final report

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Prepared by:	M.Farouk, D.Graham, T.Wood, I.Hafegee, M.Collins; N. Simmons AgResearch
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Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Pre-rigor manipulation to enhance meat quality

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Abstract

Hot boned muscles, because they are in a pre-rigor state, can be physically stretched to alter sarcomere length and tenderness in a manner analogous to the on carcase Tenderstretch system of pelvic suspension. Manipulating hot boned meat also offers some unique advantages such as portion control, which allows otherwise irregular muscle shapes to be manipulated to produce a regular (usually cylindrical) shape. When stretching is applied in conjunction with the optimal pre-rigor temperature/pH conditions, improved eating quality benefits are realised. The objective of this study is to develop a commercial muscle stretching device and demonstrate the advantages the device provides in terms of overall meat quality and presentation.

A radical approach to the meat stretching concept was developed during the current research. This was initiated by the recognition that the earlier design (the Don/ANZAC) suffered two significant limitations: first, the physical size of the equipment would make its installation into most commercial boning rooms difficult; and, second, the successful stretching of the pre-rigor meat was sensitive to the choice of tube diameter, and choosing too small a diameter produced a high risk of damage to the meat.

The new design employs an elastic sleeve that applies the pressure evenly and simultaneously along the length of the cut, and is designed to allow the sleeve to extend with the meat. These features limit internal stresses that can develop with passive stretching designs such as the ANZAC and that lead to physical damage to the meat. Once stretched, the next step was to use a ram to expel the stretched meat from the sleeve directly into a packaging system that maintains the diameter of the meat and, hence, the stretch until rigor mortis sets in (Diagram 1).

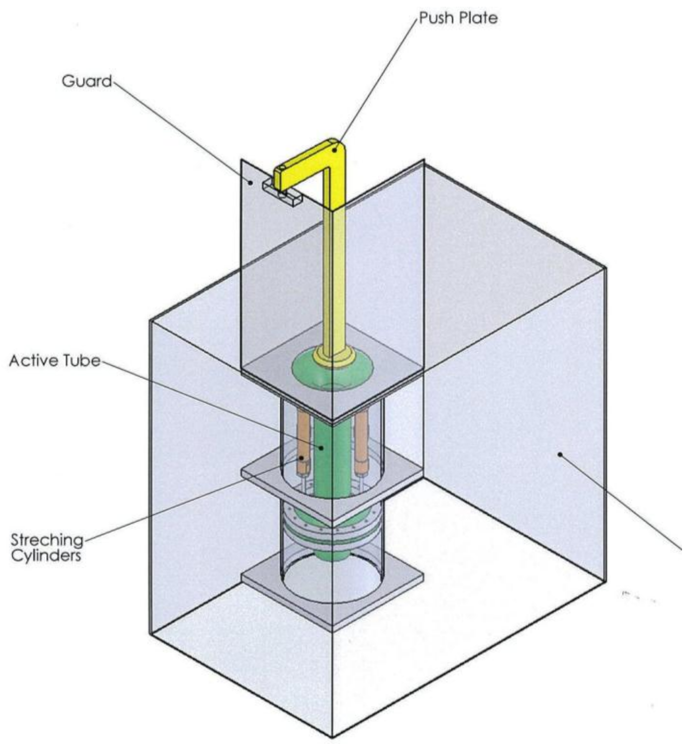


Diagram 1 – Drawing specifications of a new meat stretching commercial prototype machine.

All steps in the development process received commercial approval. One aspect that remains critical to the effective implementation of this technology into a commercial operation is the packaging of the stretched meat. This aspect of the development was recognised from the beginning as requiring special attention and, probably, the involvement of a commercial packaging company.

The introduction of the new stretcher into a plant was therefore agreed. The equipment was shown to work well and could operate at line speeds if the range of cuts was limited to 3-4. The main concern identified by the process was the ability to accommodate a wide range of cut sizes: although a range of package diameters could easily be attached, larger cut sizes were more difficult to expel from the stretcher and this slowed the process down.

This new approach to removing the stretched meat requires only modification of the existing stretcher design and ongoing evaluation to quantify the quality enhancement to hot-boned meat over a range of cuts and commercial conditions. Furthermore, the packaging system requires additional development in the next phase of testing.

Contents

1 Background

Controlling quality attributes depends substantially on manipulation of the temperature and pH decline after slaughter. Since different muscles in a carcass will have different end uses, processing to optimise the quality of each muscle means that, ideally, each muscle should be subjected to a temperature/pH history that is tailored to its end use. This goal is difficult to achieve in the processing of whole carcasses, since the control of temperature is limited by the size of the carcass and poor heat transfer characteristics of meat: this results in steep temperature gradients within most of the large cuts of, for example, a beef carcass. Manipulating pH decline using electrical stimulation cannot, with present technologies, produce an accelerated pH decline independently in specified muscles, although regions of carcasses could be stimulated independently (legs vs loin, for example).

Hot boning offers the opportunity to process individual muscles according to their specific needs. The small size of individual muscles means that temperatures can be controlled accurately throughout the tissue. However, to date, manipulating the rate of pH decline of individual, hot boned muscles using electrical stimulation has not been explored. This project will evaluate procedures for stimulating individual animals following electrical stimulation, optimise the electrical waveforms for the response characteristics of different muscles, and assess the opportunities to maximise the quality of individual cuts for specific end uses.

In addition, hot boned muscles, because they are in a pre-rigor state, can be physically stretched to alter sarcomere length and tenderness in a manner analogous to the on-carcass Tenderstretch system of pelvic suspension. However, manipulating hot boned meat also offers some unique advantages. A principle benefit is portion control, which allows otherwise irregular muscle shapes to be manipulated to produce a regular (usually cylindrical) shape. When combined with optimal temperature/pH conditions, improved colour and eating quality benefits will be apparent.

Hot boned muscles, because they are in a pre-rigor state, can be physically stretched to alter sarcomere length and tenderness in a manner analogous to the on carcase Tenderstretch system of pelvic suspension. Manipulating hot boned meat also offers some unique advantages such as portion control, which allows otherwise irregular muscle shapes to be manipulated to produce a regular (usually cylindrical) shape. When stretching is applied in conjunction with the optimal pre-rigor temperature/pH conditions, improved eating quality benefits are realised. The objective of this study is to develop a commercial muscle stretching device and demonstrate the advantages the device provides in terms of overall meat quality and presentation.

In the current research, a prototype super-stretching device will be completed. Applications this year will specifically be focused on value-adding to beef hot forequarter exercised primals and materials. After a series of pilot plant trails, samples collected will be evaluated and the super-tenderisation effects demonstrated. Following the initial pilot plant trials, processors in Australia and possibly New Zealand will be involved in the first production trials with specified hot boned beef meat. Feedback will be sought from supply chains and markets to demonstrate applications of super-stretched meats in retail and possible food service markets.

The outcome of the current year's work will be to prove a commercial prototype works for specified hot boned beef cuts/products, and that acceptable product formats can be produced with such technologies.

2 Project Objectives

The objectives of the research are :

- Complete the construction of the equipment / technology to meet requirements for a commercial operation (assumes FTO around patent protection). In combination with industry partners, finalise design specifications for the commercial prototype.
- Installation in at least 1 NZ plant and 1 Australian plant.
- Evaluate and report on the performance of the technology in a commercial operation.

3 Materials & Methods

3.1 Construction of the equipment / technology to meet requirements for a commercial operation

3.1.1 Development of stretching device

- A pre-production device for stretching pre-rigor muscles was designed and built. The device (Figure 1) is made up of the following parts:
- Three steel chamber tapers that decreased from 160mm to 63 mm (small tube), 75mm (medium tube) and 100mm (large tube).
- A button that shuts the chamber after pre-rigor muscle is loaded.
- A valve to allow air into the chamber at up to 100psi to force the muscle down the taper and into a parallel tube
- A sensor on the parallel tube that tells the electronic controller that the meat has entered the parallel tube.

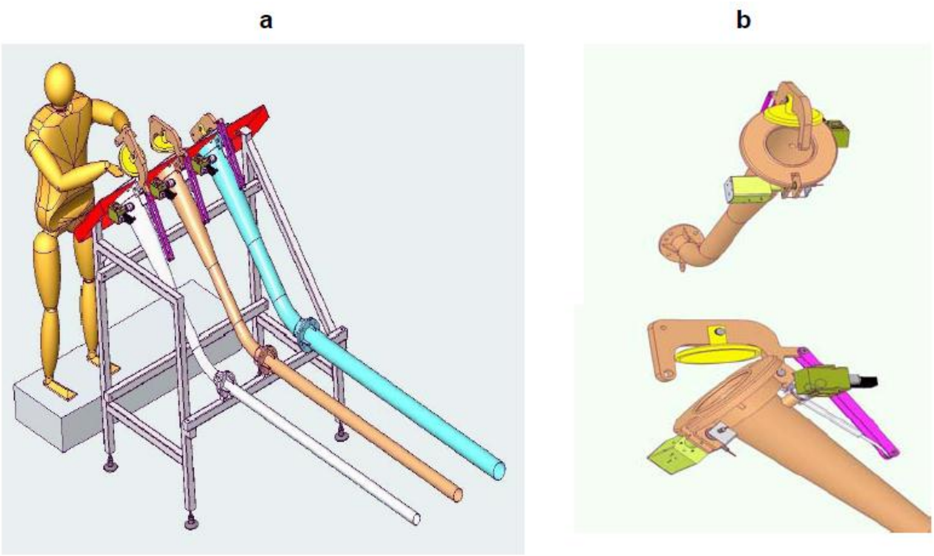


Figure 1. Sketch of the whole stretching device (a) and views of the stretching tubes (b).

3.1.2 Sample preparation

The stretching device was used to stretch pre-rigor *semimembranosus* (ST, eye of round) *biceps femoris* (BF, flat) and *semimembranosus* (SM, corner cut) from, 6 animals. Pre-rigor meat cut was placed in the chamber taper and a button was pushed which shuts the chamber door, ait at up to 100psi was allowed into the chamber forcing the muscle cut down through the taper and into the parallel tube thereby stretching the meat cut. A sensor on the tube tells the electronic controller that the meat had entered the parallel tube and the high pressure ait behind the meat was dumped to atmosphere in 400 milliseconds. The stretched pre-rigor meat in the parallel tube was relatively easy to push along at this point. The chamber was then opened and the next muscle cut was placed inside, the door was shut again and this cut was then pushed through the taper with the compressed ait into the parallel tube where it pushes the first cut along. This process was repeated until the whole tube (2meters long) was full of meat cuts and the first muscle was beginning to emerge from the tube. The stretched muscle was encased in a polythene tube with similar dimensions as the parallel tube that form a continuum with the stretching tube to prevent the stretched muscle from contracting. The stretched muscle was then maintained at 15C for the duration of the storage period.

Meat form both control and stretched muscles were sliced into 2.5 cm steaks and vacuum packaged for analyses. Meat quality attributes such pH, colour drip loss, tenderness and cook loss were determined on completion of rigor and at 24, 48, 72 and 120 hrs post-rigor. Changes in dimension on stretching were also determined, and the steaks were examined for evidence of physical defects and photographs were taken.

3.2 Installation in at least 1 NZ plant and 1 Australian plant (ie at least 2 commercial operations)

The unit is currently being tested at the Carne Technologies premises. It is also due to be trialled at Greenlea Morrinsivlle, but this has been delayed due to the annual plant shutdown. However, once the packaging system has been finalised, the unit will be tested in the boning room at Morrinsivlle.

The operation of meat stretcher is as follows :
The first clip shows the expansion of the sleeve and subsequent return as the vacuum is released. The process is very slow because of the limitation of the vacuum pump, but a new pump has been ordered that will execute this process in a few seconds.

- The second segment films the extrusion end of the Boa. This shows the sleeve shortening as the vacuum is applied, then passively lengthening as the vacuum is released.
- The next series of clips shows meat being introduced and compressed.

3.3 Evaluate and report on the performance of the technology in a commercial operation

The development of the latest version of the meat stretcher was carried out in consultation with Greenlea meat processors, following the completion of a formal confidentiality agreement with the Company. Their input ensured that the design was appropriate to the space limitations of a typical commercial boning room, met the required hygiene and safety requirements and produced a product that they could recognise as offering marketing opportunities. The design concepts were cleared with their production staff and with their marketing department and, before the equipment was installed into one of their plants, the Greenlea production staff were invited to a demonstration of the equipment.

4 Results

4.1 Construction of the equipment / technology to meet requirements for a commercial operation.

The current experimental stretching and reforming unit (known as The Anzac) was recently demonstrated to 8 representatives from Greenlea Premier Meats. While the unit successfully demonstrated the stretching of eye rounds and large cuts from the flap, it was generally felt that the footprint of this unit was too large to be easily accommodated in the majority of hot-boning rooms. Furthermore, the use of multiple pipe diameters to accommodate a variety of cuts increases the space requirements and makes operations more difficult. A last consideration is the incidence of damage to some of the softer cuts if an excessive level of stretch is attempted: while this can be controlled by appropriate choice of pipe diameter, the innate variability of cut sizes means that there will be a significant risk of damage – not observed until the cuts are unpacked by the end user – unless a high level of operator attention is applied. Therefore, while it was felt that the overall concept behind this unit was reasonable, modifications to make the system smaller and more forgiving would have significant commercial advantages.

The functional essence of the current ANZAC design is the use of a gradual taper to effect the muscle stretch. This design requires a significant length of tube and lacks the ability to conform to different product diameters. The novel modification that will be introduced into the existing ANZAC design is an active and controllable compression process to replace the taper (or function as a standalone system) that will reduce space requirements, allow a range of product diameters from a single unit and control the extent of stretch to avoid muscle damage.

The design of the modification is based on the use of an elastic (rather than fixed, metallic) stretching cylinder using a flexible food-grade based silicon material (described as Active Tube on attached diagram). The Active Tube is located inside a second cylinder (Stretching Cylinder) within which the air pressure can be controlled. The bottom of the Stretching Cylinder is a sealed piston-like design which allows the length of the cylinder to increase as the meat is stretched.

Modifications to the current pre-production prototype unit was required to overcome the issues experienced.   The commercial prototype has been constructed (Figure 2).

Figure 2. Commercial prototype meat stretching and shaping device. Top view of insertion of end of the cylinder – vacuum off.

The cabinet that will house this unit is currently being constructed, and initial testing of the unit at a local hot-boning point is scheduled to take place within the next two weeks. During the construction of this unit, input has been sought from production and engineering staff from Greenlea Premier Meats.

The basic design of the device consists of a pressure cylinder 250 mm in diameter and 600 mm long. Inside the cylinder is a flexible sleeve made of food grade silicon-based material. This sleeve is sealed to the rim of both ends of the cylinder to form an air-tight join. The device is operated with the long axis of the cylinder in the vertical plane.

The basic operation is as follows :

<u>1.Inserting the meat to be stretched and formed</u>

For this operation, a partial vacuum is applied between the cylinder and the sleeve. This causes the sleeve to expand outward towards the sides of the cylinder, so increasing the aperture of the sleeve. This allows the meat cut to be dropped into the sleeve.

2. Stretching and forming

For this step, a positive pressure is applied between the cylinder and the flexible sleeve. This has the effect of compressing the meat and forcing it to elongate along the axis of the cylinder. Because the silicon material of the sleeve is flexible, the sleeve will stretch with the meat: this avoid the build up of stresses in the meat caused by friction between the meat and the cylinder wall thereby reducing the risk of damage to the meat.

3. Ejecting the meat

Ejection is accomplished by a mechanical piston that transfers the meat to an inflexible packaging sleeve that maintains the shape of the meat until rigor mortis sets in.

To introduce the meat into the Active Tube, a vacuum is produced inside the Stretching Cylinder to expand the Active Tube diameter. The vacuum is then released and the meat is compressed by increasing the air pressure inside the Stretching Cylinder. The compression of the meat also causes the Active Tube to stretch, which avoids shearing inside the meat due to friction between the meat surface and elongation (stretch) deeper inside the muscle. In this design upgrade, the wall of the tube will stretch with the meat itself. Simultaneously, small pneumatic cylinders inside the control cylinder maintain tension on the Active tube and control the elongation of the Stretching cylinder.

The current design operates in the vertical plane. The meat is dropped into the Active Tube, and the sealed base of the Stretching Cylinder is driven downward by the air pressure and pneumatic rams to compress and stretch the meat. Once the dimensions of the meat have reached the desired level, the push plate is rotated to a position above the top of the Active Tube and the whole cylinder assembly is moved upwards, which forces the meat inside the Stretching Cylinder to be ejected downwards from the Active Tube into the packaging material. Alternatively, to continue with the design of the ANZAC, compressed air can be used to eject the formed meat into a packaging or tube system.

The design and construction of this unit will be carried out in close consultation with the Industry working group.

4.2 Installation in at least 1 NZ plant and 1 Australian plant (ie at least 2 commercial operations)

The new stretching device, referred to as the 'The Boa'. In brief, the construction of The Boa is based around a flexible, food-grade silicone sleeve that provides the active medium for producing the compression and stretch of the meat. A vacuum is applied to the outside of the sleeve to allow the meat to be introduced into the device. The vacuum expands the diameter of the sleeve and also causes it to shorten; a ring of small pneumatic rams on the outside of the sleeve controls the amount of shortening.

Once the meat has been introduced, the vacuum is released, and the passive return of the sleeve to its original diameter produces a significant proportion of the necessary pressure to stretch the meat. The simultaneous lengthening of the sleeve minimises the contact friction between the meat and the sleeve – a feature of past designs that have resulted in damage to the meat.

To provide additional compression of the meat, a positive pressure can be added to the outside of the sleeve.

Extraction of the meat following stretching is carried out with a pneumatic ram. At this stage, the design of packaging system for the meat as it is extruded is currently being developed.

Cube rolls of a variety of sizes were stretched using the Boa. Past work has shown that this cut is the most prone to tearing using the earlier stretching devices. Even with maximal positive pressure applied to the sleeve, no evidence of damage to the cube rolls could be detected.

4.3 Evaluate and report on the performance of the technology in a commercial operation

4.3.1 Current status of the meat stretcher.

A radical approach to the meat stretching concept was developed during the current year. This was initiated by the recognition that the earlier design (the Don/ANZAC) suffered two significant limitations: first, the physical size of the equipment would make its installation into most commercial boning rooms difficult; and, second, the successful stretching of the pre-rigor meat was sensitive to the choice of tube diameter, and choosing too small a diameter produced a high risk of damage to the meat.

The new design employs an elastic sleeve that applies the pressure evenly and simultaneously along the length of the cut, and is designed to allow the sleeve to extend with the meat. These features limit internal stresses that can develop with passive stretching designs such as the ANZAC and that lead to physical damage to the meat. Once stretched, the next step was to use a ram to expel the stretched meat from the sleeve directly into a packaging system that maintains the diameter of the meat and, hence, the stretch until rigor mortis sets in.

4.3.2 Commercialisation steps.

All steps in the development process received commercial approval. One aspect that remains critical to the effective implementation of this technology into a commercial operation is the packaging of the stretched meat. This aspect of the development was recognised from the beginning as requiring special attention and, probably, the involvement of a commercial packaging company. While recognising that a manual packaging operation would limit throughput, Greenlea were happy to accept that a labour intensive, low tech interim approach, to allow the rest of the system to be tested, would be necessary. In fact, their preference is for a minimum of complexity if the alternative is to increase reliability. The introduction of the new stretcher into a plant was therefore agreed.

4.3.3 In-plant experiences.

The new stretcher was installed into the Greenlea Hamilton plant. So far, the new equipment was not integrated with the packaging line to avoid any risks of hold-ups. However, a range of cuts were brought to the stretcher and the performance of the equipment evaluated, in consultation with the boning room manager.

The equipment was shown to work well and could operate at line speeds if the range of cuts was limited to 3-4. The main concern identified by the process was the ability to accommodate a wide range of cut sizes: although a range of package diameters could easily be attached, larger cut sizes were more difficult to expel from the stretcher and this slowed the process down.

These experiences identified an alternative approach to recovering the cuts after stretching. Instead of using a ram to expel the meat through an orifice at the bottom of the sleeve, trials were carried out to test the opportunity to use a hollow metallic sleeve to push into the unit from above, and use this procedure to slide the meet into the sleeve. Manual tests of this concept were successful and this approach offers clear benefits to the original design: different cut sizes can easily be accommodated by changing the diameter of the metallic sleeve; and, once the sleeve was retracted, it can be used to transfer the stretched meat to the packaging system.

This new approach to removing the stretched meat requires only minimal modification of the existing stretcher design and will be completed by the end of December. The required packaging system will be incorporated with this design as part of the next phase of research (proposed for 2006-07).

i) Effect of stretching on the physical appearance of steaks

The level of stretching achieved for all the muscles ranged from 43-97%. The level of stretch in the 3 muscles were in the order ST (97.1%) > SM (77.0%) > BF (43.7%), suggesting that higher level of stretch was achieved with muscles that have fibres aligned parallel to the lengths of the muscle (ST and SM) than muscles with fibres that have numerous orientations (BF). Overall, stretching improved uniformity, presentation and portion control (Figure 2).

When muscles were stretched using the correct tube size, there were no observed physical defects. Some of the physical defects observed in some of the muscles that had not undergone stretching included muscle fibre bundle damage, breakage of fibres in muscles with fibres running parallel to the direction of stretch (ST & SM), gaping and failure to maintain shape uniformity particularly in fatty areas in muscles with fibres running in different directions along the stretch (BF) (Figure 2). These physical damages are caused due to failure to match muscles to the right stretching tubes resulting in overstretching and thus the damage described above.

ii) Effect of stretching on meat quality

Stretching the muscles pre-rigor improved the tenderness and reduced the drip loss significantly and these effects were evident after all storage periods (Table 1). Stretching did not affect the bloomed colour of the meat, but there was some increase in the amount of cook loss, however, although these differences were statistically significant, the values for both treatments were within the typical range (Table 1). The most important attributes that determine acceptability at the point of sale such as colour of visible drip have either been improved or not affected by stretching, and tenderness – being the most important attribute that affects acceptability of cooked meat – has been improved by stretching. The samples from this trial are currently being assessed for colour stability during simulated retail display. These results will be reported as an addendum to the September milestone.

Table 1. Effect pre-rigor muscle stretching on changes in meat quality attributes with storage time

Quality Attribute	Rigor		24 hrs		48hrs		72 hrs		120		*P* level
	C	S	C	S	C	S	C	S	C	S	
pH	5.46	5.50	5.50	5.48	5.49	5.48	5.47	5.45	5.37	5.33	0.06
Drip loss, %	ND	ND	2.2	1.6	3.1	1.7	3.9	2.4	6.6	3.1	0.001
Tenderness, KgF	10.3	9.2	8.1	7.7	8.1	7.0	7.9	7.0	7.3	6.8	0.001
Cook loss, %	ND	ND	28.2	32.6	24.7	30.5	26.4	28.3	33.4	37.6	0.001
Colour, a*	18.7	18.5	18.6	17.8	17.9	16.9	15.6	14.9	14.5	14.0	ND

P level = Statistical significance of storage time on the attribute; C = Control; S = Stretched; ND = Not determined

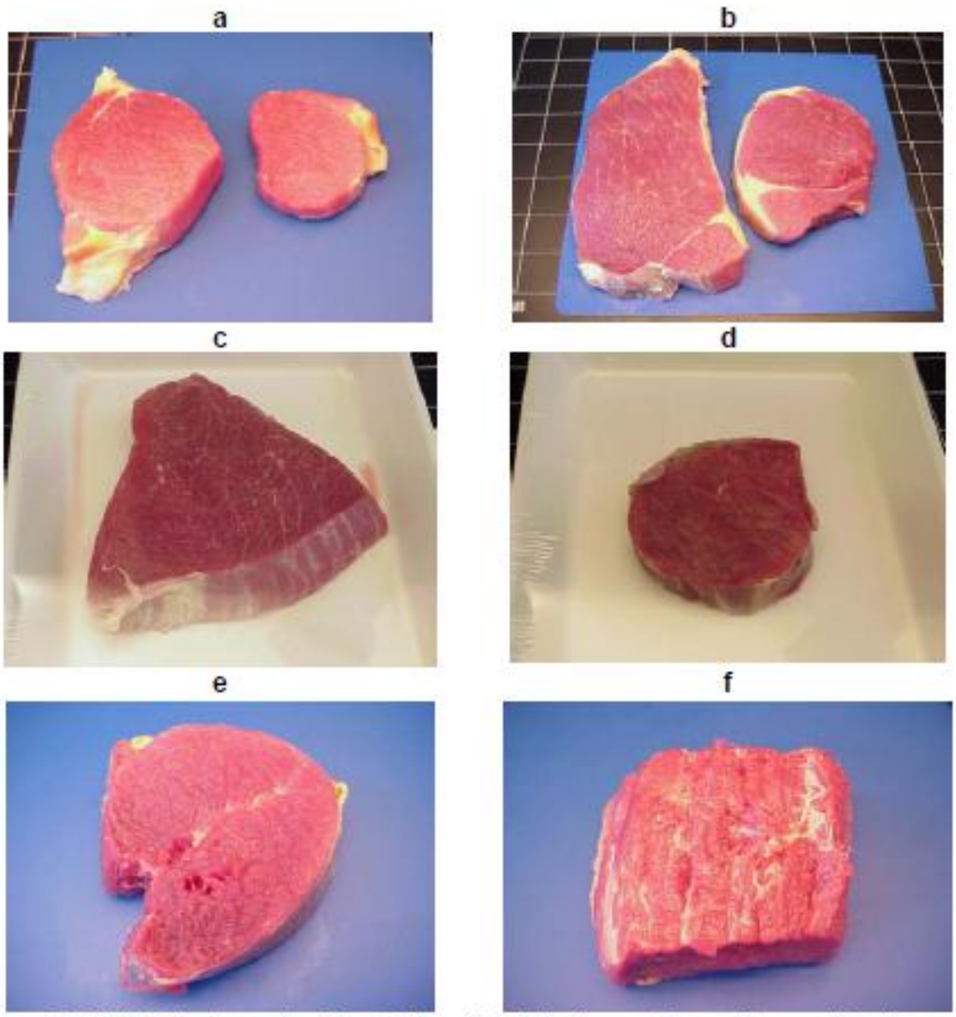


Figure 2. Digital photographs of control and stretched eye of round (a, *semitendinosus*), flat (b, *biceps femoris*) and insides corner cut (c&d, *semimembranosus*). Example of gaping (e) and fibre damage (f). Drip is clearly visible after 24 hrs in packaged control inside (c) but non in stretched (d).

5 Conclusion

A radically new approach to the meat stretching concept was developed during the current research. The modifications addressed issues identified in earlier pre-production prototypes.

There were 2 significant limitations: first, the physical size of the equipment would make its installation into most commercial boning rooms difficult; and, second, the successful stretching of the pre-rigor meat was sensitive to the choice of tube diameter, and choosing too small a diameter produced a high risk of damage to the meat.

The new design employs an elastic sleeve that applies the pressure evenly and simultaneously along the length of the cut, and is designed to allow the sleeve to extend with the meat. These features limit internal stresses that can develop with passive stretching designs such as the pre-production prototype and that lead to physical damage to the meat.

All steps in the development process received commercial approval.

The following conclusions were reached within the parameters of the commercial trialling :

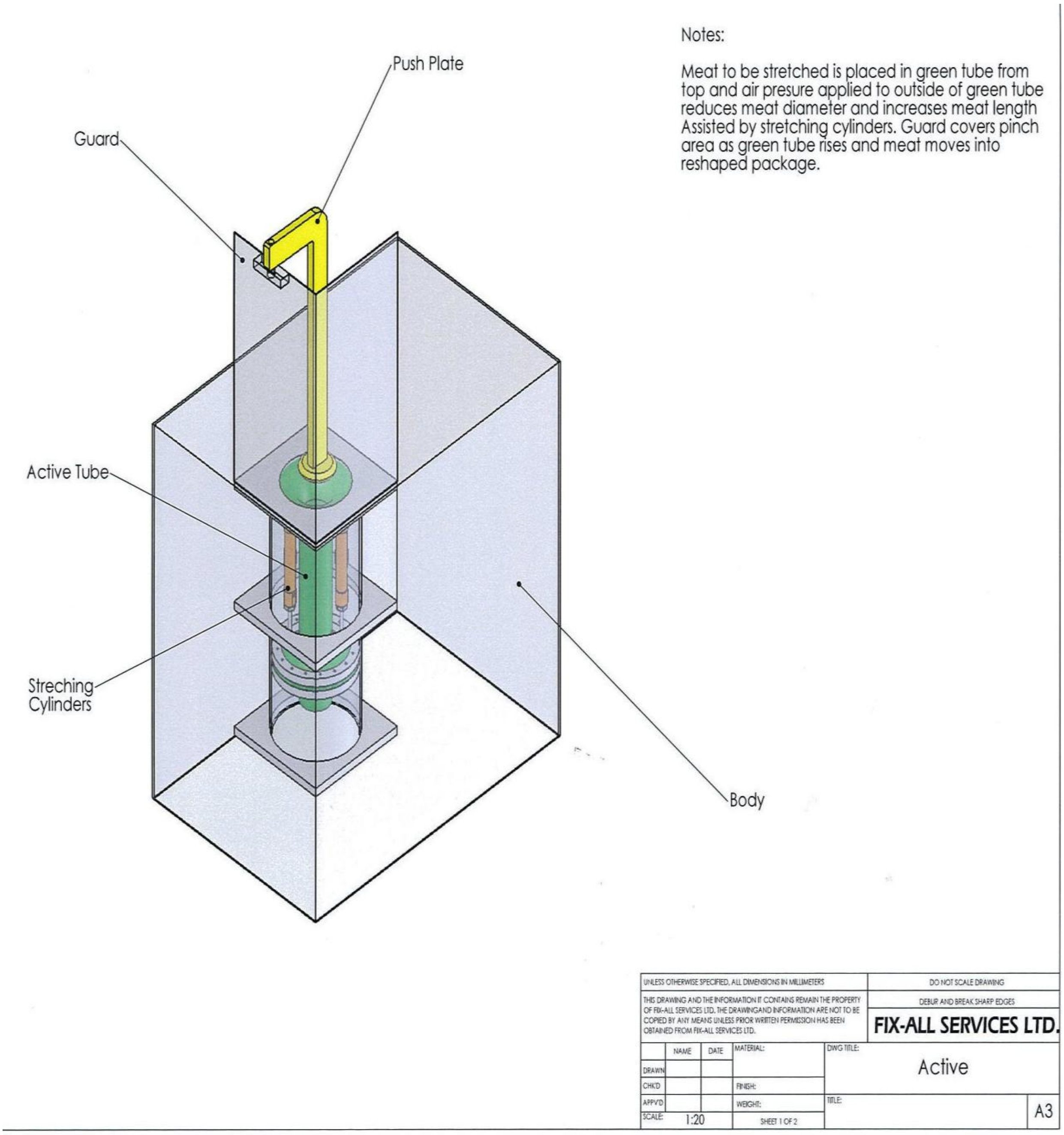
- The device developed in this study is capable of stretching muscles of different sizes by up to 97% of their original length
- Muscles stretched using the right diameter stretching tube had less physical defects than those stretched with inappropriate size tubes.
- Muscles with fibres aligned parallel to the direction of stretch tend to stretch better and had less physical defects as a result
- Meat from stretched muscles had less drip and were more tender than from corresponding non stretched control muscles
- The improvement in tenderness and the reduction in drip loss due to stretching occurred as early as at rigor for tenderness and 24 hrs after rigor for drip loss.
- Stretching pre-rigor muscles had no effect on the bloomed colour of the resulting meat.
- Meat from stretched muscles had higher cook loss than from non stretched.

6 Recommendations

This new approach to removing the stretched meat requires only modification of the existing stretcher design and ongoing evaluation to quantify the quality enhancement to hot-boned meat over a range of cuts and commercial conditions. Furthermore, the following R&D is proposed in the next phase:

- More muscles need to be stretched and the stretching tubes need to be operated at full capacity to simulate commercial setting before trialling the system in plant under commercial conditions
- A method of automatically of manually matching pre-rigor muscles with the appropriate stretching tube will need to be developed prior to commercial trials.
- Packaging system.
- A better method of controlling the muscle while in the stretching chamber when the system is not operating in full capacity will need to be developed prior to commercial trials.

Appendix 1 – Specifications drawing



Appendix 2 – Patent Application

MEAT STRETCHING DEVICE AND METHOD

FIELD OF THE INVENTION

The present invention relates to a meat stretching device and method. In particular, but not exclusively, the present invention relates to a meat stretching device and method using a flexible sleeve.

BACKGROUND TO THE INVENTION

The processing of a carcass and the meat extracted from the carcass has a significant influence on the quality attributes of the meat. This is because various changes take place in the biochemical and structural attributes of muscle tissue in the meat during processing. This is especially so when the meat transforms from a pre-rigor-mortis state to a post-rigor-mortis state.

There are two main factors that determine the pre-rigor state of the meat – the rate of pH fall and the rate of cooling of the meat. The rate of pH fall can be improved by subjecting the meat to electrical stimulation, while the rate of cooling of the meat can be improved by reducing the size of the cut of meat. Any reduction in cut size is preferably done before the carcass is chilled and while the muscles are still in a pre-rigor state. This process is generally referred to as hot boning.

Once meat is cut to size, its shape may be manipulated. Manipulation of meat shape has been shown to improve the meat's tenderness and colour stability, and reduce its drip loss. Also, the manipulation of the shape of the meat allows the portion size of the meat to be controlled.

An example way in which the shape of a meat cut can be manipulated is disclosed in US Patent 6,824,846. In particular, the patent discloses a method of packaging objects, such as meat, where the object to be packaged is pushed through a funnel and into an elastic packaging sleeve. Given its elastic nature, the packaging sleeve wraps closely around the object. Where meat is packaged, the process of pushing the meat through the funnel manipulates its shape, which is then maintained by the elastic packaging sleeve.

In this specification, where reference has been made to patent specifications, other external documents, or other sources of information, it is generally for the purpose of providing a context for discussing the features of the present invention. Unless specifically stated otherwise, reference to such external documents or sources of information is not to be construed as an admission that such documents or sources of information in any jurisdiction are prior art, or form part of the common general knowledge in the art.

It is an object of the present invention to either provide an improved device and method to stretch meat or at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

In one form, the present invention relates to a meat stretching device comprising:

- a receptacle; and
- a flexible sleeve mounted within the receptacle, the flexible sleeve having a cross-section that defines an aperture to receive one or more cuts of meat;
- wherein the receptacle is connectable to an air pressure device that is capable of generating a positive pressure in the receptacle to cause the flexible sleeve to constrict around and stretch the one or more cuts of meat that are received in the aperture.

Preferably, the air pressure device is further capable of generating at least a partial vacuum in the receptacle to cause the aperture of the flexible sleeve to widen to receive one or more cuts of meat.

Preferably, the device further comprises a pushing rod to push the one or more cuts of meat out of the constricted flexible sleeve.

Preferably, the device further comprises one or more stretching cylinders connected at one end to the receptacle, and connected at another end to the flexible sleeve to assist with the stretching of the one or more cuts of meat.

Preferably, the flexible sleeve is a silicon sleeve.

In another form, the present invention relates to a meat stretching device comprising:

- a receptacle; and
- a flexible sleeve having a first end and a second end, and a cross-section that defines an aperture, the first end being adapted to receive one or more cuts of meat and the second end being adapted to allow the one or more cuts of meat to be removed from the flexible sleeve;
- wherein the flexible sleeve is mounted within the receptacle such that an airtight volume is formed between the flexible sleeve and the receptacle, and wherein the flexible sleeve constricts around and stretches the one or more cuts of meat when the airtight volume is subjected to positive pressure.

Preferably, the device further comprises a packaging arrangement arranged adjacent the second end of the flexible sleeve.

In another form, the present invention comprises a method of stretching meat using a flexible sleeve, the method comprising the steps of:

- inserting one or more cuts of meat into an aperture defined by a cross-section of the flexible sleeve;
- generating a positive pressure in an airtight volume between the flexible sleeve and a receptacle containing the flexible sleeve to cause the flexible sleeve to constrict around and stretch the one or more cuts of meat.

Preferably, the method further comprises the step of generating at least a partial vacuum in the airtight volume to widen the aperture before inserting the one or more cuts of meat into the aperture.

Preferably, the method further comprises the step of pushing the one or more cuts of meat out of the constricted flexible sleeve.

Preferably, the method further comprises the step of stretching the sleeve lengthwise to assist the flexible sleeve constrict around the one or more cuts of meat.

The term ‘comprising’ as used in this specification means ‘consisting at least in part of’, that is to say when interpreting statements in this specification which include that term, the features, prefaced by that term in each statement, all need to be present but other features can also be present. Related terms such as ‘comprise’ and ‘comprised’ are to be interpreted in similar manner.

The present invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more said parts, elements or features. Where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

BRIEF DESCRIPTION OF THE FIGURES

Preferred forms of the device and method of the present invention will now be described with reference to the accompanying figures in which:

Figures 1a- 1d show a side view cross-sectional schematic of the device of the present invention,

Figure 2a shows a perspective view of the preferred form device of the present invention,

Figure 2b shows a plan view of the device of Figure 2a,

Figure 2c shows a side view of the device of Figure 2a, and

Figure 2d shows a front view of the device of Figure 2a.

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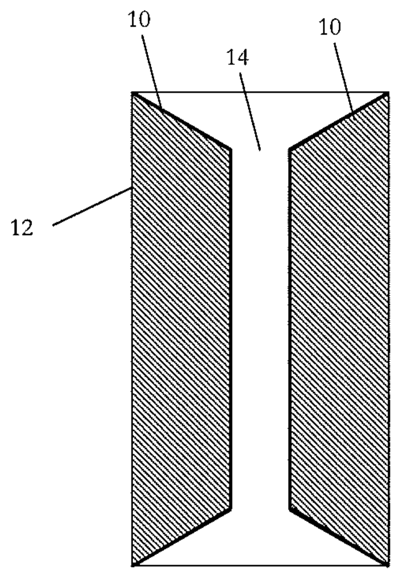

FIGURE 1a

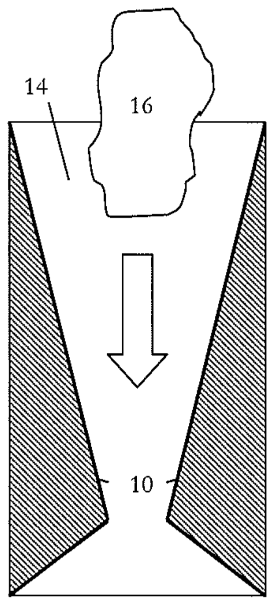

FIGURE 1b

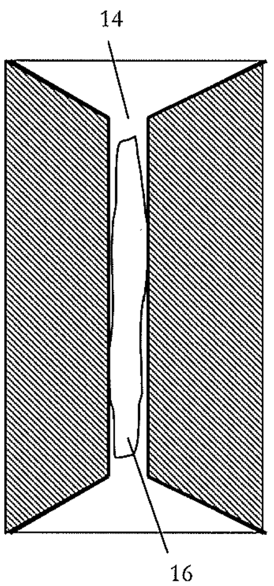

FIGURE 1c

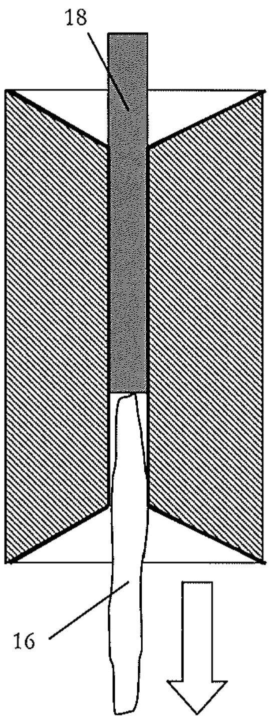

FIGURE 1d

2/2

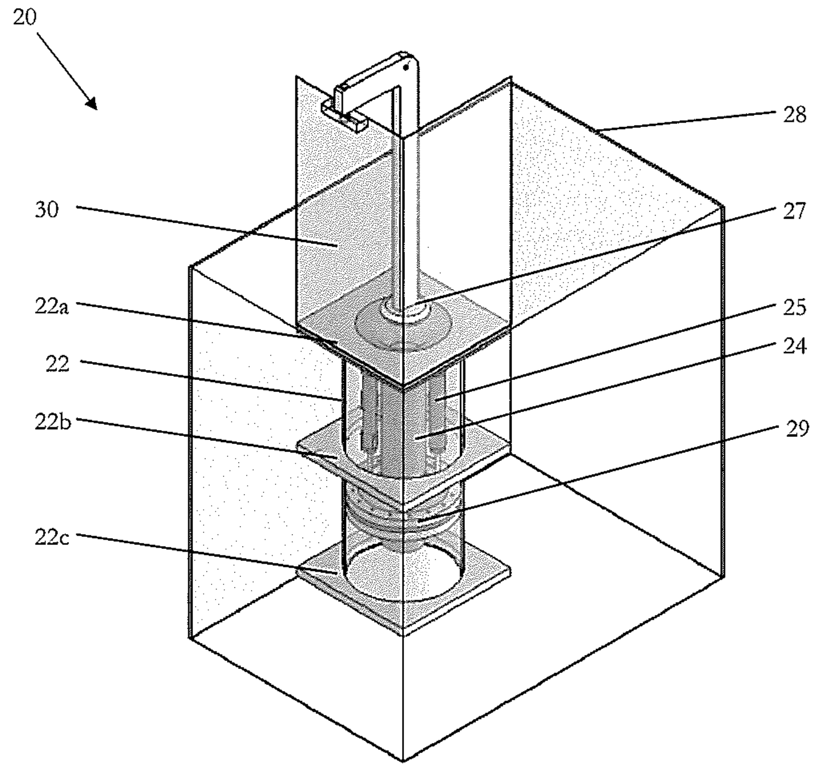

FIGURE 2a

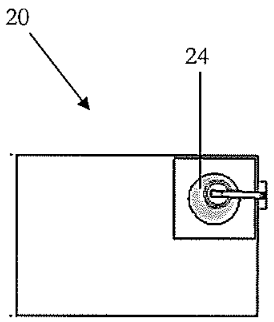

FIGURE 2b

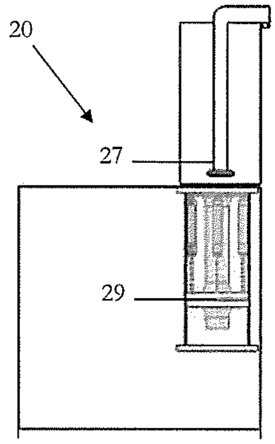

FIGURE 2c

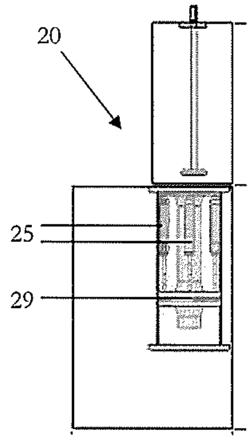

FIGURE 2d

DETAILED DESCRIPTION OF THE PREFERRED FORMS

A cross-sectional schematic of one form of the device of the present invention is shown in Figures 1a-d. In Figure 1a, a flexible sleeve 10 is shown attached to a receptacle 12. In one preferred form, the sleeve 10 is a silicon sleeve. Of course materials other than silicon may be used instead; suitable alternatives to silicon include plastics such as polyethylene terephthalate, polyvinyl chloride and polypropylene.

In the figures, the flexible sleeve 10 is illustrated as having a tapering shape near the ends of the sleeve. This tapering shape is the result of stretching the edges of the preferred form sleeve, which has a diameter smaller than that of the receptacle, to attach to the edges of the receptacle 12. Persons skilled in the art will appreciate that various forms of sleeve can be used, which may or may not result in a similar tapering shape when stretched. All that is required is for the sleeve to be able to constrict around cuts of meat, as will be described in detail below.

When not in use, the area between the sleeve 10 and the receptacle 12 (herein referred to as the interior of the receptacle), which is shown in shade, is under ambient pressure. Also, when not in use, an aperture 14, which is defined by the cross-section of the sleeve 10, preferably has a width smaller than the cuts of meat to be stretched.

The preferred form method will now be described with reference to Figures 1b-d. As illustrated, the interior of the receptacle (shown in shade) is subjected to at least a partial vacuum generated by an air pressure device. This causes the wall of the sleeve 10 to be drawn closer to the wall of the receptacle. This, in turn, causes the aperture 14 defined by the sleeve 10 to widen. In the form shown, only the top portion (called the 'working area') of the sleeve 10 is caused to widen, leaving at least part of the bottom of the sleeve 10 to remain small enough to stop the meat cut from falling right through the sleeve.

Skilled persons will appreciate that the step of widening the sleeve is not essential as the initial size of the aperture may be wide enough to receive cuts of meat. In the figure, the cut of meat 16 is shown to be a large cut, which requires the aperture 14 to be widened. Preferably, the initial size of the aperture 14 is small, which would necessitate the widening of the aperture before cuts of meat can be inserted into the aperture. The benefit of a small initial size of the aperture 14 is that the initial expansion of the sleeve under partial vacuum to receive the meat cut will assist with further stretching of the meat cut as the sleeve returns to its natural, smaller size when the partial vacuum is removed.

In Figure 1c, the interior of the receptacle 12 (shown in shade) is subjected to positive pressure generated by the air pressure device. Positive pressure is essentially pressure that is greater than the ambient pressure surrounding the receptacle. In most applications of the present invention, positive pressure will be pressure greater than atmospheric pressure. The positive pressure forces the sleeve 10 to constrict around the meat cut 16. As pressure is applied, the meat cut 16 is squeezed and stretched along the axis of the sleeve 10. This reduces the diameter of the meat cut 16, and increases the length of the meat cut 16 as illustrated. Where a silicon sleeve or similar low-friction sleeve is used, the stretching of the meat cut 16 can be made easier and less damaging to the meat cut 16.

Referring now to Figure 1d, a piston-like pushing rod 18 is preferably used to push the stretched meat cut 16 out of the constricted sleeve 10. Although the figure shows the meat cut 16 being ejected from the bottom of the flexible sleeve, the present invention can be worked such that the meat cut 16 is ejected from the top part of the flexible sleeve. One way to do this will be described later in this specification.

Regardless of whether the stretched meat cut 16 is ejected from the top or bottom of the sleeve, in the preferred embodiment, the device includes a packaging arrangement to receive the stretched meat cut 16. The packaging arrangement may use an inflexible packaging to ensure the meat cut 16 retains its stretched form until rigor mortis sets in.

A preferred form of the meat stretching device of the present invention is shown generally with arrow 20 in Figures 2a-d. The device 20 includes a receptacle 22, which is preferably a cylindrical receptacle having supporting plates 22a, 22b and 22c. The form of the receptacle shown in the figure is merely illustrative; where necessary or desired, the receptacle 22 can be made to be in another shape, size or configuration.

The device 20 also includes a flexible sleeve 24 that is mounted within the receptacle 22. In the form shown, the flexible sleeve 24 is attached to the supporting plate 22a on one end using, for example, bolts, clamps or the like. On the other end, the flexible sleeve 24 is attached to a plate 29. In the preferred form, the plate 29 comprises two or more plates that are attached together and that is movable or slidable along the receptacle 22 using one or more cylinders 25. The plate preferably comprises two or more individual plates that clamp at least part of the flexible sleeve to achieve an acceptable seal in the interior of the receptacle (i.e. between the sleeve and the receptacle walls). The above forms of attaching the sleeve to the receptacle are, of course, not the only forms of attachments that can be used. Skilled people will recognise that the purpose of the attachment is to achieve a substantially air-tight seal for the interior of the receptacle 22. Any attachment that can achieve this can be used in the present invention.

Although not shown in the figure, the receptacle 22 is connectable to an air pressure device. In the preferred form, the air pressure device is arranged to selectively generate at least a partial vacuum or positive pressure within the interior of the receptacle.

As mentioned earlier, one or more cylinders 25 are provided in the preferred form device to controllably move or slide the plate 29 along the receptacle. This is required in the preferred form to control the extent to which the flexible sleeve 24 is able to open and close to stretch cuts of meat. For instance, when vacuum or at least partial vacuum is generated in the interior of the receptacle, atmospheric pressure on the outside of the flexible sleeve 24 has a greater tendency to contract and shorten the sleeve than to expand the aperture defined by the flexible sleeve 24. To stop the sleeve from contracting and shortening, the one of more cylinders 25 are provided to force the sleeve length to remain the same as (or to be greater than) the length prior to the vacuum or partial vacuum being generated. The one or more cylinders also control the sleeve length after the vacuum or partial vacuum is removed to control the extent to which the aperture defined by the sleeve closes.

Preferably, the device includes a pushing rod, such as piston 27, to eject meat that has been stretched by the device. The ejected meat is preferably received in an inflexible packaging sleeve that maintains the shape of the meat until rigor mortis sets in. For this, a packaging arrangement may be provided adjacent the end of the flexible sleeve from which the stretched meat is ejected. Alternatively or additionally, the piston 27 itself is arranged to receive an inflexible packaging sleeve. For instance, the packaging sleeve could be a stainless steel sleeve that is coated with a low-friction coating, such as Teflon. The stainless steel sleeve could be used to temporarily hold the meat in its stretched form before it is packaged in a final packaging sleeve. Where such a packaging sleeve is used, the bottom end of the flexible sleeve is sealed or otherwise closed before the piston 27 is pushed into the flexible sleeve 24. The movement of the piston 27 into the sealed flexible sleeve 24 then causes a pressure build-up in the flexible sleeve, which results in the stretched meat being pushed upwardly toward the piston 27. By arranging a packaging sleeve about the piston 27, the stretched meat is forced to enter the packaging sleeve. Once in the packaging sleeve, the piston 27 can be pulled out of the flexible sleeve while retaining the meat within the packaging sleeve. In this form, the stretched meat is forced to remain in its stretched form even after extraction from the flexible sleeve.

It is also preferable for the device 20 to be provided in an enclosure 28, which may house the control system of the device 20 and the air pressure device (not shown).

In some embodiments, the device also preferably includes a guard 30. The guard 30 covers a pinch area that forms when the sleeve returns to its original shape after the positive pressure is removed. Also, in some embodiments, the device may eject stretched meat from the flexible sleeve 24 by pulling the plate 29 upwardly using the cylinders 25. This results in the flexible sleeve 24 being at least partially pushed out of the receptacle before it is pulled back into the receptacle for further stretching processes. The guard 30, in these embodiments, can help reduce the risk of a user accidentally coming into contact with the flexible sleeve 24 and being injured as the flexible sleeve 24 is pulled back into the receptacle.

The foregoing describes the present invention and its preferred forms. Alterations and modifications that are obvious to those skilled in the art are intended to be incorporated within the scope of the present invention.

CLAIMS

1. A meat stretching device comprising:
   - a receptacle; and
   - a flexible sleeve mounted within the receptacle, the flexible sleeve having a cross-section that defines an aperture to receive one or more cuts of meat;
   - wherein the receptacle is connectable to an air pressure device that is capable of generating a positive pressure in the receptacle to cause the flexible sleeve to constrict around and stretch the one or more cuts of meat that are received in the aperture.

2. The meat stretching device as claimed in claim 1 wherein the air pressure device is further capable of generating at least a partial vacuum in the receptacle to cause the aperture of the flexible sleeve to widen to receive one or more cuts of meat.

3. The meat stretching device as claimed in claim 1 further comprising a pushing rod to push the one or more cuts of meat out of the constricted flexible sleeve.

4. The meat stretching device as claimed in claim 1 further comprising one or more stretching cylinders connected at one end to the receptacle, and connected at another end to the flexible sleeve to assist with the stretching of the one or more cuts of meat.

5. The meat stretching device as claimed in claim 1 wherein the flexible sleeve is a silicon sleeve.

6. A meat stretching device comprising:
   - a receptacle; and
   - a flexible sleeve having a first end and a second end, and a cross-section that defines an aperture, the first end being adapted to receive one or more cuts of meat and the second end being adapted to allow the one or more cuts of meat to be removed from the flexible sleeve;
   - wherein the flexible sleeve is mounted within the receptacle such that an airtight volume is formed between the flexible sleeve and the receptacle, and wherein the flexible sleeve constricts around and stretches the one or more cuts of meat when the airtight volume is subjected to positive pressure.

7. The meat stretching device as claimed in claim 1 further comprising a packaging arrangement arranged adjacent the second end of the flexible sleeve.

8. A method of stretching meat using a flexible sleeve, the method comprising the steps of:
   - inserting one or more cuts of meat into an aperture defined by a cross-section of the flexible sleeve; and
   - generating a positive pressure in an airtight volume between the flexible sleeve and a receptacle containing the flexible sleeve to cause the flexible sleeve to constrict around and stretch the one or more cuts of meat.

9. The method as claimed in claim 8 further comprising the step of generating at least a partial vacuum in the airtight volume to widen the aperture before inserting the one or more cuts of meat into the aperture.

10. The method as claimed in claim 8 further comprising the step of pushing the one or more cuts of meat out of the constricted flexible sleeve.

11. The method as claimed in claim 8 further comprising the step of stretching the sleeve lengthwise to assist the flexible sleeve constrict around the one or more cuts of meat.