DEVELOPMENTS SERIES

Developments in Meat Science – 2

Edited by
RALSTON LAWRIE

APPLIED SCIENCE PUBLISHERS

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DEVELOPMENTS IN MEAT SCIENCE—2

THE DEVELOPMENTS SERIES

Developments in many fields of science and technology occur at such a pace that frequently there is a long delay before information about them becomes available and usually it is inconveniently scattered among several journals.

Developments Series books overcome these disadvantages by bringing together within one cover papers dealing with the latest trends and developments in a specific field of study and publishing them within *six months* of their being written.

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PREFACE

The various chapters in this second volume of the series are intended to present current views by internationally acknowledged experts on a further selection of topics within the field of meat science. Their sequence again reflects the approximate times in commodity history to which they relate.

Since the efficiency of conversion of feed by animals into edible tissue must always be a matter of economic concern, the unusually high capacity of certain cattle to elaborate muscle preferentially to bone or fat is bound to be of interest. This so-called 'double-muscling' condition is discussed by Dr R. Boccard, of the Station de Recherches sur la Viande, Theix, France, in Chapter 1.

For many years the presence of connective tissue or gristle in meat was regarded merely as an organoleptic nuisance. As understanding of its biochemistry has advanced and as the factors determining its formulation and variation have been more precisely identified, however, the subtlety of its contribution to texture has been increasingly appreciated. Mr T. J. Sims and Dr A. J. Bailey, of the UK Meat Research Institute, Bristol, have comprehensively reviewed these factors in Chapter 2.

Animals which are inherently stress-susceptible, and normal animals whose capacity to resist stress is overtaxed, may react physiologically to environmental circumstances in the few days before slaughter in ways which adversely affect the quality of the meat they provide. Such conditions as 'dark-cutting' beef and 'pale, soft exudative' pork are samples. In Chapter 3, Drs D. Lister, N. G. Gregory and P. D. Warriss, also of the UK Meat Research Institute, analyse the causes of stress in meat animals.

During the immediate post-mortem period muscles undergo anaerobic glycolysis, whereby the carbohydrate energy store, glycogen, is converted

to lactic acid, the pH falls and the *in vivo* level of adenosine triphosphate is depleted. These changes are superficially manifested by the stiffness of rigor mortis and by a loss of water-holding capacity. By comminuting pre-rigor meat in the presence of curing salts, however, the high *in vivo* water-holding capacity of the proteins can be retained, over prolonged periods, after freezing or freeze-drying. Developments in this field are described by Professor R. Hamm, of the Federal Institute of Meat Research, Kulmbach, German Federal Republic, in Chapter 4.

The preservation of meat by temperatures below the freezing point has been empirically exploited from ancient times but it is only recently that scientific study of the detailed changes in the tissues during freezing and frozen storage has been undertaken. Dr A. Calvelo, of the National University of La Plata, Argentina, reconciles the differing explanations derived from laboratory experiments and commercial practice in Chapter 5.

Intermediate moisture technology has intrinsic advantages as a preservative procedure since it significantly extends storage life without expensive refrigeration chains or thermal processing, on the one hand, and yields organoleptically succulent products which can be eaten without rehydration, on the other. Dr D. A. Ledward, of the University of Nottingham, assesses the advantages and disadvantages of intermediate moisture meats in Chapter 6 and indicates that the humectant, glycerol, commonly used in such products, is by no means chemically inert.

It is both understandable and nutritionally justifiable that proteins of acceptable biological value, derived from the plant kingdom, should be used increasingly in manufactured foods to substitute for the expensively produced proteins of animal tissues in human diets. It is concomitantly important, however, that analytical means of detecting and quantifying the extent of such substitution should be available. In Chapter 7, Drs W. J. Olsman and P. Slump, of the Division for Nutrition and Food Research, TNO, Zeist, The Netherlands, demonstrate the need to replace long established analytical procedures for meat, which involve assumptions based on averages, by modern methodology, which is specifically designed to determine the amount of muscle proteins present in even severely processed products.

Despite the length of time during which the human race has enjoyed meat and derived excellent nourishment from it, consumption of the commodity has been recently criticised as being a major cause of cardiovascular conditions, hypertension and cancer. Professor A. M. Pearson, of Michigan State University, East Lansing, USA, considers the health

aspects of meat in Chapter 8 and it is thus fitting that the final chapter should present his reassuring evidence that the benefits of meat are overwhelmingly predominant.

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Chapter 1

FACTS AND REFLECTIONS ON MUSCULAR HYPERTROPHY IN CATTLE: DOUBLE MUSCLING OR CULARD

R. BOCCARD

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1. INTRODUCTION

Various countries use different terminology to refer to cattle showing signs of muscle hypertrophy, the terms being inspired by the most prominent aspects of their phenotype. In Great Britain and the USA they are called 'double muscled' animals, in Germany, 'doppelender', in Italy, 'a groppa doppia' and in France, 'culard'. These animals appear now and then in herds of certain breeds and have been noted since the beginning of the 19th century. The birth of such animals both worries and pleases the stockbreeder. The carcases of these animals are highly valued by certain butchers and high prices are paid at slaughter; however, from calving onwards, numerous rearing problems must be faced.

The phenomenon of muscle hypertrophy has either been suppressed or sought after and established by the creation of pure-breed strains, depending on the economic and geographical conditions in which the cattle are raised. The aims of the development of this phenomenon have been to obtain either groups of males displaying typical characteristics of hypertrophy, which may be cross-bred with mothering cows, or strains of animals able to reproduce whilst maintaining their characteristics of hypertrophy.

The first method was chosen for meat production from dairy breeds[1] and it brought a large financial gain for the stockbreeders. The cross-breeding solution was also proposed in the USA for beef production.[2]

The second method was used in Italy before the First World War with the Albese strain of the Piemontese breed,[3] and later in Belgium with the breed known as the Blue Belgian.[4]

The double muscling characteristic, which probably originated in Dutch cattle,[5] thus gradually diffused into British and European breeds and later all round the world—and into the USA and Australia in particular.

2. DEFINITION AND GENERAL DESCRIPTION

Despite the fact that the phenomenon of hereditary hypertrophy (hereafter referred to as double muscling or culard) was first detected and described a long time ago, as yet it has not been described or defined without ambiguities. Indeed, the manifestation of the characteristics varies according to the breed, sex and age of the animals. Nevertheless, compared with a normal animal, the typical double muscled animal presents distinctive features.

Generally speaking, the animal appears to be compact. There is an extraordinary bulging of muscle in the hindquarter. The general outline of the rump and round, from the hip to the distal end of the tibia, is a convex line like the arc of a circle, the centre of which would be at the femur/tibia articulation.[6] This contrasts with the angular shape of dairy type animals. The muscles of the round are enlarged and creases appear, especially between the *Semitendinosus* and the *Biceps femoris* and, to a lesser extent, between the *Biceps femoris* and the *Vastus lateralis*.

The creases are not only the result of hypertrophy. They are exaggerated because of the absence of subcutaneous fat and due to the thinness of the hide, which is very supple and wrinkles easily. On top of the rump the hypertrophied *Gluteus medius* give the impression of elevation on each side of the sacrum. The muscles of the shoulder (especially the *Triceps* muscles) are also enlarged and, conversely, the belly and belly muscles seem atrophied. These main characteristics may be associated with certain traits such as macroglossia (large tongue), and others which depend on the age. This variation with age has been widely observed, and although authors agree that the phenomenon of hypertrophy is of genetic origin, there has been some inconsistency between the descriptions they have given.

The numerous degrees of expression of the gene have led to different hypotheses on the way in which the characteristic is transmitted. For most geneticists it is based on a recessive gene with incomplete penetrance. This

explains the variation observed and the classification of animals into three main types:

(i) Normal animals which are dominant homozygous.
(ii) Pure double muscled or culard which are also homozygous.
(iii) Intermediary animals, sometimes called semi-culard, which are heterozygous.

Different scoring Tables have been proposed to resolve difficulties in determining the genotype of an animal from its phenotypic aspect. One of these Tables, used by Vissac *et al.*[7] was proposed in 1962 and has been used experimentally by geneticists and breeders' organisations in France since then. Although Rollins *et al.*[8] proposed a more sophisticated index, they reported that 'whether or not an animal is classified as a double-muscled animal depends on the classifier's opinion'. This assertion emphasises how difficult it is to ascertain whether a live animal is a real homozygous double muscled animal, a heterozygous, or a good normal animal with an excellent conformation. There is clearly a need for more information about the phenomenon.

3. ECONOMIC POSITION

It has long since become a tradition that butchers offer high prices for double muscled live animals or carcases. For example, in 1940, Carbone sold, on the Torino market, a group of five Piemontese animals of the 'a groppa doppia' type at a price 40 % higher than that for normal animals. In France, for the production of veal, crossed calves obtained by artificial insemination, using semen from double muscled animals, made an overall price estimated at 7 % more than normal calves.[9]

Butchers have a long established preference for double muscled animals, mainly for steers and heifers. Figure 1 shows the position of culard animals and other slaughter animals in the price lists of the present French market.[11]

On the Belgian market,[10] a difference in conformation corresponding to the changeover from conventional animals to hyper-muscled animals (culard) has been reflected by a large increase in the selling prices per kilogramme live weight. Thus the price of a culard heifer is double that of a culling cow (100 Belgian francs versus 43 Belgian francs per kilogramme) when a dairy heifer sells at 54 Belgian francs per kilogramme.

But the selling price does not accurately reflect the return for the breeder

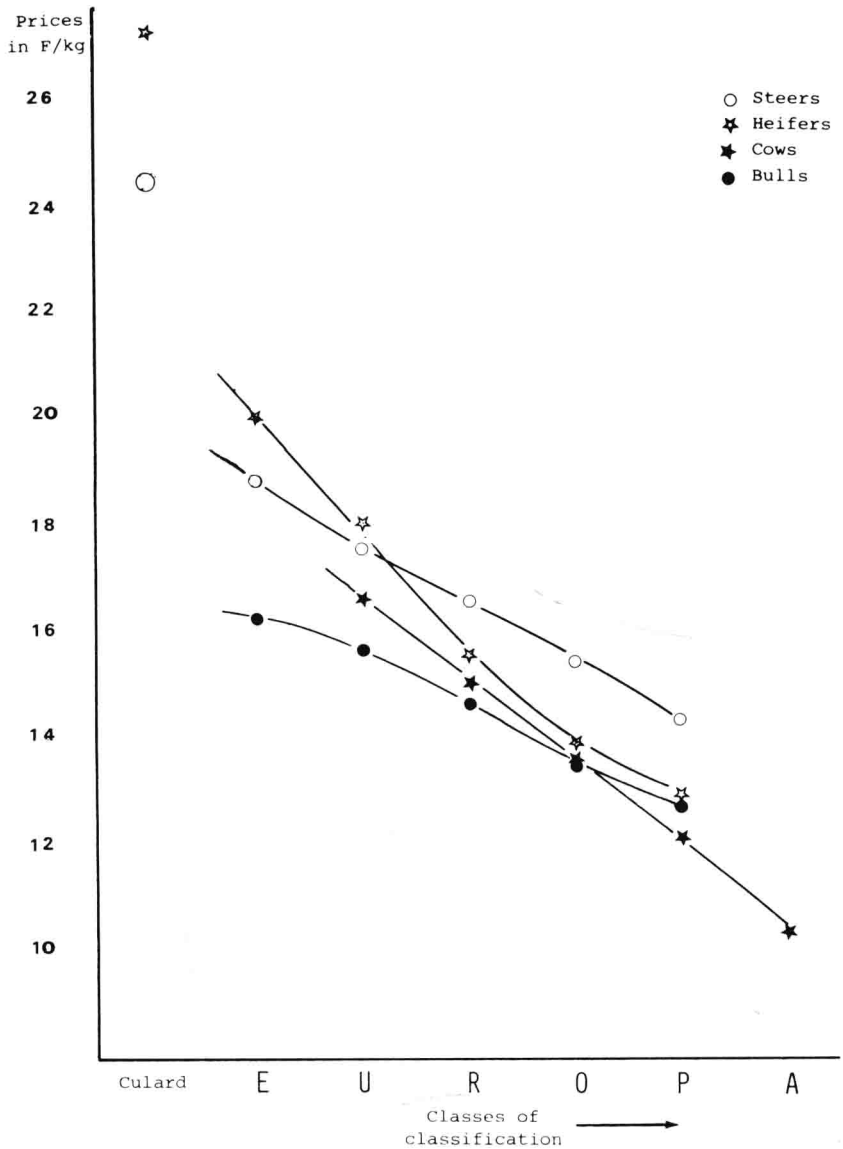

FIG. 1. Official carcase prices observed by ONIBEV on the Valenciennes Market on the 17 July, 1980 for the different classes of normal cattle and culard types.

and this is the reason why Hanset and Leroy[10] tried to take into account the economic consequences of the different breeding requirements—high mortality at calving, cost of caesarian removal, longevity and other factors—on the real income of the breeders. They concluded that 'for a medium conformation beef herd and a hyper-muscled herd, the difference in the gross income per cow could be in the region of 10 000 Belgian francs and this difference increases with the size of the livestock. It could even reach as high as 15 000 Belgian francs for identical periods of time between calvings. The income difference must, of course, cover the costs of caesarians, and possibly a higher mortality rate of the young. An increase in the mortality rate of 5% in the case of hyper-muscled cattle can bring a decrease in the gross income of around 2500 Belgian francs per cow'.

The commercial success of double muscled animals, or even the heterozygous or semi-culard animal, is due to their carcase and meat characteristics.

4. DRESSING PERCENTAGE AND COMPOSITION OF THE 'FIFTH QUARTER' AND CARCASE

Despite the progress of modern transport and slaughter methods and the ever wider diffusion of charts for the assessment of carcase quality and the corresponding price lists, the market on the hoof for slaughter animals remains very important. For the stockbreeder and butcher alike (either a small-scale butcher or an industrial sized meat plant), the dressing percentage is one of the first technico-economic factors to be carefully considered.

In the literature on this subject, the results available for the dressing percentage have been obtained by taking into account, on the one hand, the live weight of fasted or non-fasted animals (or even with the weight corrected for their digestive content, i.e. empty body weight) and, on the other hand, the weight of the warm carcase, either taking into consideration the loss of water as the carcase cools or the weight of the cold carcase after different times and methods of cooling. In the biological sphere the most interesting ratio is warm carcase weight versus empty live body weight but it is not always possible to obtain these data because of the conditions and place of slaughter.

Generally speaking, the double muscled animal offers a dressing percentage of around 5% more than a normal animal of the same breed, sex and weight.