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TO: Academic Staff and Nutritionists

FROM: Henry Blackburn, M.D.

RE: Our Continuing Education in the Department of Meat Sciences

I thought some of you would be interested in the enclosed rambling commentary on information acquired in a recent chat with C. Eugene Allen, Professor of Meat Science on the St. Paul Campus. The object, of course, was primarily to increase my knowledge of meat production and the composition of meat and the agro-economic forces brought to bear to produce fatter or leaner meats. A parallel goal was to improve our discourse with the St. Paul Campus in which there is a considerable block to understanding. I feel that such personal contacts and discussions are likely to be more rewarding than those such as our joint seminar of last year.

Tenderness. Beef tenderness enters into beef grading and in my naivete I have always thought that fat content was the prime requisite for tenderness, with perhaps some consideration of the animal's age and proper postmortem aging. It turns out that perhaps the principal contributor to meat tenderness is the state of muscle relaxation in the slaughtering process. This is the primary factor determining sarcomere length, thus meat density, thus tenderness. Thus, the psychological state of excitability of the animal at slaughter is very important. This may be one explanation of why the Kiamini breed from Italy (a rather nervous "Latin-type" animal) has not gone well in the American system, because of their extreme agitation in our "environment." This might also explain the remarkable quality of Kobe, beef, the famous Japanese beef. They are not only fed beer but are systematically massaged by hand prior to slaughter.

Another factor in sarcomere length and tenderness is that called "cold shortening" in which too rapid cooling leads to severe contraction in rigor mortis. This is prevented by having an adequate subcutaneous fat cover on the carcass, or which can be made up for by various plastic blankets for animals of different age and fat covering. The distribution of subcutaneous fat, in turn, is related to the breed and feeding practice and this all affects the acutely-acting factor of cold shortening.

A related factor in tenderness is the degree of stretch applied to the muscle at the time of slaughter. This is thought to be one of the reasons why tenderloin is tender because it is stretched maximally in the carcass hanging process. Some attempts are now being made to apply this principal of maximal stretching to the other major muscles. To go back to my naive assumptions earlier, it is likely that about 10% of the variance in tenderness is explained by the intramuscular fat content, but probably no more.

Recognition of this cold shortening factor (which can be corrected for by a plastic cover when there is less than .2 of an inch of fat cover on the carcass) dates back only a decade or so, but the old concept of the state of relaxation at slaughter and indeed the use of tenderizers goes back to cannibalism. It was apparently a part of common knowledge among South Pacific tribes that the better food preparations were from those warriors "killed early in battle rather than late."

In the feeding and fattening process of beef as indeed in the growth and maturation process itself, the heavier the weight at slaughter and the older the animal the greater the intramuscular marbling fat deposition. The intramuscular depot comes last. Apparently the primary factor determining relative leanness of breeds is the age at which they reach the standard weight (1000-1200 pounds) to produce a standard-sized carcass in turn to be handled by standard semi-automated and union controlled practices. Obviously the younger the animal reaching such a weight, the less likelihood of excessive intramuscular fat depots. In this regard certain European breeds, the Charolais and Semmenthal are superior to the Angus and Hereford species. Apparently the Angus is most likely to have marbling deposits and the Angus, of course, is an important breed in American beef culture. This breed characteristic is apparently related to the large frame size and later-maturing propensity of the European strains. So that they have less fat at the given slaughter weight of 1000 to 1200 pounds. They are slaughtered less far into the muscle fattening phase.

One of the problems in beef culture has been that the beef producer can't see his carcasses. It has something to do with safety rules, so that the producer identifies with the finished state of the whole animal and doesn't receive informational feedback based on the real composition of his carcasses. The very best of the meat science people are able to correlate animal appearance with carcass composition at, I believe, 70%. When and if awards to producers for their cattle at the State Fair or other awards and rewards become dependent on the carcass composition rather than the appearance of the animal on the hoof, producers will become producers of quality meat and not of quality animals. Despite current practice, recent awards for prize beef are tending away from the fat and squat animals toward a leaner line and changed body types, for inapparent reasons.

Aging of Meats. From my own post-war experience buying whole filets in the butcher shop of an Austrian village I was much impressed by the qualities of well-aged beef, already perhaps a couple of weeks old. We bought it and leisurely ate a whole filet (*longissimus dorsi*) over a period of a couple of weeks. I was reassured that some of my perceptions about tenderness and flavor were indeed related to such aging, but that my conceptions that we eat beef too soon after slaughter in this country were not entirely accurate. By the very nature of the slaughter and transport process, meat that we buy unfrozen at the meat market is at least seven days old and the maximum is usually ten days. There is a Safeway chain in one part of the country that emphasizes its aged beef at 12 days. So as a matter of fact, most retail beef is at or near its maximal "tenderness" on purchase. Slaughtering and boxing under vacuum pack at the site of production is now the practice.

On the other hand, there is a distinctive "aged" flavor to beef, which I had come to enjoy in European meat. It turns out that this is one of the principal characteristics of beef that we are served here in first class restaurants. It has been aged about 14 days from slaughter, yielding some lipid breakdown, a slight degree of oxidative rancidity and free amino acids, giving a distinctive and distinguished flavor.

Gene Allen was kind enough to describe to me his own aging process in which he exposes beef cuts to the air in the refrigerator for up to 12 hours, creating a protective desiccated coating and then rewrapping the cut loosely in foil and storing in the refrigerator. His common experience is that aging for 4 to 5 days after purchase is quite acceptable and safe, but he watches the change in color of the meat which is optimally flavored at the point of change from red to brown. At that time the meat may be consumed or in part consumed and the rest frozen for subsequent use.

Grading. We discussed grading at some length but it takes more than one session to come anywhere near understanding the complexity of this question. I will attempt to attach a grading scheme which he provided me which indicates the numerous subcategories within each major category contributing to beef grading, such as 1) maturity of carcass, primarily determined by ossification and fusion of the vertebrae, 2) marbling, 3) taste and 4) juiciness. The farm campus students in Meat Science become very proficient graders.

Apparently one of the reasons that fore-quarter meat cuts have more seam fat and intramuscular fat is that they "mature" first, in contrast to rear quarter maturation. The skeletal system apparently matures in an opposite fashion, the sacral bone maturing first with vertebrae fused with the lumbar. This allows grading into A-B-C, young, middle-aged and mature carcass. As you will see in the accompanying diagram within classes of age or maturity of carcass, one of the principal grading criteria is marbling in many different levels. Even below the level of modest marbling, there are four subcategories, for example, devoid, trace, slight or small amounts of fat.

I didn't completely understand Dr. Allen's interest and optimism about greater development of the new "U.S. Good" grade. Because it is now specifically and narrowly defined, because it comes from carcasses of lesser age, and because it involves only the first degree of marbling and significantly increases the classification of young lean meats which can be graded "Good," and because it advances some of the other Good grades into the area of Choice, the overall impact of a recent grading change is leaner meats! He also feels that the market will become more pointed toward a Good grade in its present better-defined state.

Also because there is now an \$8 differential between Good and Choice, he believes that USDA Good grades will grow. There is a Rochester retail chain, for example, which is keying in on USDA Good and it's called something like "Monford Blue". To his knowledge there is no new activity going on in attempts to create major shifts in the USDA grading classes to upgrade leaner meats.

Dr. Allen has nothing but disdain for the USDA "Prime" grade, for which he has never seen any valid argument for taste or ecological argument. Nevertheless, in the "market" view, Prime is still best, and Choice is the most common housewife sought-after grade. He informed me that Commercial grade, the third grade of beef, is not sold in chains but is in the small stores. Commercial carcasses are mature animals but can be bought with relatively small marbling.

Veal. We talked a little bit about veal and he indicated that socio-cultural factors have led to Steak as the symbol of good eating, as well as the agro-economic factors of productivity, as well as the lack of familiarity with veal of the present generation, all have resulted in an extensive fall-off of veal slaughtering and its availability. Apparently much veal is still made in Milwaukee but most veal is still sold in the New York and Philadelphia markets. The reason of its decreased availability and expense is purely economic. One year's beef production yields only 200 pounds of veal when a calf is slaughtered. This makes it too expensive to be profitable when only one calf can be produced per year per cow. The beef producers obviously have no qualms at all about metabolic manipulations in animals and they are actively pursuing techniques of multiple ovulation (as in the "fertility pill") to increase productivity. This might lead indirectly to greater availability of lean veal if multiple calves result.

Lamb. The lamb market is very similar in distribution to the veal market and is a costly product. The socio-cultural influence in regard to the lamb, Dr. Allen feels, is an aversion to eating mutton acquired by many in institutional and armed forces menus during World War II. Of course, there is very little resemblance between old fat mutton and tender lamb, nevertheless! The Wilson plant at Albert Lea and the Swift and Armour plants in Minnesota no longer slaughter lambs at all. And the beef image has improved steadily in recent decades along with its relatively low cost.

Marketing. This is a huge field which we did not try to cover. He did point out that technological developments are primarily responsible for stockyard slaughterhouses and beef production plants moving closer to the site of beef production, such as Omaha, etc., and closer to sources of cheaper labor, and with technological developments such as refrigerated transfer and computerized sales and distribution. The TV and radio controlled computer marketing is an impressive operation. Some of you may have seen as I the beef film produced by the Monford feedlot on Channel 2 a couple of weeks ago. (I would be grateful if Wanda could find out from Channel 2 about the availability of that film on beef production and its cost for rental.)

Pork. I posed the question of why breeding and feeding practices have been strongly pointed toward the development of high protein and lean pork and away from fat pigs in the last twenty years. Dr. Allen's research has demonstrated that the pig fat per hundred weight has been cut in half (14 to 7) in the last two decades. The lean meat has simply become more valuable as meat and the market for lard has dropped markedly. Interestingly enough a large market for lard was for the production of explosives in World War II. With the reduced need for explosives and the development

of soy beans at 4¢ a pound the economic impetus to produce pig fat has decreased. In addition, there has, of course, been some increasing consumer demand for lean pork because of the general fatty image of the pig. Actual pork consumption has remained relatively constant for 40 years, between 50 and 75 pounds and in periods of privation and shortage and economic shifts, pork is the first meat replacing beef. When beef and poultry prices are up, pork is a bargain. The market for lard which is now at 16¢ a pound includes its continued use in some margarines and shortenings, and its use in baked goods, such as pastries.

Associated with this image of the fat pig is the general feeling that pork is not a prime food to give a prime meal. Dr. Allen's personal opinion about this is that some of it is due to the fact that pork is cut too thin. Whoever heard of cutting beef as thin as we cut pork chops? They end up thin and dried out and measly on the plate, whereas a thick pork cut is much more delicious and much more competitive with beef.

Another major problem with pork is the pork stress syndrome (pss). In the active breeding for lean pork, which has taken place since World War II along with the fall in the fat pork market, a mutant occurred which is now widely distributed in pork herds, i.e., stress susceptible animals. This is a fascinating syndrome in which animals are exquisitely sensitive to stress such as physical activity. They develop high levels of lactate and die suddenly of arrhythmias. A majority of these pss herds have been observed to die when first turned out in a large lot running after their food. They simply drop dead in droves. Apparently the genetic susceptibility is identical to Halothane susceptibility and the malignant hyperthermia syndrome in man. Consequently these animals are being intensively studied. Thus, the breeding emphasis on increased muscling bred in harmful genes which have become an economic problem in pork culture. Similar attempts for selective breeding for specific economic purposes have led to other disorders such as the frequent occurrence of dwarfs in Hereford herds.

Physiological manipulations: I learned Dr. Allen's concepts of growth-promoting substances including female hormones. He made a very particular reference to the use of DES in "fattening" cattle, not in "fattened" cattle. In concentrate-fed cattle he finds DES delays fattening. Another growth factor, commercially called, Ralgro, is an estrogen-testosterone mixture. The rate of gain in DES fed cattle is increased by 15%, the feed efficiency is increased by 10%, maturity and body size are increased and the overall result is a beef animal having less marbling for a given body size. The DES is most efficient in the common castrated steer. Castration, of course, is another extreme physiological intervention routinely carried out at weaning between 4 and 6 months. Later castration, say after 13 months, would probably be preferable in terms of producing leanness, but a very practical problem prevents this. Any steer taken out of a herd and castrated at 13 months and put back into confinement finds that he has lost his pecking order and he will either be mauled or killed by his confrere on return to the stall. About 60% of the steers are fed and 40% of cows. This is probably brought about by the cows being directed to the breeding herd and then used later on culling the infertile or inefficient cows for use in commercial grades of meat, such as ground beef and beef in sausage.

The goal of leanness. In summary, on confronting Eugene Allen with our Public Health question of how we get leaner beef for the national diet, I found him generally sympathetic. In fact, he is in the forefront of beef researchers seeking to encourage leaner beef. I refer you all to his publications which I have if you are interested.

These are the major factors tending to promote the production and availability of leaner beef:

- 1) Major use of the "exotic", that is, the continental European breeds.
- 2) The departure from the dumpy animal toward the sleek animal for prize-beef raising.
- 3) Growth-promoting additives.
- 4) The closer definition of USDA Good grade and the advancement to USDA Good to Choice grades having minimal marbling.

All these encouraging developments are going on. The discouraging aspects are that we continue to produce huge quantities of surplus cheap corn which encourages the confined feedlot operation.

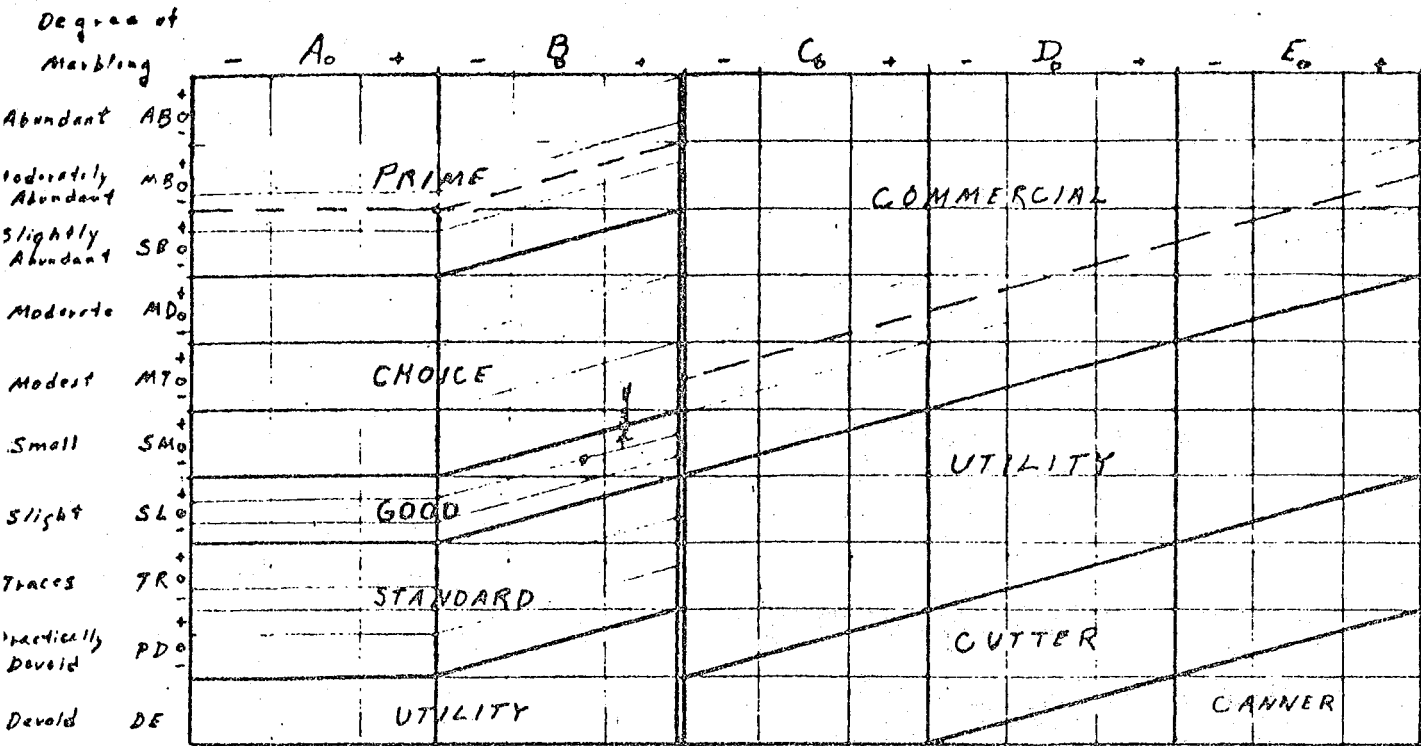
The Beefalo. According to Dr. Allen, "Beefalo" are a myth. Even in animals claimed to be Beefalo, i.e., from 1/8 to 1/4 buffalo, they are questionably 1/16 buffalo and are mainly the exotic European breeds such as the Charolais. The buffalo has certain desirable qualities such that a full weight buffalo can be marketed at 11 months if fed on concentrate. The Mt. Rushmore buffalo steaks are probably real buffalo and are relatively lean. Buffalo meat has a good taste and is in the middle and upper choice range of fat content. Basically, however, the buffalo can't do things other ruminants can't and there is no specific production advantage in the buffalo or the beefalo. According to Dr. Allen, Bud Basilow is simply a promoter. Beefalo are in his opinion simply not a significant advance in actual production and their real availability is a myth.

The Prudent Diet. The food science investigators do not see why, as many medical practitioners and investigators do not, a socio-cultural approach to the American dietary is necessary. Why not just treat those who need it? It takes time to appreciate that individual intervention will never address the public health problem, that "treating" those at higher risk in a high risk culture touches only a fraction of the problem, that absence of social custom and supports for lower calorie and fat eating mitigate even the individual "treatment," and that mass diet, not mass genetic susceptibility probably accounts for mass hyperlipidemia and large differences in the distribution of blood lipid levels between cultures.

He did indicate that the principal fury in the Agricultural establishment about the "Minnesota Group" in heart disease prevention is because we are supposedly "anti-meat." I pointed out that we are not at all, and that the only reason we ever counsel individual or mass reduction of beef eating is because U.S. beef production characteristically gives us 20% to 50% of "meat" calories as fat calories!

In other words, give people the lean meat it is possible to give them by breeding and feeding practices and the public health community will be delighted!

Platn



Sacral	very distinct	becoming fused	completely fused						
Lumbar	cartilages becoming ossified		nearly completely ossified	completely ossified					
Thoracic	red, porous coarse bony	No ossification	5%	6-15% 16-20% 20-25%	25-48% 45-65 65-85%	86-90%	96-100%	almost completely ossified	no outline completely ossified
Ribs	red rounded		slightly flat					moderately wide and flat	wide and flat
Lean	very light red	light red	Light red	fine texture				Dark red	Dark red
	red	red						Slightly coarse texture	Coarse texture

MD - Moderate
MT = Modest