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TECHNOLOGIES TO IMPROVE THE SHELF LIFE AND PRESERVATION OF FRESH VENISON

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SUMMARY

- The New Zealand Venison industry is in a rapidly expanding phase where production is expected to increase from 3,525 tonnes in 1988 to more than 20,000 tonnes by 1995. New technologies in processing and packaging need to be developed now to cater for the future markets and consumers.
- Electrical stimulation of carcasses in deer has been shown to be necessary in avoiding tough meat when carcasses are placed in chillers shortly after slaughter. Venison quality at the point of sale, after a long period of chilled storage, is greatly influenced by the degree of bacterial contamination between slaughter and packing. Inverted carcass dressing machinery keeps contamination to a minimum.
- Colour has been shown to be the major factor in selling red meat to clients. Controlled Atmosphere Packaging (CAP) was examined to establish its potential advantages with chilled venison. Vacuum packing was found to be as good or better than the CAP system tested.
- Future market requirements for red meat indicate a developing preference for pre-packed and partly cooked meat products suitable for the microwave oven. There are signs that accelerated processing using electrical stimulation and hot boning of carcasses on line will become important and it is suggested that the venison industry is well placed to take advantage of the new technology to improve efficiency, reduce costs and develop new consumer venison packs.

Venison as a New Zealand Export

Venison as a top quality gourmet food item is becoming an important primary export and is set to grow at a rapid rate during the 1990's. Last year 3,525 tonnes, earning $32M, were sent to many world markets and that figure will rise to in excess of 20,000 tonnes by 1995. Who buys the product and why? The European market now accounts for 74% (West Germany 40%), USA 10% and Japan 5% (Game Industry Board report, 1989). Much of the venison is marketed and served to customers as high cost restaurant and hotel menu items but in years to come it seems likely that increasing quantities will be marketed through various meat sales outlets. Market outlet will have profound effects on product presentation if we believe in catering for the customers requirements.

Catering for the restaurant trade means delivering a venison package that allows the executive chef to derive the maximum amount of usable meat of the desired tenderness at an acceptable price. Colour may not be particularly important if the chef has confidence in New Zealand's quality management because the final customer only sees the cooked product. On the other hand, selling venison to a discerning buyer at a sales outlet will require careful consideration of product colour because that is the most important factor in shifting red meat off the shelf. Packaging technology will be a vital factor in marketing venison in the future in order to deliver what the customer wants and the systems will need to give the product a relatively long shelf life to allow transport of chilled product around the world.

Fresh venison, when stored at chiller temperatures (+3°C to -1°C), has a very variable shelf life of a few days to many weeks and many factors are responsible for this variation. Some of these are discussed.

Table 1 : The effects of low voltage electrical stimulation and ageing on venison tenderness (saddles) measured in kg shear force.

	Storage and time conditions post slaughter		
	2 hr 10°C and 22 hr 0°C	24 hr 10°C	24 hr 10°C and 3 days 0°C
		Yearling red deer	
No stimulation	10.6	7.7	6.0
Stimulation	5.4	4.8	3.8
		2 year red deer	
No stimulation	11.3	5.6	4.3
Stimulation	5.6	5.3	3.3

Electrical Stimulation

Electrical stimulation of sheep carcasses has become almost standard practice in New Zealand to prevent tough meat through cold or thaw shortening. Experiments from Chrystall & Devine (1983) and Drew *et al.*, (1988) have shown that if non-stimulated deer carcasses are subjected to 0-2° C temperatures within 2 hours of slaughter then tough meat will be produced. Table 1 shows the effect of low voltage stimulation applied within 3 minutes of death on meat tenderness and indicates the extent of improvement that can be expected with up to 3 days "ageing".

It is clear that in both yearling and 2-year-old stags the penalty in meat toughness is severe if electrical stimulation is not used when carcasses are placed in low temperature chillers within a few hours of slaughter.

There is a 50% reduction in toughness through the use of electrical stimulation. It follows that incorrect use of stimulation equipment will have detrimental effects on venison tenderness if carcasses are placed in chillers shortly after slaughter.

Holding carcasses at 10° C overnight will largely substitute for electrical stimulation but give very little added improvement in tenderness to stimulation. It is usually necessary to have carcasses down to a deep bone temperature of 7° C the morning after slaughter to allow cutting for some markets and this necessitates the use of stimulation.

Slaughter Processing

To obtain venison products with a long shelf life in chilled form requires high standards of equipment and methodology right through the slaughter and dressing procedure. Hair from the skin of deer is a major source of bacterial contamination and this is a critical matter in quality management. A machine has been developed at Invermay by AWA Milmech for efficiently removing the skin from the head to the tail when the carcass is suspended from the front legs (inverted dressing). The procedure means that no hand or knife is in contact at any time with the high value saddle/hind leg part of the carcass. Table 2 gives information on the bacterial quality of carcasses (saddle and shoulder) using the inverted method and compared with two other plants (B & C).

Counts below 1,000 CFU/cm^2 show excellent quality and it can be seen that on average all three plants have done a top quality job. Counts of a million or more indicate poor quality. Plants B and C, however, do show a large range in quality not apparent at Plant A, which uses inverted dressing. Operator skill and consistency have a major effect on quality in Plants B and C but quality in Plant A is largely independent of the operator. Care in packaging is important and Plant B uses a skinning machine which probably accounted for some increase in contamination.

Table 2 : Aerobic microbial counts (CPU/cm^2) from carcasses and from saddle prior to packaging.

Plant	At slaughter				Packaged boneless saddles	
	Shoulder		Saddle			
Plant A	1	(0-11)*	1	(0-24)	22	(0-2,000)
Plant B	33	(0-53,000)	30	(0-2,000)	355	(0-407,000)
Plant C	10	(0-10,000)	21	(0-158,000)	17	(0-7,000)

* Figures in parentheses are the range in counts

Packaging

Most chilled venison is leaving New Zealand in vacuum packs. The system removes air, and therefore oxygen, from contact with the meat surface. Hazards are seal breakage ("leakers") and the poor colour presentation through the pack wall where the meat is often seen as very dark and/or discoloured. If the venison is not repacked for sale display it is very uninviting. Recent technology in meat storage has seen the development of various controlled atmosphere packaging (CAP) systems where air is displaced from storage bags by CO_2 or a mixture of gases. Europe leads the world in this technology and 35% of all Denmark's retail meat trade uses CAP (Bruce, 1988). The recently developed CAPTECH system in New Zealand vacuum packs lamb in a gas permeable film and the package is then stored in a "master pack" which is very impermeable to gases, flushed with CO_2 and sealed. The system will extend the shelf life of chilled lamb to 16 weeks or more at -1° C. At the point of sale the outer bag is broken open, the meat is retained in the inner bag, but the permeable wall allows oxygen to penetrate and the colour "blooms" up for sale presentation.

Venison has a very high iron content which is almost three times that found in lamb (Drew & Seman, 1987). While this is an excellent nutritional attribute, it is the major reason why venison is naturally a very dark meat. A CAP system might greatly improve the display characteristics of chilled venison without decreasing shelf life. A series of experiments at

Invermay have been done to test a number of CAP options with venison. Aerobic bacteria increased from about 100 CPU/g after 6 weeks storage to 10-100,000 after 18 weeks storage. Vacuum packed venison was generally a little lower in counts than CAP treatments. Colour acceptability and stability are important characteristics. Table 3 shows how package systems affected venison colour with storage time.

Table 3: The effects of venison packaging method on meat colour after prolonged storage at -1 °C.

	Packaging method		
	Vacuum	CO_2-[1] Ultra high barrier bag (UHB)	CO_2-foil[2]
Colour acceptability[3]			
12 weeks storage	3.00	1.85	2.96
18 weeks storage	3.00	1.76	3.00
Colour stability[4]			
6 weeks storage	2.8	2.7	2.8
12 weeks storage	1.6	1.6	1.7
18 weeks storage	1.5	1.4	1.7

1 CAP system with 100% CO_2 and a clear barrier outer bag.
2 CAP system with 100% CO_2 and a dual aluminised polyethylene outer bag.
3 Scored on a 3 point scale where 3 = purchase without reservation and 1 = would not purchase.
4 Number of days required to reach a colour acceptability of 2 (purchase with reservation).

Surface colour was much less acceptable in venison from the CO_2-UHB system than the other two at 12 or 18 weeks of storage and this was due to oxygen penetration through the film. Colour stability was assessed by taking 1.5 cm thick slices of meat, placing them on white polystyrene trays wrapped in PVC and displayed in a retail cabinet (3 °C) for 5 consecutive days. Table 3 indicates little difference between packaging systems but does show that there is rapid loss of colour stability after 6 weeks of storage. Colour acceptability declined at a rate of about 1 day of acceptable display for each 6 weeks of storage. CAP conferred little additional shelf life to chilled venison saddle when compared with vacuum packed since the pH of venison was low, showed little variation and because the meat can be fabricated commercially with low levels of initial contamination (Seman *et al.*, 1988).

Transport and Storage

Chilled meat should be held just on the point of freezing (-1 °C) with minimal variation to ensure long shelf life. It is ironic that rapid air transport of chilled venison is often more hazardous in relation to temperature stability than sea transport because the air freight containers sometimes sit at airports not plugged into refrigeration gear in temperatures >20 °C. This will have very bad effects on venison quality and needs urgent attention in quality management. Although extending the shelf life of chilled venison is a worthwhile objective, attention should also be directed at increasing the efficiency of getting the product from the plant to the market in the shortest possible time. As export volume rises and more venison is displayed for sale where good colour is critical, storage time before sale should be minimised.

Future Trends

At the recent International Congress of Meat Science & Technology, Professor Schmidt said that "consumers will be buying a wide range of pre-packed and partially cooked meat products which can be cooked in a microwave oven." (Schmidt, 1988). Venison technology needs to be positioned to take advantage of changes in consumer requirements. Partial cooking in a bag means that control of the cooking process is largely retained by the seller with obvious advantages through to the consumer in consistency of eating quality. The technology also resolves the problem of colour perception and deterioration. There is no indication at this time of shelf life.

An important development is accelerated meat processing which is the mixing together of electrical stimulation and hot boning. There are large advantages in refrigeration and building costs to establishing a continuous batch process from stunning box to packaged meat from carcasses which are hot boned on the slaughter line. One company in South Africa now has a plant which processes 240 beef carcasses/day, all hot boned. A two stage electrical stimulation system is used and all carcasses are recorded for pH, 45 minutes after slaughter. Those that have a pH less than 5.8 (90% of total) are selected for hot boning. There has been improved efficiency through less drip, increased yields of primals and retail cuts, no cooking shrinkage, better colour, productivity increase of 20% because staff prefer hot boning and a saving in planned capital expenditure because carcass chillers have been converted into smaller units for primal joints (Taylor, 1987).

In the next five years the New Zealand venison industry must plan for major expansion in killing and processing facilities. It would be wise to carefully consider accelerated processing technology as a means of improving efficiency, reducing cost and developing new consumer venison packs.

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