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# Restructured meat using bovine plasma protein UNSW.007

## 1995

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MEAT & LIVESTOCK
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**Executive Summary.**

This project was initiated with the aim of demonstrating the value added potential of blood fractions, produced and often wasted, by Australian abattoirs.
The specific strategy chosen, was to demonstrate the potential bovine plasma protein had in its ability to produce a commercial product which could have consumer acceptance. Essentially this was achieved, in that the ability to make meat adhere together and reform into what could be considered a more tender and shaped portion piece of meat, differing from hamburger, in that the meat fractions are larger. To be successful in the commercialising the project strategy, it is essential that the abattoir industry be willing to consider the implementation of blood collection and the meat processing industry consider using the plasma produced. As part of the project blood collection and plasma separation was implement at the Brisbane abattoir, and the efforts of Mr R Stevenson for undertaking this task has to be acknowledged. Another aspect of the project strategy was to show industry that the abattoirs could market frozen plasma instead of spray dried plasma which is currently available from Europe and the USA. The logic of this approach was to encourage implementation of blood collection with minimal capital outlay. When a cash flow develops from the frozen plasma, further expansion of the industry into spray drying, and blood fraction separation could be considered.

Promotion of the commercial potential bovine plasma has for the meat industry was achieved in a number of ways. Initial research results were presented to the food industry at the Australian Institute of Food Science and technology Conference in Canberra in 1992. A workshop in which the Fibrisol Company participated, a subsidiary of the German Hoerchst Chemical Company, was held at the University of Western Sydney; Hawkesbury in May 1995. As a result of these promotions a number of companies have expressed interest in the potential of plasma. The Aspen Technology Company of Victoria has commenced blood collection, Carroll's Kitchen in Victoria has been using plasma for restructuring meat, the Chisholm Manufacturing Company has contracted for trials relating to the observed antioxidant effect of bovine plasma and the Blackforest Smallgoods company in Sydney is using plasma in meat pumping pickle formulations.

The project clearly demonstrated the potential and the positive function character of bovine plasma protein as a meat processing aid. Also the combination of the bovine plasma protein with a food phosphate, potassium poly meta phosphate, proved to be an extremely powerful food emulsifier. The Hoerchst company has expressed interest in this concept and will most

probably market an emulsification system based on the observations from this project. It is important to realise that dried plasma will be the essential raw material. Hence the need for the Australian abattoir industry to move quickly is acute. It is also important for food legislation to approve the term bovine plasma protein for labelling rather than blood protein.

Probably the greatest potential for commercialisation of bovine plasma protein lies in the fact that it is now possible to use the plasma in conjunction with modern operations management mathematics to introduce to the meat processing industry a new intermediate raw material, which will bring to the meat processing consistency of quality. Further work on the project will be directed in developing both a business plan and marketing plan for the concept, described in the report, if funding is approved.

The author wishes to express thanks to Mr R Stevenson for initiating blood collection and negotiations with AQIS, to Mr R Kutasi of Australex for use of factory premises to carry out commercial scale operations and Mr S Campbell of the Muscle Meat Research Centre at the University of Western Sydney; Hawkesbury for assistance with some of the technology related to the project.

31/5/95.

**Restructured Meat Using Bovine Plasma Protein**

**Dr P M Cranston**

**MRC Project UNSW 007**

## Introduction

This project sponsored by the Meat Research Corporation, is designed to not only develop a simple process whereby fresh meat can be easily restructured into steak like shapes using **bovine plasma protein**, but also to initiate interest within the meat industry to think about up-grading the low value status blood currently has and bring to Australia a new food processing industry. For the meat industry the conversion of a low value by-product, namely blood, to a more valuable functional food ingredient, should encourage investment, not only because of the commercial potential but because the treatment of blood will reduce one waste disposal problem within the meat industry.

Restructuring meat is not a new technology. Current meat processing practice, especially in Australia, Europe and in the United States of America, produce large quantities of cured meat products compressed after massaging and blending with farinaceous materials. The addition of starches or vegetable proteins is optional depending on the desired quality of the final restructured meat product. The move to develop restructured meat products started during World War II when the demand to feed over two million service people put a strain on the supply of prime meat cuts. To meet this demand for steaks and portions suitable for roasting, lower quality cuts off the carcass were relegated to pot roasts, stews and to comminution into sausage like products. Relief on middle cut supply started in the late 1950's when the hamburger industry began with McDonalds and the other fast food chains. It could therefore be argued that the comminution of meat into hamburger mince and then to hamburgers is in fact the beginning of the restructuring technology. Market trends in affluent countries, indicate that consumers are switching more and more to meat middle and prime cuts. Since these middle cuts constitute 15% to 20% of the carcass, a large proportion of meat has to be comminuted into sausage or hamburger like products.

The preference for lower fat content processed meat products is another noticeable trend in meat consumption. In European supermarkets it is not unusual to find comminuted and emulsified meat products with 5% fat or lower. The technology of meat restructuring lends itself well to satisfying this market demand. Hence the need to be able to transform shapeless carcass meat into value added meat products with eating qualities similar to the highly desired but limited middle cuts.[1 2]Restructured meat is simulated middle cut portions composed of meat which has been reduced in size but not to a size commonly used to produce the hamburger. The name restructured can of course be easily confused with the word reconstituted and therefore another definition of the process is the utilisation of manufacturing steps to create a consumer-ready product which resembles a steak, chop or roast.[2] Originally the institutional market was the target for restructured meat. Controlled portions of consistent product quality makes for attractive cost control for those organisations such as airlines, hospitals, fast food outlets and meat canneries.

So what is the difference, between a hamburger and restructured fresh meat?

Restructured meat is simulated middle cut portions composed of meat which has been reduced in size but not to the degree used for hamburger production. The name restructured can of course be easily confused with the word reconstituted and therefore another definition of the process is the utilisation of manufacturing steps to create a consumer-ready product which resembles a steak, chop or roast.[2] In 1974 and 1975 Mandigo after reviewing the literature relating to meat formulations came to the conclusion that there was considerable potential in supplying the institutional market with restructured meat, in particular restructured pork.[3]

**Technological strategy**

The strategy adopted for this project was to look at the value adding to bovine blood plasma, currently spilled and often wasted in the Australian abattoir system, and use it to develop the technology for restructuring meat without the aid of gums and farinaceous materials. The deliberate decision was made not to look into the spray drying of blood or its fractions because the capital cost of such a development would frighten off industry. By utilising the bovine plasma protein as a processing aid, and maintaining a high standard for the plasma, it was felt that the meat processing industry would benefit more.

Now the meat processing industry needs quality more than ever before. The consumer has to be assured that meat which has passed through mincers, cutters and combined with other

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[1] Restructured meats the past and the present 1987. J L Secrist, Advances in Meat Research, Ed A M Pearson, T R Dutson, 3 pp 1-19

[2] Restructured Meat, R W Mandigo, 1988 Developments in Meat Science 4 pp297-315 Ed R Lawrie

food ingredients comply with expected and legislated standards. This project has identified a processing concept for meat which has the potential of bringing to the Australian meat processing industry the where-with-all to accurately control meat blend quality. The process of utilising bovine plasma protein as the binding aid for meat restructuring and by adaptation of linear programming mathematics (sometimes referred to as least cost mathematics in meat processing), now offers the potential to produce meat blends with consistent lean to fat ratios and long shelf life expectation.

**Conventional Restructuring Technology.**

Early technology centred around the concept of flaking meat and using a combination of freezing and pressure to allow the meat flakes with large surface area to interlock and bind. The flaking process was patented by Urschel and called the Comitrol process. A centrifugal cutting process whereby tempered meat rotated at high speed around stationary cutting edges. The binding characteristic of the meat flakes depended on the type and shape of the cutting head. Temperature is critical. If meat is above the tempered temperature mush results.[1]. Comitrol equipment is not common in meat processing operations. More common are choppers, mincers or grinders and dicers. We took the pragmatic to develop a restructuring process whereby meat size reduction is accomplished by one of these commonly used pieces of processing equipment.

Chunking and forming is the preferred method by which meat trim can be reduced in size. Irregular surface topography is the key factor for maximum adhesion. A grinder, sometimes referred to as a mincer, is equipped with plates each with holes of varying size; or with a kidney shaped aperture from which the meat is forced before meeting the cutting head. The larger the pieces of meat and the more irregular the surface area the more steak like the restructured product. The objective is for the meat pieces to interlock and adhere. However the ability for the meat to adhere depends on more than shape irregularity. Myosin, plasma and other non-meat additives aid the restructuring process, because of their ability to gel and hold the tissues together.

Current restructuring processes, especially with cured pork based products rely on the use of starches and the addition of functional vegetable proteins to not only increase protein at the expense of meat, but to aid the fat emulsification process. Myosin extraction, aided by salt addition and mechanical action is also important for meat adhesion. Finally adhesion is accomplished by heating the combined meat and non meat components in a metal form or in casing. Products made in these way can be exceptional in quality.

Fat oxidation and increase in TBA values is a consequence of exposing disrupted muscle tissue to air. Flaking was particularly blamed for this because of the high speed of the process and the increased meat surface exposed to air.[4] To overcome this problem ascorbic acid, citric acid sodium citrate, erythorbic acid and sodium ascorbate can be added to the meat mixture.[5] Process equipment is now available whereby meat can be cut in an atmosphere of nitrogen. This engineering development will clearly offer the processor the opportunity to lengthen the shelf life of restructured fresh meat, however the studies have not as yet been done.

**Restructuring Meat with Bovine Plasma Protein**

The experimental work concentrated on taking beef trim and trim from other meat species, supplied as cartoned and frozen, and restructuring it to meat logs later to be portioned into roasts or steaks. The log shape was convenient. However the meat processor can with similar ease convert fresh trim into chop like shapes or square slices to satisfy the steak sandwich market if desired. The process developed will also allow the production of larger yeros logs with equal control and hygiene. Alternatively it is equally possible for the restructured meat to be boxed and frozen, for subsequent conversion to a value added meat product such as a sausage or salami.

The use of bovine plasma protein eliminated the need to use vegetable protein extenders or gums and at the same time increase the yield by approximately 10%. Addition of **potassium poly meta phosphate** is both novel to the restructuring process and eliminates the need to extract myosin using salt, a common process to aid the restructuring process. Consequently the use of bovine plasma protein allows for the production of meat of defined composition without the addition of salt. (Potassium poly meta phosphate is produced when long chain crystalline poly phosphates are solublised *in situ* in the presence of soluble alkali metal phosphates, sometimes called Kurrol's or Maddrells's salts, first demonstrated by Roland 1951[6].)

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[3]ABMPS 1981. Examination of flavour and colour changes in NLABS process for flaked and formed meats. Report 119. Committee on food stability. Advisory Board on Military Personnel supplies, National Research Council.
[4]USDA 1986 Ascorbic acid, erythorbic acid, citric acid, sodium ascorbate, sodium citrate in fresh pork cuts. Fed Reg. 51 (163)30052-30054
[6]Roland C T, 1951 Processed Cheese and method of making same. US Patent 2,564,374 Aug 14.

This is not to say that the addition of food ingredients will not produce better physical characteristics for the restructured meat. The addition of milk protein isolate in combination with the potassium poly meta phosphate did enhance the moisture retention during thawing and cooking, Increasing the meat pH has a significant effect on the water holding capacity.[7,8] The effect potassium poly meta phosphate has on the water holding capacity of the meat is most probably a function of its ability to raise the pH from approximately 5.7 to just over 6., Table 1.

**Table 1 Chemical and physical analysis of restructured meat**

***Effect of the bovine plasma protein on the basic physical and chemical characteristics of restructured beef meat, also indicating the water binding capacity of the bovine plasma and the enhancement of it through the addition of potassium poly meta phosphate and milk protein isolate.***

| *Sample* [a] | *Moisture %* | *Protein %* | *Fat%* | *Ph* | *Drip loss %.* |
|---|---|---|---|---|---|
| 1 | 59.39[b] | 18.46 | 19.36 | 5.89 | 1.96 |
| 2 | 69.05 | 18.90 | 13.32 | 5.74 | 0.03 |
| 3 | 70.38 | 18.28 | 10.74 | 6.18 | 0.61 |
| 4 | 69.68 | 19.06 | 8.4 | 6.18 | 0.13 |
| 5 | 59.41 | 11.93 | 28.04 | 6.26 | 0.01 |

b All measurement as mean of at least two test results.

a 1= Control, no bovine plasma protein added.

2= Meat plus 10% bovine plasma protein

3= Meat + 10% bovine plasma protein + 0.5 % phosphate.

4= Meat + 10% bovine plasma protein + 0.5% phosphate + 2% milk protein isolate.

5= Meat + 10% bovine plasma protein + 0.5% phosphate + 2% milk protein isolate + 10% extra beef fat( increasing the fat content of the meat to approximately 30% fat.)

**Functional Characteristics of Bovine Plasma Protein**

Bovine plasma protein has good gelling characteristic common with that of egg albumin. The substitution of bovine plasma protein for egg albumin is a distinct possibility for the baking industry. Work carried out at the University of NSW demonstrated that bovine plasma protein added to the soft wheat flour and converted to pasta resulted in an acceptable product

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[7]Ham R, 1971 Interactions between phosphates and meat proteins, in Symposium (Phosphates in food processing) J M DeMan and P Melnychyn eds AVI Publishing Co Westport, Conn. pp 206-222

[8]Lindsay R C. 1985 Food Additives. Food Chemistry O R Fennema ed Marcell Dekker Inc, Ney York p 640

without the utilisation of Durham wheat, the common protein source for pasta and spaghetti. The gel formed by heating bovine plasma protein has no odour and neutral taste provided it is not added to products above 15% as liquid plasma.

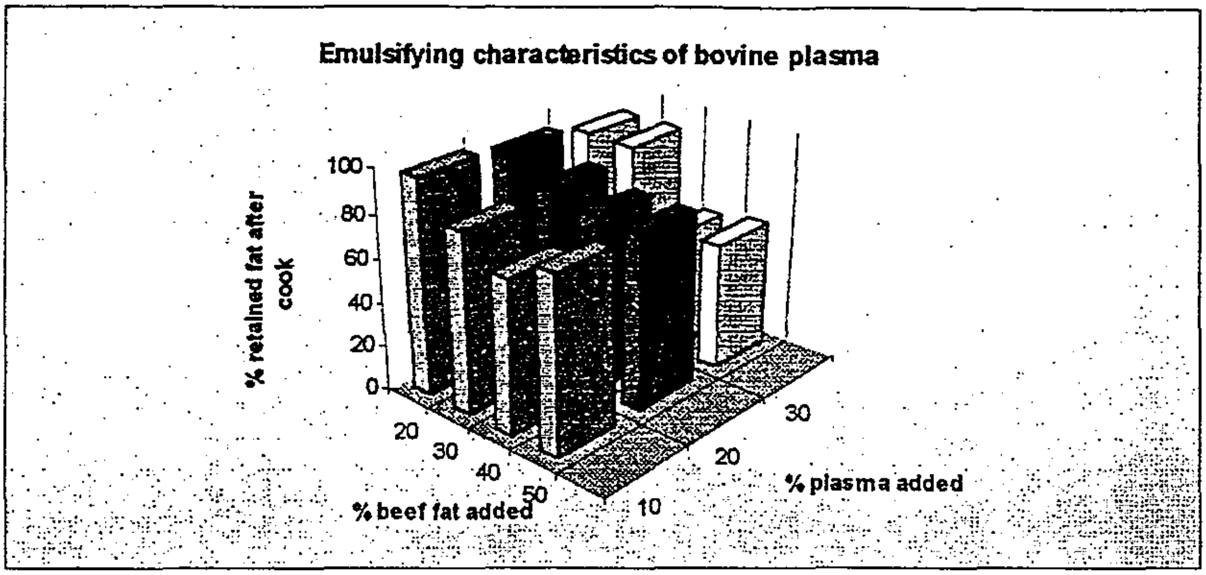



***Fig 1 Representation of the emulsification ability of bovine plasma protein added to a meat emulsion with varying additions of beef fat. The degree of emulsification is measured as the fat retained after cooking the meat batter at 120° C FOR 5 mins.***

Figure 1 indicates the relative fat emulsification power of bovine plasma protein. The methodology used to demonstrate this aspect of functionality was based on the amount of fat retained after retorting a meat batter made with beef, added beef fat and bovine plasma protein. The results indicate that there is a strong emulsifying functional quality in the plasma, but it is a function of the amount of fat in the meat batter. By adding more plasma as the fat increases does not necessarily improve the emulsification ability of the plasma. It would appear that the optimum amount of plasma would be between 15 and 20%. However if emulsification additives are added, such as the potassium poly meta phosphate there is a marked improvement, as demonstrated in Fig 2.

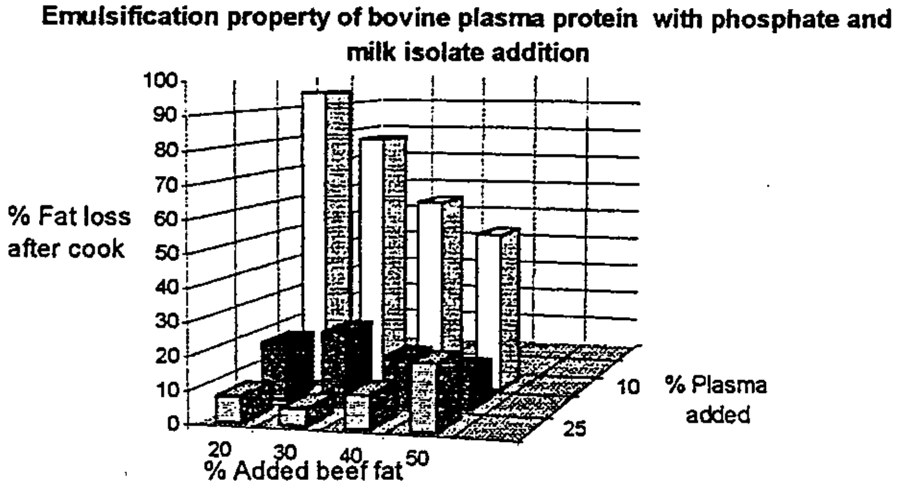



***Fig 2. Improvement of the emulsification property of bovine plasma protein by the addition of potassium poly meta phosphate (0.5%) and milk protein isolate (2%) to the meat batter, measured by the loss of fat after retorting the batter for 5 mins at 120°C.***

Application of blood plasma to meat for restructuring is not well documented. Further more little if any published material exists whereby the peculiar functionality of potassium poly meta phosphate is adapted to the restructuring process. Schmidt and Means 1986 filed patents for the restructuring of fresh meat using sodium alginate and a process whereby calcium ions replace the sodium to form a stable and strong calcium alginate gel.[9,10] The process was based on technology used by the sausage maker. Salt and phosphates combine to extract the salt soluble meat proteins. Gelling ingredients are then added and the resulting sticky mass is extruded from a conventional sausage filler, formed and frozen.[11] The phosphate most commonly used is sodium tri poly phosphate. The alginate process for restructuring described by Schmidt is the recognised process at present.[12] The alginate process is often modified to utilise the water binding functionality of other carbohydrates and hydrocolloids such as carrageen.

[9]Schmidt G R, Means W J, 1986. Process for preparing algin/calcium alginate gel structured meats products. US patent 4,603,054 July 29

[1]USDA 1986 Binder consisting of sodium alginate, calcium carbonate, lactic acid and calcium lactate. Fed. Reg. 51 (159):29546-29458

[11]Schmidt G R, Trout G R. 1982 Chemistry of meat binding. In 'Meat Science and technology International symposium Proceedings' Lincoln, NE Nov 1-4, p265. Natnl. Live Stock and Meat board, Chicago. IL

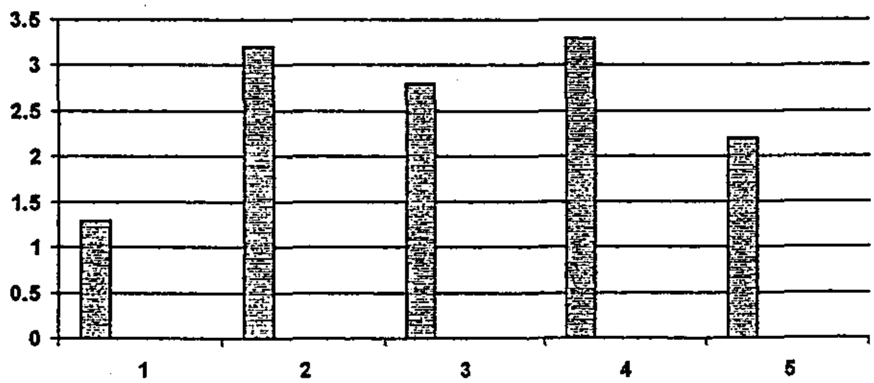
[12]Schmidt G L 1988. Restructured and reformed meat. Meat'88. Proceedings of 34th International Congress of Meat Science and technology, Brisbane, Australia, Aug 31, p83-86

Essentially a restructured meat product should look similar to a whole piece of meat. However the essential difference between restructured meat and a whole cut is that it can be a blend of meat species with the muscle cells in random orientation. This random orientation imparts bite tenderness to the meat: a positive characteristic. The degree to which meat is comminuted before being restructured plays a significant role in determining the bond strength. It was found by experimentation that the ideal meat reduction size was 14 mm. That is, the beef and trim from other species put through a mincer with a 14 mm plate before being tumbled with the potassium poly meta phosphate, milk protein isolate and bovine plasma protein produced the best bonding at fat levels below 20%. See Appendix 3 "Manufacturing process for restructuring meat using plasma protein". Se, also Appendix 2 "Restructured of meat by the addition of gums and non-meat proteins" for a comparison of methods for meat restructuring. The use of bovine plasma protein as a restructuring aid, is significantly simpler than the conventional process using gums and other non meat additives.

Restructured meat portions should have the ability to withstand a certain amount of shear and not fall apart at chilled holding temperatures or after cooking. The ability of plasma to coagulate on heating overcomes the problem of disintegration during cooking.

The addition of potassium poly meta phosphate is a novel concept to the restructuring of meat. This food phosphate is currently used as an emulsification aid in the meat processing industry. It is for this reason it was chosen to enhance the emulsification potential of bovine plasma protein.

***Fig 3 Rheological properties of restructured meat in terms of Stiffness index***




Mean Stiffness index (g/cm$^2$) = Breaking stress / Unit extension

(Stiffness index represents the mean of four measurements.)

Breaking stress = breaking load / cross sectional area of sample

Unit extension = Extension at break point / length of sample

**Legend for Figure 3:**

1 = Control no blood plasma added

2 = Beef plus 10% bovine plasma protein

3 = Beef + 10% bovine plasma protein + 0.5% phosphate

4 = Beef + 10% bovine plasma protein + 2% milk protein isolate

5 = Beef + 10% bovine plasma protein + 2% milk protein isolate + 10% extra beef fat.

The results represented in Figure 3 above, indicate the significant improvement in bind strength as described by the stiffness index by bovine plasma protein and the fact that if the fat content is increased the stiffness index is reduced. That is, increased fat concentrations will reduce the bind strength. The addition of the potassium poly meta phosphate and the milk protein isolate had no significant effect on the bind strength. These ingredients only enhance the emulsification properties of the bovine plasma protein.

Tissue binding is a critical for restructuring. If binding is excessive then the product will be too chewy and rubbery. A high degree of binding is required for restructured meat destined to be further process at high temperatures, such as a canning, or for long periods of heating, such as in an atmospheric cook common to meat pie production. A lesser degree of bind will be required for restructured meat destined for normal cooking eg frying or grilling.

The degree of connective tissue in the meat is another factor determining quality of the restructured meat. Essentially restructured meat is more tender than some middle cuts, because the muscle cell orientation is random. If there is too much collagen or connective tissue in the meat or the meat pieces are too large, a cooked restructured steak curl cooking. Alternatively the collagen may protrude from the steak surface resembling a wart like structure. If meat with large amounts of connective tissue is to be used in the restructuring process (eg tendons, backstrap, abdomen tunic) then the degree of size reduction has to be carefully determined. The greater the collagen content the greater the reduction in particle size.

Addition of salt will increase the degree of bind.[13] Increasing the salt level increases the bind strength. In our work the salt level was not considered because there was no desire to add salt to the meat. The effect on bind strength as the result of sodium increase does not differ significantly from the effect of potassium addition.[14]

**Commercialisation**

Commercialisation of bovine plasma protein will depend on the development of a market which will recognise the value of the material and secondly the willingness of the meat industry to implement collection procedures which meet with the highest standards. To-date the project manager of this project has been able to demonstrate the usefulness of the plasma protein by the production of restructured meat which appears to have a shelf life greater than meat alone as demonstrated from the measurement of fat oxidation parameters and colour values below. The application of beef plasma protein to the meat not only increased the binding strength without the application of salt, but appeared to limit the tendency for restructured steaks to darken after exposure to air.[4]

***Table 2 Chemical changes to restructured meat with liquid plasma and dried plasma in the presence of potassium poly meta phosphate (PMP)***

A. Thio barbituric acid values (TBA), a measure of the oxidation of unsaturated fatty acids in the meat.

| Time at -15oC | Control | Plasma only | plasma liquid + PMP | Plasma dried + PMP |
|---|---|---|---|---|
| 3 mths | 0.040 | 0.049 | 0.083 | 0.085 |
| 4 mths | 0.090 | 0.043 | 0.550 | 0.340 |

B. p-anisidine value, a measure of the fat breakdown in the meat which would manifest as off flavour.

| Time at -15oC | Control | Plasma only | plasma liquid + PMP | Plasma dried + PMP |
|---|---|---|---|---|
| Zero mths | 3.84 | 1.84 | 0.94 | 0.76 |
| 4 mths | 6.78 | 5.01 | 2.91 | 5.43 |

[13]Effect of salt phosphate and some non meat proteins on binding strength and cook yield of beef roll. Moore S L, Theno D M, Anderson D R, Schmidt G R, 1976. J. Food Sci. 41,424

[14]End product quality assessment systems for flaked and formed steaks Berry B W, 1984. Rep. to the US Army Natick Research and Development Laboratories.

C. Colour changes of restructured meat during storage at -20oC

| Time at -15oC | Colour | Control | Plasma only | plasma liquid + PMP | Plasma dried + PMP |
|---|---|---|---|---|---|
| Zero mths | L | 49.13 | 46.88 | 50.98 | 46.68 |
| | a | 20.83 | 20.12 | 18.86 | 22.21 |
| | b | 12.88 | 12.15 | 13.32 | 13.01 |
| 3 mths | L | 49.08 | 47.47 | 47.19 | 46.76 |
| | a | 20.59 | 22.08 | 21.50 | 21.96 |
| | b | 10.66 | 11.25 | 11.20 | 11.73 |

L= Black to white; a = red tones, b = yellow tones.

The surprising observation from the above information in Table 2 hint to the fact that there is some aspect of liquid (frozen) bovine plasma which inhibits the oxidation of conjugated bonds in beef fatty acids. This inhibition seems to be destroyed in the presence of PMP and possibly by the spray dried process for plasma. Clearly this observation should be investigated further and in a more detailed manner. The p-anisidine values do not allow for the formation of a hypothesis as to the effect of the additives. Peroxide values measured showed no significant change over the period of storage for restructured meat with or without plasma addition. Similarly the colour of the restructured meat did not change greatly over the period of storage. This is a significant positive feature of the restructuring process as, experience with conventional restructured meat incorporating gums and vegetable proteins tend to discolour rapidly during frozen storage.

The results of the project have been presented at the 1993 AIFST Conference in Canberra and at a workshop for the industry in May 1995 held at the University of Western Sydney, Hawkesbury. From this exposure there has been some interest in that Chisholm Manufacturing, Sydney, has expressed interest in the use of bovine plasma protein as a shelf life additive for meat products, Aspen Technologies of Victoria have commenced the processing of bovine blood, the Brisbane abattoir has the potential to supply plasma for limited work, Blackforest Smallgoods has successfully incorporated plasma into pumping pickles and Carroll's Country Kitchen in Victoria is using the plasma for restructuring.

However the real potential lies in the production of a controlled meat based raw material for the meat processing industry. Currently the processing industry converts boxed trim into product by blending different grades and meat species into sausage by an ad hoc blending process. In some cases companies which still have a boning operation will take the table trim and covert it to product by blending it with cartoned meat trim. Few companies have the skill or training to utilise modem mathematical mixing equations in conjunction with CL measurements to produce consistent processed meat product, hence enabling them to improve their purchasing power over the meat wholesalers. In general the meat processors are locked into a recipe and have to accommodate their production costs to the price fluctuations which occur with meat. In other words they don't have the ability to maintain meat recipe standards and at the same time minimise the effect of market price variation of meat on their product.

The ability to use the restructured meat technology developed in this project using bovine plasma protein, offers the potential for the consistent production of blended meat to precisely defined lean to fat ratios. This concept is best explained by scenario example which will form the basis of a business plan to be developed as an extension of this project.

Using linear programming mathematics it is possible to take a number of grades of meat which vary in the amount of fat, and of course price, and calculate the proportions required to meet a defined standard. If, for example a frankfurts manufacturer has to produce a product with fat between 18-20% and a total meat content (fat + lean) of 66%, the restructuring process developed in this project allows for a consistent meat mixture to be made, stored frozen and be available to be added to the frankfurts process at defined levels without the extra work of thawing, and blending. Production recipes will be defined and consistent and product quality will be consistent.

Supplying the meat processor with a defined blend of meat now puts meat into the same category as the spices used in processing. That is, specified amounts can be added without variation. Also, restructured meat can be stored at 2°C, hence allowing refrigeration cost savings. This also enables the processor to utilise the meat ex storage without thawing.
In summary the advantages of utilising restructured meat as a defined work in process raw material offers the meat processor production efficiencies currently not available. It also allows for the development of other industries, such as suppliers of restructured meat to meat processors. The simplicity of the process developed means capital costs will be minimal and quality control, maximum.
Other opportunities for the use of restructured meat lie with the meat pie industry. The restructuring process will allow for the delivery of defined meat blends to the pie maker and

the function of restructuring offers the pie maker the potential to reduce the cooking time and delivering a chunkier and tender pie filling.

**Results and Discussion.**

The process for collecting blood has been established since before 1979.[15] and because blood contains about 18% protein it is called **liquid meat.** Therefore it is logical to incorporate at least part of it back into meat products. Abattoir blood can represent about 2.4 to 6% of the beef live weight, 2-6% of the pig and 4-9% of the sheep, and is part of the 20% of the animal called by-product. All by-product is edible depending on the perceptions of the consumer, culture and religion. Many consumers readily eat animal by-product without knowing the exact anatomical origin.

Beef and pork blood is well recognised as a valuable food and food additive.[16] It is used as a stabiliser, colour, lysine supplement, egg substitute, resin extender, seed coating and clarifier in the wine. It is also used in the ceramic and cosmetic industry. Blood has been incorporated in cheese as a stabiliser, emulsifier for butter, colouring for poultry products, substitute for egg albumin, utilised for synthetic films, and incorporated into flour for baking. It is a rich source of lysine. However its use as an emulsifier and as a gelling agent is of particular importance to meat processing. Increasing the plasma content increases the ability of the emulsion to bind the fat and prevent fat after cook split. Blood contains enzymes and components which may play an increasingly valuable role in food processing. A process developed by Paardekooper, 1987, utilises the fibrinogen in plasma to bind meat proteins together [17]. This process is now commercialised in North America. Mandigo 1993[18]. Australian and US markets have been slow to see the advantages of bovine plasma protein this is despite the fact that products such as blood sausage is popular, and in Europe the use of frozen plasma flake for the production of emulsion sausage is wide spread.[19]. It would appear that the main reason is the perception of blood as being goulish and not a fit component for food. Apart from some religious factors it is important for the meat industry to promote the use of blood plasma as bovine plasma protein, thereby softening the negative

[15]Utilisation of animal blood in meat products. Wismer-Pederson J, 1979. Food Technology 33, p76-80

[5]Ockerman H W, Hansen C L, 1988 Animal By-Product Processing. "Blood utilisation" Ellis Harwood Pub. p232-255

[6]Paardekooper E J C, 1987 Recent advances in fresh meat technology. In 33rd Intl. Cong. of Meat Sci and Technology. Helsinki, Finland, p 170-172

[7]Mandigo R 1993. Personal communication. University of Nebraska.

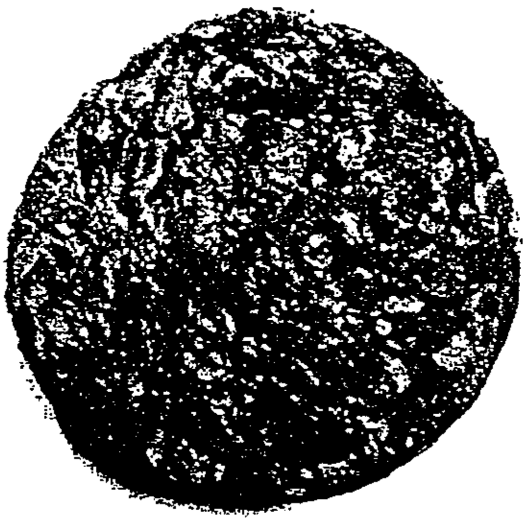
[8]Hoenikel 1993 Personal communication. Federal Republic of Germany Meat Research Centre. Kulmbach, Germany.

perception of the word blood. Increasing the ratio of lean meat to milk protein isolate explains the further reduction in drip loss as a consequence of increased beef fat.

## Appendix 1

Restructured steaks manufactured from beef trim using bovine plasma protein and Potassium poly meta phosphate and milk protein isolate.

10% PLASMA



10% PLASMA
+
0.5% PHOSPHATE
+
2% PROTEIN ISOLATE

# RESTRUCTURED MEAT BY ADDITION OF GUMS AND NON-MEAT PROTEINS

FRESH OR AGED MEAT SIZE REDUCTION

↓

NON MEAT INGREDIENTS ADDED

Sodium alginate 0.7-1.0%

*Soy protein gels optional*

Calcium Carbonate 0.1-0.25%

Glucona δ lactone

↓

PADDLE OR RIBBON MIXER

EXTRUSION OR MOULDING

↓

REFRIGERATE TO ALLOW TO SET.

**Adapted from:**

Means W J, Schmidt G R, *Restructuring without the use of salt or phosphate*. Advances in Meat Research; Ed Pearson A M, Dutson T R. 3 469-487 1987

Schmidt G R, *Restructured and reformed meat. Meat 88 Proceedings of industry day: 34th International Congress of Meat science and technology. August 31, pp 83-86 1988*

# MANUFACTURING PROCESS FOR RESTRUCTURED MEAT USING PLASMA PROTEIN

FROZEN TRIM

↓

TEMPER

↓

DICE & SIZE REDUCTION 14mm PLATE

↓

TRANSFER TO Z-ARM or PADDLE MIXER

↓

ADD PLASMA PROTEIN AND FOOD POLY PHOSPHATE

↓

*MIX 20 Min*

↓

TRANSFER TO FILLER

↓

FILL INTO FORM WITH MODERATE PRESSURE

↓

FREEZE

↓

STORE

↓

TEMPER

↓

SLICE OR DICE PRIOR TO COOK

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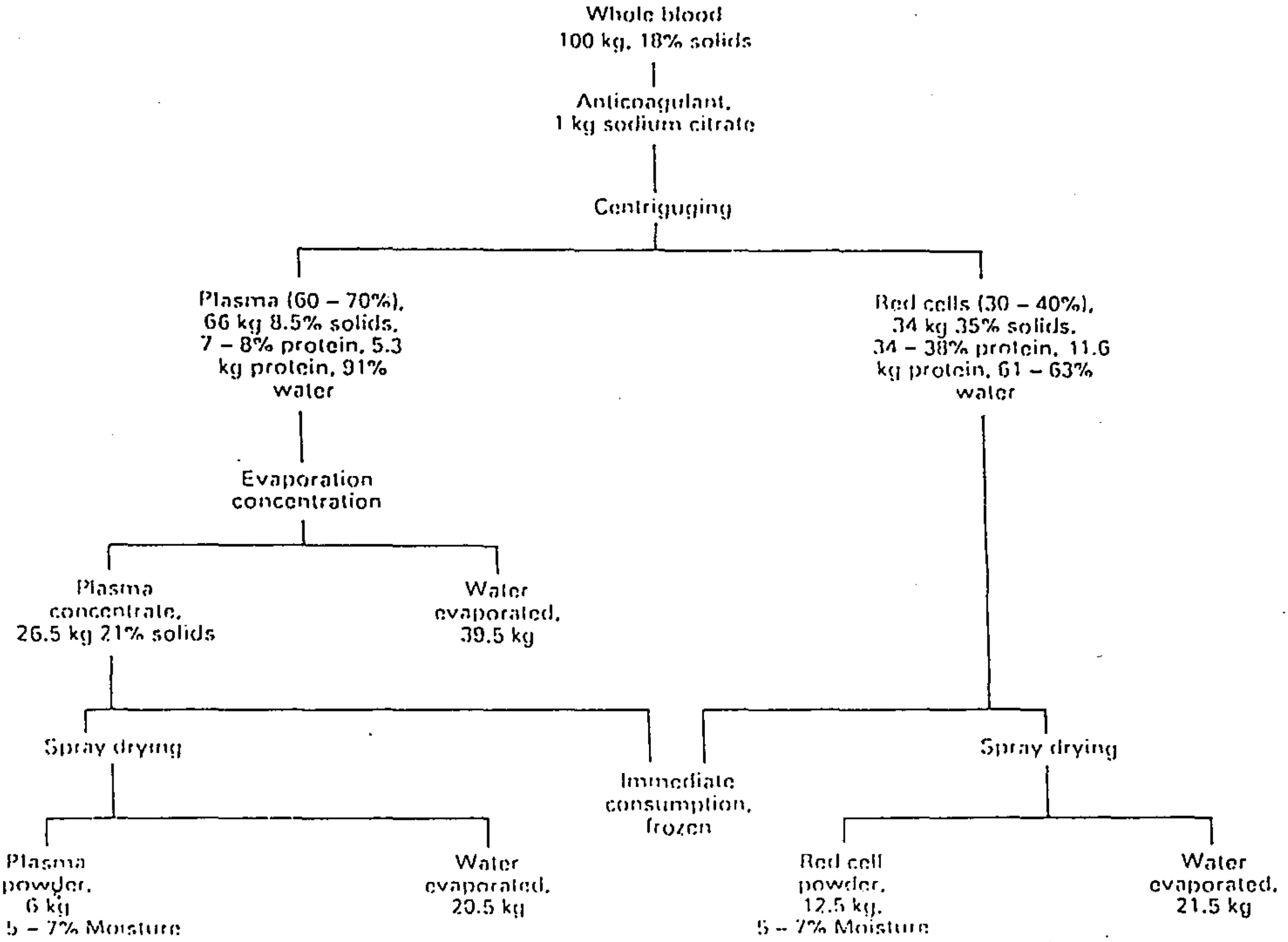
# COMMERCIAL BLOOD PROCESSING

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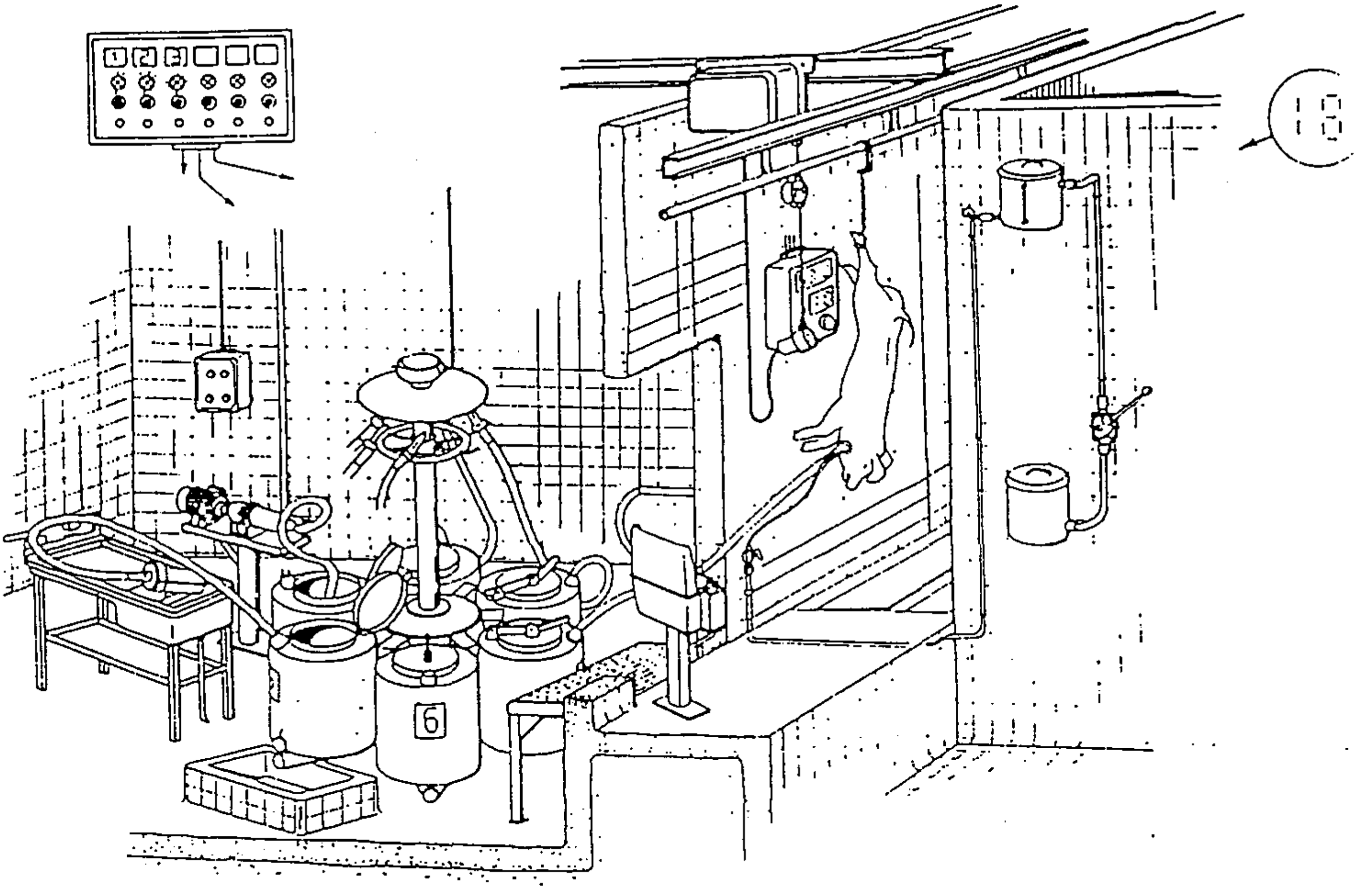
Appendix 6




'ig. 1—BLOOD-COLLECTING EQUIPMENT LAYOUT *(source Nutridan Engineering Co., 1978)*

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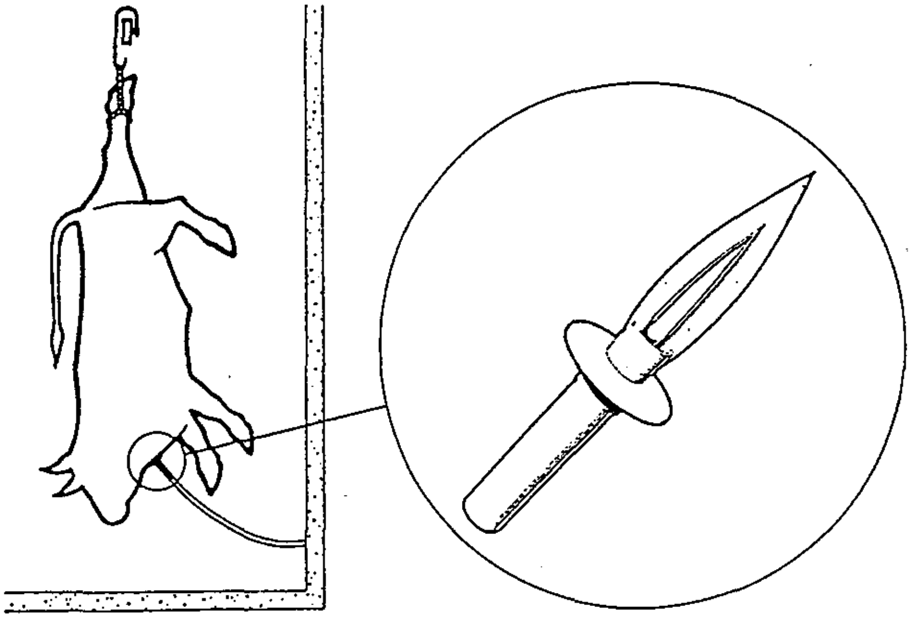
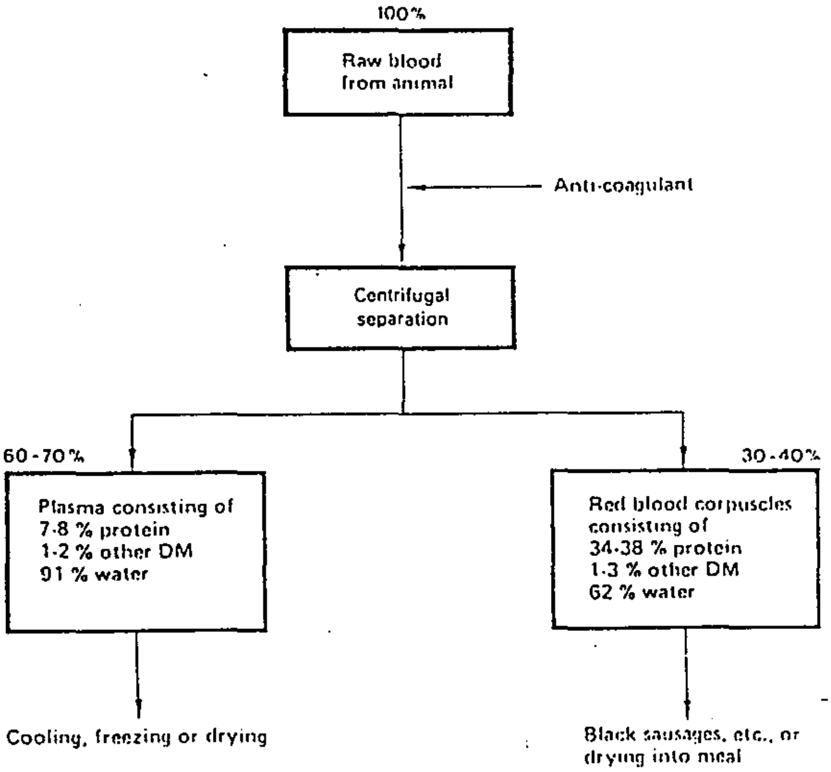
## THE BLOOD COLLECTION PROCESS SIMPLIFIED
(Taken from Filstrup 1976, Handbook for meat by-products industry. Alfa-Laval, Sweden)





# Quality Smallgoods using Bovine Plasma Protein Workshop - 4th May 1995

**Presented by the Meat Research Corporation in conjunction with the Food Industry Development Centre, University of New South Wales and the Muscle Food Research Unit, University of Western Sydney Hawkesbury**

We would like to invite you to participate in a Smallgoods Workshop. A initiative from the Meat Research Corporation provides the technology for the meat processing industry to utilise good quality Australian bovine plasma protein in smallgoods production.
This workshop is designed to demonstrate to the meat processing industry the practicalities and the resulting quality of products made using frozen bovine plasma protein now available.

**Demonstrated will be the binding capacity, the emulsification capacity and the quality in pumped meats obtainable from what has previously been considered an abattoir by-product.**

The application technology has been developed by the Food Industry Development Centre at the University of NSW and the Muscle Food Research Unit at the University of Western Sydney, Hawkesbury.

Hoechsts Australia Limited is proud to involve themselves as the organisers and we are proud to have as the key demonstrator Klaus Keye, a Master German smallgoods maker with experience in the utilisation of plasma protein in meat processing.

If you are unable or do not wish to attend personally but feel that another member of your staff would benefit from the workshop please pass the invitation on to them.

| | |
|---|---|
| 9.30 - 10.00 | Registration - * Conference Centre (map ref: P21 Bldg. C9) |
| | |
| 10.00 - 12.00 | Plasma protein functionality in meat processing, discussion |
| | |
| 12.00 - 1.00 | Lunch * Yarramundi Centre (map ref: E9 Bldg. P12 |
| | |
| 1.00 - 5.00 | Workshop demonstration -* Pilot Plant ( map ref: H5 Bldg. M10) |

## Venue : UNIVERSITY OF SYDNEY, WESTERN HAWKESBURY
## Cost : $60.00

** Bring a clean white coat to comply with the hygiene requirements of the UWS Pilot plant.*

To register, accommodation if needed or for more information please contact or send to:
** Hawkesbury Campus provides Motel style accommodation at reasonable rates.*

✂------------------------------------------------------------------------

*Spaces are limited, so book early.*

| | | |
|---|---|---|
| Denyse Robertson | | Registration : ☐ Accommodation:☐( tick or cross ) |
| Food Industry Development | | Name : |
| University of NSW | | Company: |
| Sydney NSW 2052 | | |
| | | Address: |
| Ph: 385 5354 | | |
| Fax: 313 6403 | | Ph: Fax:: |

ATTENDANCE LIST

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