course the fact that machinery is used is one of the obvious differences. One could expect that the use of machines may lead to more uniformity and standardisation of the end product. For instance lymphatic nodules represent a more firm tissue than mucous tissue. Because all tissues of the intestine are squeezed through the rollers set at a fixed distance, it is likely that lymphatic nodules are scraped off, which might not be the case with the more flexible method of hand stripping. On the other hand machinery can be set in a wrong way and not be systematically adjusted, which may lead to 'continuous' errors. As observed, mechanical manure stripping in the UK abattoirs as well as mechanical cleaning and stripping in the processing plant was done from the middle of the jejunum towards the duodenum and bung ends. In this way the pressure on the casing might be smaller than manual stripping of the whole casing in one direction from duodenum to bung end. However, with mechanical stripping half of the material is pressed through the narrow duodenum side, which is not the case with manual stripping where all material is pressed form the narrow stomach side to the wider bung end. By histological research we hoped to reveal to what extent the different processing methods affected the safety of the casings, in terms of remaining tissues other than submucosa.

## 2.3 Sampling

Sampling of manually processed sheep casings was done in one plant in Turkey. Fresh, unsalted samples were collected from two different batches of sheep casings, one from a batch of the Karaman breed of sheep (Manually A) and one from a batch of Australian sheep casings (Manually B). The two batches of collected samples were processed by two different groups of operators. Sampling of mechanically processed casings was done in a British processing plant. Fresh, unsalted samples were collected from sheep casings originating from two different slaughterhouses (Mechanically A and Mechanically B).

From each of these 4 batches 15 randomly selected sheep casings were taken and put on a table. The casings were divided into 10 zones: No.1 = duodenum, Nrs. 2-8 = jejunum and No. 10 = terminal jejunum. From each zone a sample of 1 cm length was cut out and put in a container with formalin. Sample 1 was taken at 30 cm distance from the stomach side of the casing; samples 2-9 each time from the centre of the zones, approximately 2.5 meters apart from each other. Sample 10 was cut out at 30 cm distance from the bung side of the casing. This was done to see if in the duodenum – when still present – the pattern of any remaining tissue other than submucosa was different from the jejunum samples. The largest Peyer's patches in the small intestine are concentrated in the ileum part (Fig 5). According to the standard operating procedures in the casing industry the ileum part is removed. When part of the ileum should still be present, the likelihood to find any remaining lymphatic tissue would be at the bung end. Therefore, sample 10 was taken at that location. Peyer's patches, in which most infectivity

should be present are located on the opposite side of the mesentery (Dellmann, 1993; Krölling & Grau, 1960). To ensure that any remaining of Peyer's patches - if present at all – would be included during sectioning, complete rings of 1 cm length were sampled.

## 2.4 Histological research

After fixation in formalin, complete transverse sections of the tissue were cut with a scalpel and embedded in paraffin wax. Then paraffin sections of 5 µm thickness were made according to standard procedures (Drury & Wallington, 1980; Junquiera & Carneiro, 1984). Subsequently the sections were stained with Haematoxylin / eosin and Picro Sirius red (Flint & Pickering, 1984). In total 600 histological sections were examined microscopically with different magnifications: 2 batches of each manually and mechanically cleaned casings, 15 animals/casings at 10 different locations (see scheme).

| | | | |
|---|---|---|---|
| Manually A | 15 animals/casings | 10 locations | 1 section |
| Manually B | 15 animals/casings | 10 locations | 1 section |
| Mechanically A | 15 animals/casings | 10 locations | 1 section |
| Mechanically B | 15 animals/casings | 10 locations | 1 section |

*Table 1. Scheme with histological sections selected from animals and locations used for qualitative microscopic examination.*

The qualitative microscopic examination was aimed at two questions. Is there evidence for the presence of remains of Peyer's patches? Is there any remaining tissue other than the submucosa – the tissue layer which actually constitutes the natural casing (Fig. 6) - in particular serosa, mucous or muscle tissue? In this examination only the presence of these tissues was scored (yes/no), regardless the quantity. Percentages of sections with remaining tissues were calculated and analysed statistically.

## 2.5 Image analysis

Histological sections from five randomly selected animals per batch of 15 animals were also used for analysis. The locations chosen were 1 (duodenum side), 3, 5, and 8 (jejunum) and 10 (bung side). In each section 8 fields of view were analysed; this means that in total 800 microscopic fields of view were analysed.

| | | | |
|---|---|---|---|
| Manually A | 5 animals/casings | 5 locations | 1 section/8 fields of view |
| Manually B | 5 animals/casings | 5 locations | 1 section/8 fields of view |
| Mechanically A | 5 animals/casings | 5 locations | 1 section/8 fields of view |
| Mechanically B | 5 animals/casings | 5 locations | 1 section/8 fields of view |

*Table 2. Scheme with histological sections selected from animals and locations used for image analysis.*

Image analysis was done according to standard procedures for morphological measurements (Russ, 1990) with an IBAS system (Kontron Bildanalyse GmbH) and a television camera (Panasonic WV-CD50) connected directly to the microscope. Eight fields of view were selected randomly. Per field of view (magnification x 40) the absence or presence of mucous and/or muscle tissue was recorded, regardless the amount of tissues (yes or no). Based on these data,

the percentages of casings with or without remaining tissue could be calculated, similar to the microscopic examination of the 600 sections (complete rings). However, compared with the examination of sections with complete rings, this approach with 8 randomly selected fields of view per section was more subtle. With the latter method the presence or absence of mucous and muscle tissue was recorded 8 times per section, while in complete rings the presence of only one small spot with mucous or muscle remaining designated the whole histological section as positive. The data obtained were statistically analysed.

In fields of view where remaining tissue was present the area percentage of mucous and/or muscle tissue was measured by image analysis. First the total area of the casing was measured. Then the area of the field of view occupied by mucous and/or muscle tissue was selected (Fig. 7), after which the area % could be calculated. The data thus obtained enabled the determination of the amount of remaining tissue other than submucosa. In addition, these data were statistically analysed.

## 2.6 Statistical analysis

With respect to the level of significance of results from the detection of Peyer's patches in 600 histological sections 95 and 99% confidence intervals were determined (Diem & Lentner, 1975).

In order to see which statistical model fitted the data of the qualitative and quantitative analysis of remaining tissue best, as compared to another model, Akaike's Information Criterion (AIC) was used. The model with the lowest AIC value was best supported by the data and subsequently used in the statistical analysis.

# 3 Results and Discussion

## 3.1 Qualitative histology

The results of the qualitative histological research of 600 sections (complete rings of the casings) are listed in Table 3. In none of the sections Peyer's patches or remains thereof were observed. This finding represents a 95% confidence interval of 0.00-0.61% and a 99% confidence interval of 0.00-0.88% (Diem & Lentner, 1975). Further, this result is in agreement with earlier observations (Koolmees *et al*, 1998; Koolmees *et al*, 2002). Hence, both manual and mechanical processing of the casings were effective in terms of removal of lymphatic nodules.

| Method | Sections | Peyer's Patches | Mucous tissue | % | Muscle tissue | % |
|---|---|---|---|---|---|---|
| Manual A | 150 | 0 | 128 | 85 | 50 | 33 |
| Manual B | 150 | 0 | 134 | 89 | 51 | 34 |
| Mechanical A | 150 | 0 | 139 | 93 | 45 | 30 |
| Mechanical B | 150 | 0 | 143 | 95 | 14 | 9 |
| Total | 600 | 0 | 544 | Mean 90.7 | 160 | Mean 26.7 |

*Table 3. Presence (number and percentages) of Peyer's patches, mucous and muscle tissue in 600 histological sections of different batches of sheep casings.*

The serosa layers were also completely removed. Remaining tissues consisted only of mucous and muscle tissues (Fig 8). Mucous tissue remaining was found in 544 out of the 600 sections (90.7%) while muscle remaining was observed in 160 out of the 600 sections (26.7%). Hence, regardless the amount of remaining tissue (see 3.2.2), the vast majority of cleaned casings still contained traces of mucous tissue while in approximately a quarter of the sections muscle tissue remained.

To see which model fitted the data for mucous tissue best, as compared to another model, Akaike's Information criterion (AIC) was used. A logistic regression model with random animal effects was used. The model with manual/mechanical, AB, location groups and all possible interactions had an AIC of 373.4. The same model without the interactions had an AIC of 364.8. A model with only AB and methods had an AIC of 364.08. So the last model is best supported by the data. There were no significant differences for remaining mucous tissue between batches manually A and B and batches mechanically A and B. However, between manually and mechanically processing the percentages of sections with remaining mucous tissue were 87 and 94% respectively. This difference was significant ($p=0.005$, odds ratio= 0.42).

To see which model fitted the data for muscle tissue best, as compared to another model Akaike's Information criterium (AIC), was used. Again a logistic regression model with random animal effects was used. The model with manual/mechanical, AB, location groups and all possible interactions had an AIC of 655.34. A model with only AB and manual and their interaction, had an AIC of 349.32. So the last model is best supported by the data. There was no significant difference for remaining muscle tissue between manual A and B. However, between manual and mechanical there was a significant difference ($p<0.001$) as well as between mechanical A and B ($p<0.001$).

## 3.2 Image analysis

### 3.2.1 Qualitative determination of remaining tissue

The results of the qualitative histological research of 800 microscopic fields of view are listed in Table 4. In 800 microscopic fields of view analysed, mucous remaining was found in 451. On average this was 56.4 %. Compared with the 90.7% mentioned in the previous paragraph this is significantly lower. Muscle remaining was found in 36 out of the 800 fields of view (4.5%) Compared with the 26.7% reported in the previous paragraph this percentage is again significantly lower. The lower percentages found here can be explained by the different method of histological examination used.

A logistic regression model with random animal effects was applied. The model with two batches of each manually and mechanically cleaned sheep intestines, number of animals/casings, location groups and all possible interactions had an AIC of 1127.7. The same model without the interactions had an AIC of 1121.0. A model without interactions and location groups as a linear effect had an AIC of 1118.2. Hence, the last model was best supported by the data.

The statistical analysis revealed that there was no significant difference between manually and mechanically cleaned casings with respect to remaining mucous tissue ($p=0.62$) and between batches A and B of both methods ($p=0.38$). Muscle tissue remaining was low with both methods, but slightly higher with manual than mechanical cleaning. For muscle remaining (only 36 sections out of 800 positive) there seemed to be an animal effect. This means that when remaining muscle tissue was present, it was concentrated in casings of certain animals. With respect to manual processing, of course this could also be related to the operator.

| Method | Fields of view | Mucous tissue | % | Muscle tissue | % |
|---|---|---|---|---|---|
| Manual A | 200 | 105 | 52.5 | 15 | 7.5 |
| Manual B | 200 | 117 | 58.5 | 15 | 7.5 |
| Mechanical A | 200 | 115 | 57.5 | 6 | 3 |
| Mechanical B | 200 | 114 | 57.0 | 0 | 0 |
| Total | 800 | 451 | Mean 56.4 | 36 | Mean 4.5 |

*Table 4. Presence of mucous and muscle tissue (number and percentages) in 800 fields of view from histological sections of different batches of sheep casings.*

Significant differences were measured between the locations along the casing where remaining mucous tissue was observed (Table 5). Locations 1 and 10 respectively, had significantly lower and higher percentages of microscopic fields with mucous tissue than locations 3, 5 and 8 ($p<0.001$). This may be explained by a pushing forward effect during the cleaning and stripping process. An increasing amount of removed mucous and muscle tissue has to pass through the final part of the intestine under an increasing pressure, causing a less effective cleaning of the latter parts of the intestine. The odds ratio for location effect was 1.31, which means that on average, each subsequent location had approximately 1.3 times more microscopic fields with remaining mucous tissue than the previous one.

| Location | 1 | 3 | 5 | 8 | 10 |
|---|---|---|---|---|---|
| Manual A and B<br>Locations with mucous tissue (%) | 43.2 | 48.8 | 51.1 | 63.6 | 71.6 |
| Mechanical A and B<br>Locations with mucous tissue (%) | 40.0 | 61.3 | 57.5 | 56.3 | 71.3 |
| Mean of manual and mechanical<br>(%) | 41.7 | 55.0 | 54.2 | 60.1 | 71.4 |

*Table 5. Percentage of microscopic fields of view with remaining mucous tissue at subsequent locations of manually and mechanically processed sheep casing.*

The results of the qualitative determination of remaining tissues (% of microscopic field with mucous and muscle tissue) confirmed the observations made in sections with complete rings of the casings reported in paragraph 3.1. Again mucous tissue occurred more frequently than muscle remaining. It can be concluded that both manual and mechanical cleaning and stripping processes did not yield completely clean casings. Parts of mucous and muscle tissue remained attached to the submucosa layer. As stated in paragraph 2.5 the qualitative approach - presence or absence of remaining tissue, regardless the amount – provided relatively rough data on the cleaning efficacy of both methods. The quantitative approach, with which the area percentages of remaining mucous and muscle tissue were determined, provided a much deeper insight into the desliming efficacy of both methods.

### 3.2.2 Quantitative analysis of remaining tissue

The results of the image analysis of percentages of remaining tissue are listed in Table 6. The main amount of remaining tissue consisted of mucous tissue varying from 8.32-9.73% with an average of 8.99%. The amount of remaining muscle tissue was very low and varied from 0.00-1.28% with a mean of 0.74%. There were only very slight differences between batches A and B from manual processing and between batches A and B from mechanically cleaning and stripping, both for remaining mucous and muscle tissue.

| | Manual A | Manual B | Mechanical A | Mechanical B | Total |
|---|---|---|---|---|---|
| Mucous tissue % | 8.43 ± 10.15 | 9.73 ± 12.09 | 8.32 ± 9.50 | 9.41 ± 10.53 | 8.99 ± 10.69 |
| Muscle tissue % | 0.90 ± 04.16 | 1.28 ± 7.87 | 0.69 ± 4.29 | 0.00 ± 0.00 | 0.74 ± 5.14 |

*Table 6. Percentages and standard deviation of remaining mucous and muscle tissue in 4 different batches of sheep natural casings.*

| Location | 1 | 3 | 5 | 8 | 10 |
|---|---|---|---|---|---|
| Manual processing A and B<br>Mucous tissue (%) | 5.4 ± 8.1 | 7.3 ± 9.5 | 8.3 ± 9.7 | 7.6 ± 8.1 | 17.0 ± 15.5 |
| Mechanical processing A and B<br>Mucous tissue (%) | 4.8 ± 7.6 | 9.3 ± 8.9 | 8.1 ± 9.1 | 7.9 ± 8.6 | 14.4 ± 12.8 |
| Mean of manual and mechanical<br>Mucous tissue (%) | 5.1 ± 7.8 | 8.3 ± 9.2 | 8.2 ± 9.4 | 7.7 ± 8.3 | 15.8 ± 14.3 |

*Table 7. Mean percentages and standard deviation of remaining mucous tissue at subsequent locations in batches of manually and mechanically processed sheep casing.*

Similar to the qualitative analysis reported in paragraph 3.2.1 there was a difference between locations along the casing where remaining mucous tissue was observed (Tables 7 and 8). Location 10 had a significantly higher percentage of remaining mucous tissue than locations 1, 3, 5 and 8. As stated in paragraph 3.2.1 a pushing forward effect could explain that more tissue remains in the bung end of the casing. This seems logical for the manually processed casings, which were stripped from the duodenum side to the bung side. However, mechanically processed casings are stripped from the middle of the jejunum, so half of the tissues are pushed in the direction of the duodenum side of the casing with a narrower end. Nevertheless, a lower percentage of remaining mucous tissue was found at location 1 of mechanically processed casings. Perhaps, differences in thickness and elasticity along the casing may play a role in this respect.

For the statistical analysis data could only be used when mucous tissue was present (excluding all zero values). A model with random animal effects and a normal distribution were used for the log of the percentages. Logs were used to obtain data, which better fitted a symmetric distribution. The model with manual/mechanical, AB, location groups and all possible interactions had an AIC of 916.54. The same model without methods and interactions with methods had an AIC of 915.73. Some of the location groups could be taken together: group 1: locations 1 and 8; group 2: location 3 and 5, group 3: location 10. This model with this location groups and AB interaction had an AIC of 911.8. So the last model was best supported by the data.

The statistical analysis revealed that there was no significant difference between manually and mechanically cleaned casings. However, location 10 had significantly higher area percentages of mucous tissue ($p<0.001$) than the other locations along the casing. Location 10 not only had the highest frequency of presence of mucous tissue (table 5), but also the highest area percentages of this tissue.

| **Location** | **1** | **3** | **5** | **8** | **10** |
|---|---|---|---|---|---|
| Manual processing A and B<br>Mean log % mucous tissue | 11.7 | 16.5 | 16.5 | 11.7 | 23.2 |
| Mechanical processing A and B<br>Mean log % mucous tissue | 13.7 | 13.6 | 13.6 | 13.7 | 20.4 |

*Table 8. Mean log percentages of remaining mucous tissue at subsequent locations in batches of manually and mechanically processed sheep casing.*

From the results of the quantitative analysis of remaining tissues it can be concluded that although both manual and mechanical cleaning and stripping processes did not yield completely clean casings, the area percentages found were relatively low. For remaining mucous and muscle tissue this was overall on average 9.0 and 0.7%, respectively. In spite of distinct differences between manual and mechanical processing – bamboo stick versus sets of rollers; cleaning and stripping from the beginning to the end of the runner versus cleaning and stripping from the middle of the runner - no significant differences between the two methods were found. Regarding remaining tissue found, there was a distinct effect of animals and locations along the intestine. When remaining tissue was present it was concentrated in casings of certain animals and concentrated at certain locations along the intestine.

An important observation in this research was that in terms of remaining Peyer's patches, no significant difference was found between manually and mechanically processing. Even more

important was that Peyer's patches were not found at all. Some differences were found between remaining mucous and muscle tissue, depending on the method used, location along the casing, and animal. Due to the experimental design of this research, the cause of these differences could not be explained completely. Many variables can play a role in this respect, including breed, age, and operators. To obtain a deeper insight into these differences this research should be repeated in such a way that manually and mechanically processing should be performed with sheep of the same breed, age in the same season of the year in one country.

With respect to TSE risk reduction and infectivity titres for the different tissues present in natural casings, it would be desirable that all remaining mucous and muscle tissue were removed from the runners during processing, leaving only the *tunica submucosa* as natural casing. Mucous tissue and particularly muscle tissue do not represent high potential risks, Peyer's patches however are considered as category II tissue with respect to infectivity titres (Bradley, 2002; SSC, 2000; SSC, 2001, SSC, 2002). Therefore, the observation that Peyer's patches are removed by manual as well as mechanical processing, which is reported in this study, is very important. The confidence intervals and odds ratios computed in the statistical analyses (close to 1.0) showed that sufficient histological sections were analysed to enable reliable findings with respect to the efficacy of manual versus mechanical desliming of sheep intestines. This study also confirms the earlier observation that a significant risk reduction of potentially infectious material occurs during the processing of sheep natural casings (Koolmees *et al.*, 2002). The additional data on the presence and quantity of lymphatic, mucous and muscle tissues in manually and mechanically processed casings reported here, could be used to further refine the risk analysis regarding the consumption of natural sheep casings.

## 4. Conclusions

With respect to the removal of aggregated lymphatic nodules (Peyer's patches), serosa, mucous and muscle tissues during the cleaning and stripping of sheep casings, no significant differences were found between manually and mechanically processing. No lymphatic nodules were found in any of the 600 histological sections examined. Both manual and mechanical processing did not yield completely clean casings; some mucous tissue and negligible amounts of muscle tissue remained attached to the submucosa layer. The mean area percentages found for these remaining tissues were 9.1 and 0.7 respectively. By manually as well as mechanically processing of sheep casings a significant risk reduction of potentially infectious material occurred. Regarding remaining tissue found, there was a distinct effect of animals and locations along the intestine. When remaining tissue was present it was concentrated in casings of certain animals and concentrated at certain locations along the intestine. The results provided a deeper insight into the degree of removal of tissues other than submucosa by the different desliming processes. In addition, the data obtained can be used in risk analysis.

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## Appendix

*Fig. 1. Pouring water through a runner prior to stripping.*

*Fig. 3. Manual stripping of a sheep runner with a bamboo stick.*

*Fig. 2. Bamboo stick used for manual stripping of casings.*

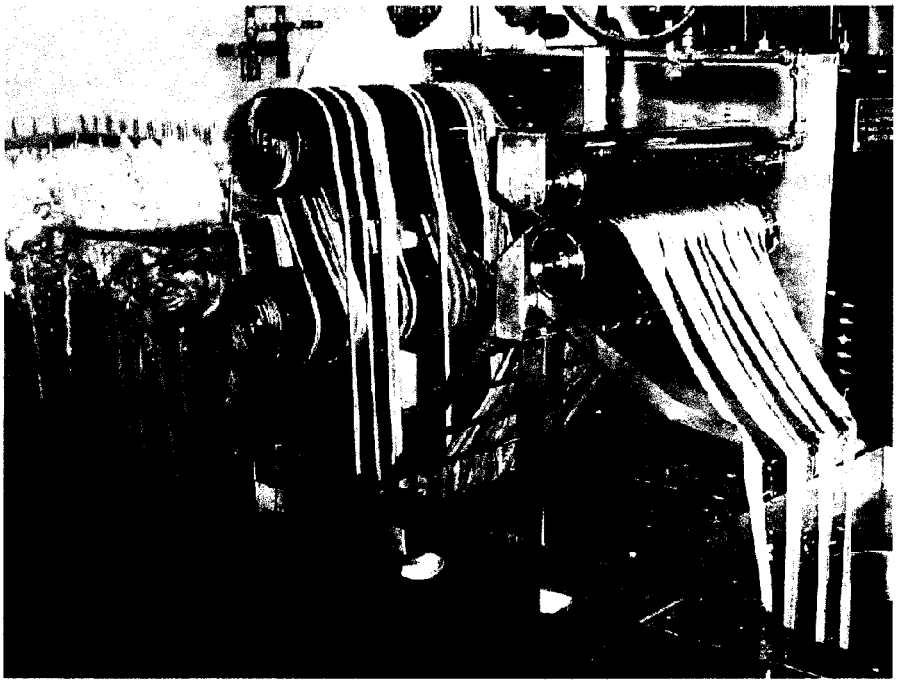

*Fig. 4. Pulling machine.*

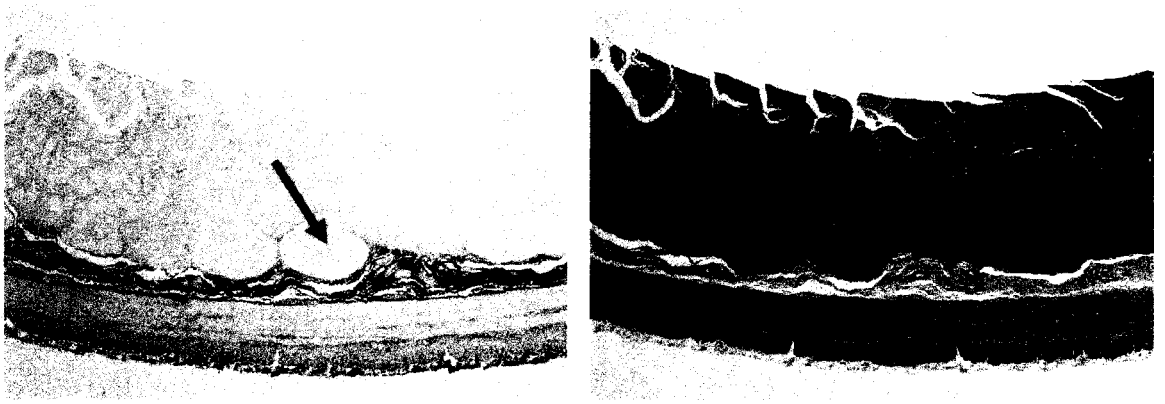

*Fig 5. Micrograph of sheep small intestine (ileum part) with Peyer's patches (arrow) and submucosa layer (S). Left: staining with Picro Sirius red; right: staining with Haematoxylin and eosin. Magnification x 25.*

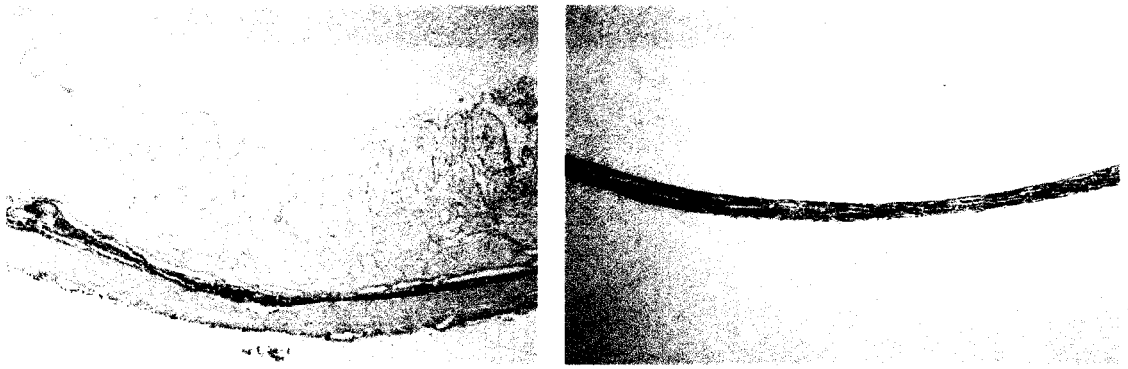

*Fig. 6. Complete sheep small intestine (left) and processed sheep natural casing, which consists of only the submucosa layer (right). Staining Picro Sirius red, magnification x 25.*

*Fig. 7. Image analysis of remaining mucous and muscle tissue. Measurement of the total area % of the casing (top); selection and measurement of mucous and muscle tissue area % (middle, bottom). Staining Picro Sirius red, magnification x 100.*

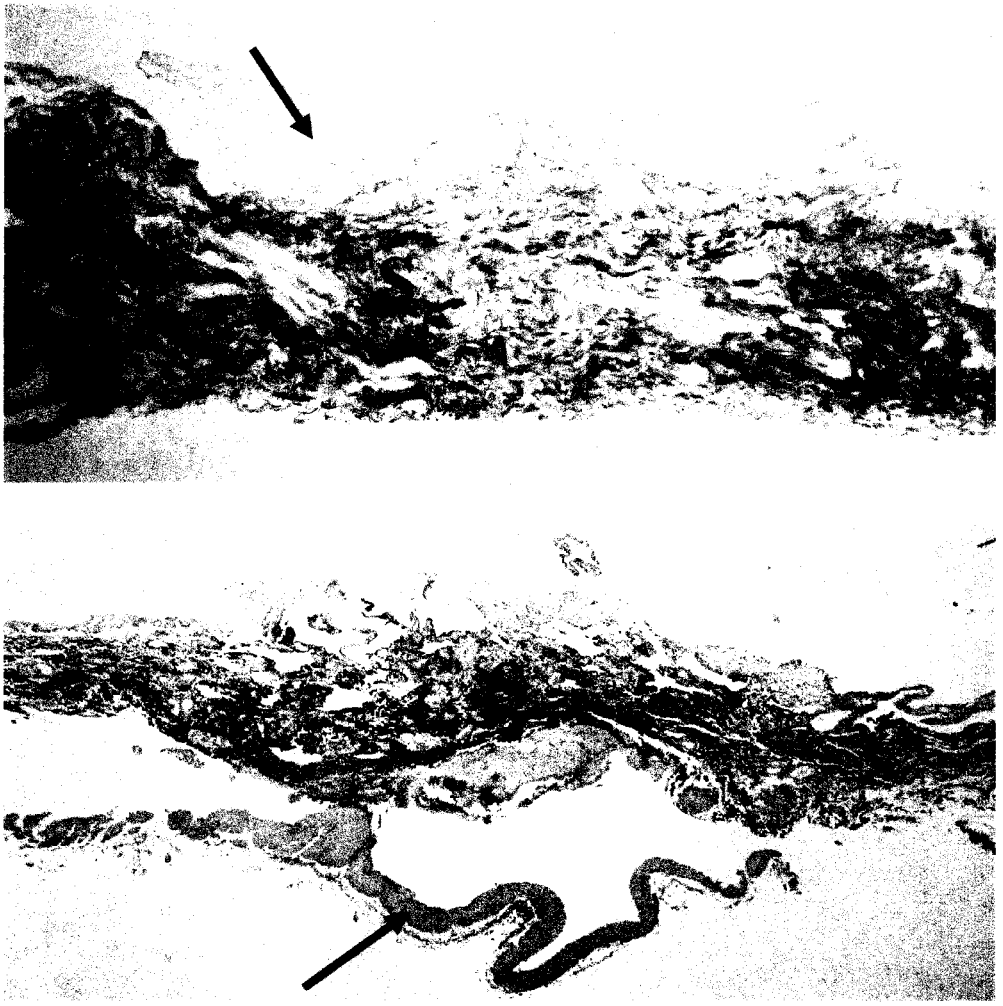

*Fig. 8. Micrographs of sheep natural casings with attached mucous tissue (top, arrow) and muscle tissue (bottom, arrow). Staining: Picro Sirius red, magnification x 100. S = submucosa layer.*