AUSWIRKUNG DER ORIENTIERUNG VON MUSKELFASERN AUF DIE KOMPRESSIONSEIGENSCHAFTEN VON RINDFLEISCH

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ZUSAMMENFASSUNG

Der Zusammenhang zwischen dem mechanischen Verhalten von Fleischzylindern und der relativen Orientierung der Kompressionsrichtung und der Muskelfasern wurde untersucht. Die Ergebnisse betonen die Notwendigkeit, die Vor- und Aufbereitung von Mustern für die Bestimmung der Fleischfaserung zu standardisieren.

L'EFFET DE L'ORIENTATION DES FIBRES MUSCULAIRES SUR LES CARACTERISTIQUES DE COMPRESSION DU BOEUF.

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RESUME

Le rapport entre le comportement mécanique de cylindres de viande et l'orientation relative de la direction de la compression et des fibres musculaires fut étudié. Les résultats soulignent le besoin de normaliser la préparation et le mode de présentation des échantillons pour la détermination de la texture de la viande.

EFFECT OF THE ORIENTATION OF MUSCLE FIBRES ON THE COMPRESSION CHARACTERISTICS OF BEEF

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SUMMARY

The relationship between the mechanical behaviour of cylinders of meat and the relative orientation of the direction of compression and of the muscle fibres was studied. The results emphasize the need to standardise the preparation and the mode of presentation of samples for the determination of meat texture.

ЭФФЕКТ ОРИЕНТАЦИИ МЫШЕЧНОЙ ТКАНИ НА ХАРАКТЕРИСТИКИ ГОВЯДИНЫ ПРИ ПРЕССОВАНИИ.

Е. ДРАНСФИЛЬД.

представлено Д.Н. Роудсом.

Было изучено соотношение между механическим состоянием мяса в контейнерах и относительным направлением прессования мышечной ткани. Результаты подчёркивают нужду в стандартизации подготовки и способа представления проб для определения строения мышечной ткани.

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Introduction

Texture is an important factor in consumer appreciation of meat quality and is often measured by determining the resistance to deformation of a small sample of the meat. No standardized sampling procedure has yet been adopted but those described can be divided into those where the deforming device is oriented with respect to the direction of the muscle fibres and those in which the reference is to the external shape of the muscle or joint. In the latter, since the disposition of the muscle fibres often varies with location within the muscle, the measurement is liable to be confounded by the variability in the orientation of the fibres in the sample. The purpose of this work was to examine the variability in mechanical behaviour as a function of the orientation of the muscle fibres.

Experimental procedures

Cylinders of meat were cored from the *M.semitendinosus* and *M.semimembranosus* obtained from a commercial beef carcass. The angle between the direction of the muscle fibres and the longitudinal axis of the cylinder was measured. The cylinders were compressed between parallel plates (Fig 1) and the force-deformation curve recorded during compression with a crosshead speed of 0.5 cm/min. The cylinders of meat were weighed before and after compression to a deformation of 20% of the initial height.

Results

A. Force-deformation curves (Fig.2)

Raw meat

The force-deformation curves of raw meat were non-linear, even with deformation as little as 2% and the shape of the curves was markedly affected by the orientation of the muscle fibres (Fig.2a). When the muscle fibres were parallel to the direction of compression, the curve was convex (decelerating) up to 10% deformation and linear thereafter; when perpendicular the curve was concave (accelerating) and the forces in both cases were higher than those obtained with intermediate geometry.

Heated meat

The force required to deform cylinders with the direction of the muscle fibres parallel to the direction of compression increased approximately in proportion to the deformation up to 3%. With further deformation the structure yielded producing a discontinuous curve (Fig. 2b, 5° curve), the latter part of which was similar to the curve obtained with intermediate angles. Smooth concave curves were produced at 42° and 90° (Fig.2b).

B. Relationship between the orientation of the muscle fibres and the resistance to deformation.

The resistance to deformation was expressed as the force/unit area exerted when the cylinders of meat were compressed by 10% and its relationship to the orientation of the muscle fibres is shown in Fig.3. In both raw (Fig.3a) and heated (Fig.3b) meats, polynomial regressions showed that the variation in angle accounted for about 75% of the variability in resistance and the minimum resistance was found at an angle of about 45°. In the heated meats, the variability due to the angle was 3 to 4 fold which was twice as large as that found between the two muscles (Fig.3b). However, the force-deformation curves show that the variability in resistance due to the orientation of muscle fibres can be as high as 10 fold, depending on the deformation at which measurements are taken (Fig.2).

When the cylinders of raw meat were compressed by 20%, there was no change in the weight but in the heated meats fluid was expelled. The amount increased in proportion to the angle, increasing from zero at 0° to 1.6% at 90°. Such small changes in the weight of the samples are unlikely to be the major cause of variability in the resistance to compression.

Discussion

The orientation of the muscle fibres had a marked affect on the force-deformation characteristics of raw and heated meat. Small ($< 5\%$) deformations in the direction parallel to that of the muscle fibres compresses the sample and forces the cylinder into a barrel-shape. The muscle fibres therefore tend to be forced apart, a change which is opposed by the transverse linkage of connective tissue which hold the muscle fibres and fibres bundles together. The large resistance is then the summation of the stresses produced by the myofibrillar, sarcoplasmic and connective tissue proteins. Larger compressions cause the cylinders to buckle, thus affectively increasing the angle between the direction of the muscle fibres to that of compression and the muscle fibre bundles now slip over one another, lowering the resistance. This slippage becomes dominant as the angle is increased up to 45° when the resistance was found to be minimal. A further increase in the angle has the reverse effect, slippage is decreased and the compressive component increases but, unlike the compression at 0°, at 90° the muscle fibres are forced together and the connective tissue proteins contribute little to the resistance.

Since the mechanical properties of meat under parallel plate compression were affected by the orientation of the muscle fibres, it is likely that measurements using other compressive and shear tests would be affected in a similar fashion. When meat samples are used for the measurement of texture therefore, care should be taken to ensure that the tests are performed with respect to the orientation of the muscle fibres.

Fig.1 Diagram of the apparatus used for parallel plate compression of cylinders of meat

The apparatus was mounted on an Instron Universal testing instrument

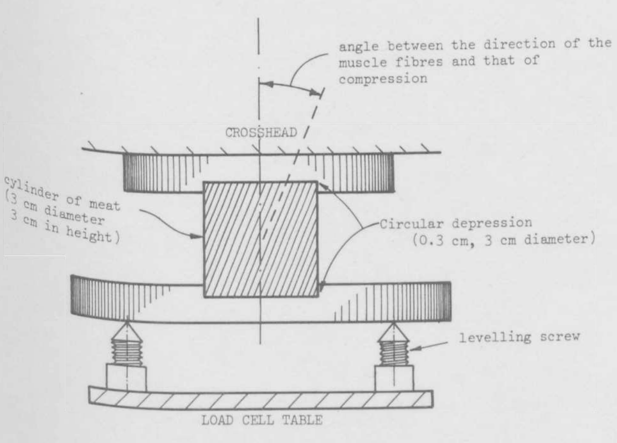

Fig.2 Force-deformation curves for compression of cylinder of meat

The number of degrees was the angle between the direction of the muscle fibres and that of compression.

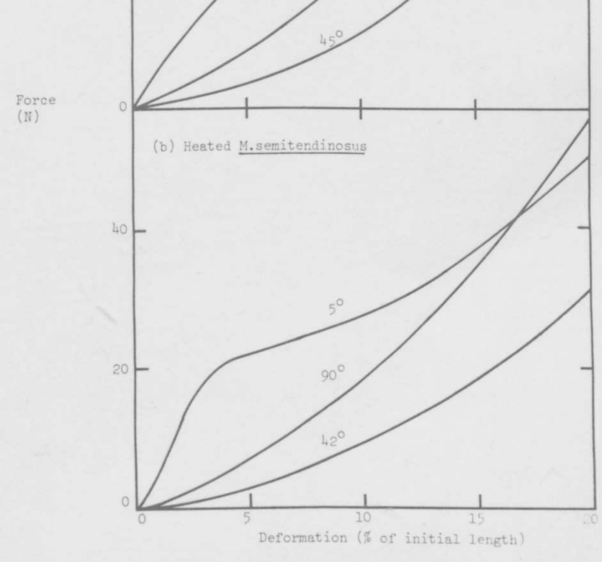

Fig.3 Relationship between the resistance to compression and the orientation of muscle fibres