Sausage manufacture

Principles and practice

Effiong Essien

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Foreword

Effiong Essien has written *Sausage manufacture* at a time when consumer focus on meat and meat products has never been sharper. Despite all the threats to consumer confidence, however, the sausage remains a popular part of the European and American diet.

But what is the sausage? This book will tell you. It charts the steps of product formulation and production and the requirements of sausage quality and safety management. It details market trends and the challenges that will have to be met by the successful sausage manufacturer of the future.

The meat manufacturing industry is bound by a plethora of regulations in order to ensure the quality and safety of the product. No other industry is as highly regulated. This compendium highlights the legal requirements of sausage manufacture. It also recognises that there are an increasing number of new customer and consumer-led requirements attached to successful sausage production.

Where meat is concerned, customers generally want to know its country of origin. They also want to know about the ingredients of a product. Nowadays customers also want to know about the lifestyle of the animals producing the meat. Were the animals raised in welfare-friendly systems? What did the animals eat? There is consumer concern not only about genetic modification of our primary food products but also of animal feed.

Mr Essien rightly pays close attention to the need for first-class quality management systems, the application of HACCP principles, the importance of obtaining raw materials from recognised quality assured sources and essential traceability and documentary evidence. These provide the cornerstones of customer confidence, but they are not the only quality criteria demanded by the customer.

Where once there were E-numbers, now there is a desire for natural ingredients. Recently we have seen an increase in the demand for organic sausages, for reduced fat sausages, for low salt/sodium sausages – even vegetarian sausages. Above all

we have seen a demand for the exotic/gourmet sausage. This book examines the evolution and healthy survival of the sausage. It encourages the sausage manufacturer to look forward to change and the challenges such changes bring with them.

Celia Bennett
Director, British Meat Manufacturers' Association

About the author

Effiong Essien is a qualified meat scientist with a broad range of experience in Technical and Quality Assurance within the processed meat industry.

He is currently working as a Technical Manager in charge of QA and NPD departments for one of the leading manufacturers of processed meat products.

Apart from conducting internal audits of the Quality Management System he also specifies the raw material, process and finished products of the company. As part of his raw material specification his responsibility extends to cover external audits of the raw material base. He leads the quality system, NPD and initiative. He is also responsible for customer care, hygiene and technical training as well as general technical services for his current employer.

He holds an MSc in Meat Science from Bristol University and a BSc in Animal Science. He is a member of the British Society of Animal Science and a Fellow of the Royal Society for the Promotion of Health, as well as being a Chartered Biologist and member of the Institute of Biology.

About the book

The book presents principles of sausage manufacturing in a simple and practical way. It highlights factors responsible for the success of the industry over the years. It gives facts and figures regarding consumption patterns and sausage retail market share. There is still a great potential for the industry, and this lies in the hands of directors and managers with flexible production systems amenable to consumers' ever-changing needs and requirements. Key features of the book include new sausage product development, sausage quality and safety management and certification/accreditation requirements as well as relevant HACCP systems within the industry. The book ultimately points to new directions the whole industry is likely to follow in the next decade.

This book is aimed at:

- all manufacturers and suppliers within the food industry, ingredients suppliers, importers and exporters
- sales and marketing managers
- production, technical, NPD and research managers, including directors
- information and regulatory managers
- company legal advisers and solicitors
- students and lecturers of food science.

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Introduction

Use of sausages as a processed meat product and a food component has been identified with different and diverse cultures around the world dating back many centuries. In British society sausage consumption has been traditional and will continue to be popular for a long time as shoppers buy sausages as a single item or as a meal component. *Meat and Poultry News* (2000) published a survey indicating that 82% of consumers said a full English breakfast would not be complete without a sausage. The 1997 estimated total retail volume of UK pork sausages and beef sausages was 197 000 tonnes (Table 2.3). Estimated household expenditure on pork sausages (uncooked) in 1993 was £289 million, a figure that increased to £392 million in 1998 (Table 2.2).

Passion for sausage consumption is not only traditional among the British and the rest of Europe, but also among the Americans, with an estimated seven billion hot dogs consumed in the USA in summer 2000 (*Meat International*, 2000). The increasing trend in consumption and popularity of sausages in Europe and America is just a reflection of a global consumer interest in these processed meat products.

Sausage manufacture is a simple process of allowing meat to undergo series of controlled structural and chemical changes. These are basic to all cultures but the changes rely on varied methods of preparation and spicing to achieve desired distinctive characteristics. Even though the size and scope of operation have undergone a remarkable level of change the principles and idea behind modern-day sausage manufacture in achieving products of high organoleptic value and improved shelf life remain the same (FAO, 1985).

The uses of sausages as a meal and sandwich component have been well explored by the manufacturers. Grocery shop shelves are full not just of sausages of different types and forms but also ready meals made with cooked sausages of

different flavours, types and dimensions. There is still a great potential in the cooked range, which has recently led to a change in the process among some manufacturers to accommodate an increasing demand for cooked sausages in the sandwich and ready meal sector. Equally on the increase are the organic, low salt, gourmet and low fat ranges of sausages in various forms, taste and dimensions.

What factors are vital to the success of sausage manufacturing?

Like any other successful item in the food market, sausage manufacture and survival have been customer- and consumer-driven. The proliferation of new types and ranges of sausages made possible by advances and greater understanding of meat science and technology, and by casing technology coupled with the experience of the key players in the sector, point to the endorsement of these products by consumers. The sausage manufacturing process is flexible and amenable to consumers' needs and their ever-changing and increasing requirements.

Customers in recent times have been not only concerned about the country of origin of the meat used but also that the animals are reared in an acceptable welfare-friendly system. Some consumers would like an assurance that the meat comes from animals fed on vegetarian rations. Controversy surrounding the use of ingredients suspected to be from genetically modified sources has been extended to cover sausage manufacturing. Even though this controversy is rife and a sensitive issue among some societies of consumers, use of such ingredients raises very little protest in other societies. Many consumers want sausages made with ingredients devoid of genetically modified organisms (GMOs), but a few have expressed the need to ensure that GMO ingredients are not fed to animals from which meat is derived. Concerns are voiced that genetically modified foods have not yet been established as safe for human consumption. Many manufacturers targeting the market of those averse to GMOs' presence in food do welcome advances, research and new developments regarding the benefits of these organisms even though they may be required to provide customers with a policy statement indicating the absence of GMOs in the food material and process. The industry is capable of sourcing to satisfy all these needs – however challenging.

Another factor is the price of sausage, which is quite competitive when compared to other meat products. Sausage production as a norm utilises meat leftovers, which are relatively cheap as a raw material. Such materials are basically trims characterised by a high fat content and connective tissue with low functionality. Sausage manufacture is therefore a means of adding value to these off-cuts and thereby increasing the utilisation of carcass meat.

A third factor is a panoply of sociological trends such as provision of convenience in preparation of food. Less time is now spent in food preparation as more family members are career individuals. Also cooked sausages provide a microwavable option, especially as a meal component. Additionally, more meals are eaten out as many manufacturers open up their own retail and catering outlets. Many such outlets have sausages as their meal components. Sausages have found a real market in the catering industry in schools, hospitals, leisure/travelling industries and public establishments.

Finally, sausage manufacturing offers within the processed meat product sector

an unsurpassed new product development (NPD) opportunity. Every new food product in the market has its life cycle, and a new product development initiative is capable of constantly satisfying consumers' expectations, thereby exposing them to the enormous new product opportunities that sausage production can provide.

What are the challenges facing the sector?

There is a high level of competition within the sector, and following meat scares and recent safety issues in the meat industry many consumers seem to relate safety with premium products. To break even, some sausage manufacturers have diversified their operations to become meal component and sandwich filling plants, exposing themselves to wider competition. Some have even considered narrowing their operation to capture only a specialised market, thereby placing themselves in an advantageous position to offer premium products. These revolutionary steps have had a significant impact on the price margins of other operators who would like to tilt towards premium products. The big names seem to acquire the small names and probably achieve good margins through economies of scale.

Competitiveness in the price of sausages in the processed meat product sector is undoubtedly a natural drive towards achievement of quality. Adding quality and safety to sausages requires a systematic approach to design, development, testing and implementation at every stage of the production process. There must be an established framework of assuring customers and product users that sausages are made to their specified and regulatory standards.

To beat competition, many sausage producers increasingly recognise that identifying themselves and actually achieving certain quality standards and marks is instrumental to their sales successes. These quality identifiers are not or should not be sales flags but rather a pointer to the real process situation, since customers and product users now have available to them very objective and/or subjective tools for measuring quality and safety. It is an understatement that application of excellent food quality and safety standards is mutually beneficial to consumers and producers alike. Sausage manufacturers who apply the most robust food quality, safety and traceability standards have placed themselves in the right industry and will almost always continue to grow, expand and flourish in the meat processing sector.

One of the biggest challenges facing the sector, however, relates to labour usage and availability; and the industry continuously searches for practical and cost-effective solutions to the shortage of skilled manpower. There is a constant loss of skilled and experienced staff, probably owing to insufficient levels of motivation and remuneration. Employers, on the other hand, find it difficult to offer a structured staff training programme to staff who are not likely to stay for any length of time. It will be interesting to assess the impact of the level of skills and operational knowledge and competence of the workforce on the future potential of the sector.

Another problem the sector must face up to is the availability of a competent management team with good knowledge and experience to cope with the ongoing

expansion and increasing demand within the sector. The food industry as a whole is learning from experience on past issues and is undergoing a significant change in terms of due diligence, food and consumer safety, including traceability, requiring standards and benchmarks to be set and reinforced not just nationally but also internationally. As a consequence accurate information regarding source, origin, composition and labelling are becoming more extensive and detailed to enable traceability and possible recall. The sector requires a culture change to be able to adopt a more robust and intelligent management approach to these evolving issues and requirements. The culture change involves adapting to the constantly changing needs of the industry and should not be a matter of despondency. Good and well-structured management training of food managers would be a step in the right direction since it will take their natural abilities and experience further.

The biggest problem facing the industry is probably meat-related since meat forms a greater proportion of recipe ingredients. Any food scare that is meat-related has a direct effect on sausage manufacture and the sausage market. Producers are already familiar with episodes involving dioxin, BSE, salmonella and GMOs in livestock feed, demanding a good due diligence, traceability and quality system. The significance of a dynamic quality system that constantly evolves to recognise and possibly embrace new knowledge, development, experience and consumers' requirements and perceptions can never be over-emphasised. Producers who are flexible in their sourcing with regard to their meat suppliers' approved list will always be among the least affected. Manufacturers whose systems are also flexible enough to vary and extend product lines from the traditional breakfast type sausage to the cooked and organic range, including a wide diversity of new sausage products, may also command a good market share in the next decade.

1

Definition of sausages

It is difficult to fit sausages into one single definition since they are many and varied. Attempts, however, have been made to define sausages either by shape, type or meat content. Characteristically, sausages are comminuted processed meat products made from red meat, poultry or a combination of these with water, binders and seasoning. They are usually stuffed into a casing and may be cured, smoked or cooked. The FAO (1985) views sausages as one of the oldest forms of meat processing in which meats go through various modification processes to acquire desirable organoleptic and keeping properties.

1.1 Shape

Sausages are popularly defined as cylindrical in shape with hemispherical ends. This conventional definition by shape is becoming less popular, with greater demand for convenience leading to sausages of different shapes and sizes. As a meal component, sausages are produced sliced (sandwich sausages) or diced, skin-on or skinless, for fast food outlets, ready meal and sandwich sectors. With prime interest in presentation and customer appeal sausage making has become creative with regard to shape. Some customers may require various cuts across the length to achieve a certain shape at cooking for plate presentation. Others may like a shape that is compatible with meal/sandwich packaging to provide the desired effect.

1.2 Type

Types of sausages include UK-style fresh, cooked, fermented and emulsion sausages.

1.2.1 UK-type fresh sausages

The UK-style sausages are uncooked, coarsely comminuted products that are sold as uncooked, fresh or frozen. These are the most popular type in the UK and command the greatest share of the sausage market. Unlike fermented or emulsion sausages they are uncured and often with various degrees of chopping and meat content.

1.2.2 Cooked sausages

Some manufacturers have gone further to cook, slice or dice primarily to add safety and convenience for the fast food and ready meal sectors. This requires cooking using the oven, grill, fat or oil to deep fry the sausages after filling. Many cooking programmes require the monitoring of time and temperature to achieve a consistent quality. In this situation probes may be used to monitor the product core temperature for good results. Further extension of the process may lead some producers to slice or dice cooked sausages for different size and shape using sharp blades. The resultant products find significance as a component in sandwich and meal sectors.

1.2.3 Fermented sausages

Fermentation, which is one of the oldest methods of meat preservation, is used in making fermented sausages. Fermented sausages are characterised by their relatively longer shelf life, which is brought about by production of lactic acid in the fermentation process.

Fermented sausages are classified into dry and semi-dry:

1 Dry
   - Salami
   - Pepperoni
   - Genoa
2 Semi-dry
   - Summer sausage or cervelat
   - Lebanon bologna

The production utilises curing ingredients, spices and relatively large numbers of cultured micro-organisms (starter culture) in a fermentation process. Products come out at the end of the process as cured dried product. Traditionally, fermented sausages are made using acid bacteria naturally present in the meat or with the inoculation of the new batch with an old batch. The introduction of microflora occurs at the chopping point; the mix is filled in casings and left to ferment and then dried. Some processes allow drying before cooking. The development of the pathogenic bacteria is inhibited by the acid produced by the fermentation. The low pH and the dry nature of the product are primarily responsible for the long keeping quality. Fermented sausages have a relatively higher meat content and take a

longer time to prepare owing to the series of required drying processes, which may take up to seven weeks. Semi-dry sausages are smoked, cooked and finished off as dried.

1.2.4 Emulsion sausages

Emulsion sausages are much more finely comminuted compared with UK-style sausages. They are cooked and/or smoked sausages and largely continental. Examples include bologna, kochwurst, bruhwurst, frankfurters and liver sausage. The frankfurter process takes advantage of the natural ability of the meat to absorb and retain water without the use of rusk or other cereal binders. A large number of frankfurters finish off as an oven-cooked product with a variety of colours, sizes and flavours. The characteristic smoke flavour is achieved by adding natural or liquid smoke to the process, while the colour could be obtained by dipping in a vat of the appropriate colour. Successfully achieving these characteristics would warrant the peeling of the skin. Although produced in the UK they are still mostly imported as cooked sausage into the UK.

1.3 Varieties of sausage

Many different varieties of sausage are available including: Lincolnshire, wild boar, venison, pork, pork/leek, lamb/mint, pork/beef, lamb/rosemary, spicy lamb, Chinese, sausage nuggets, Irish, Wiltshire, Cumberland rings, catering sausage, Halal chicken sausage, gourmet sausage, chipolata, low fat, Irish, low salt, Cajun, apricot, lemon juice/tarragon seasoned chicken, chicken frankfurter, pork/ale, pork frankfurter, Toulouse, saveloy, cranberry, Stilton, low fat, beechwood smoked bacon sausage and highland.

These sausages could be made to the quality range of premium, middle of the range or cheaper/economy and are available at retail outlets such as supermarkets, groceries and butchers' shops. They could be fried, grilled or browned for eating and served with a range of accompaniments such as salad, mashed potato, chips, hot dog rolls, ketchup and mustard spread, at catering outlets such as leisure centres, educational settings, healthcare facilities, airlines, hotels, restaurants, sports complexes and other public establishments.

In addition to the accompaniments, sausages have found a place in many dishes such as goulash, soup, toad in the hole, bangers and mash, curry-wurst, omelette and hot pot.

1.4 Meat content

The British Meat Products and Spreadable Fish Product Regulations of 1984 define sausage by meat content as indicated below. The term sausage is used to include chipolata, frankfurter, link, salami, sausage meat and any similar product:

- Sausages
  Sausages in general are allowed 50 % minimum meat content of which at least 50 % lean content is required.
- Beef sausage
  Beef sausages are allowed 50 % minimum meat content of which at least 50 % lean and 50 % minimum beef content are required.
- Pork sausage
  Pork sausages must have 65 % minimum meat content of which at least 50 % lean and 80 % pork are allowed.
- Pork/beef sausage
  Pork/beef sausages are allowed 50 % minimum meat content of which at least 50 % should be lean and 80 % pork and beef.

With the emergence of the new meat regulations intended to harmonise meat definition in the EU the above reserved descriptions will give way to new meat regulations enforceable from 1 July 2003. Details on the new meat regulation are given in chapter 3 dealing with formulations.

2

Sausage market trends

Statistics over recent years demonstrate the success story of sausage production and put the sector's operation in proper perspective. Such data act as a pointer for investors, people with a general interest in the sector and, more importantly, those whose decisions can have an impact on sausage manufacturing and consumption in the UK. Despite the spate of meat safety issues within Europe, sausage consumption in the UK is still as popular as ever.

Estimates from the Meat and Livestock Commission (MLC) show the total volume of UK retail sausage in 1992 as 138 223 tonnes, of which pork/beef had a 45.1 % market share (Table 2.1). In 1998 an estimated 187 000 tonnes of pork and beef sausages were consumed (Table 2.3). Estimated household expenditure on uncooked pork sausage rose from £289 million in 1993 to £392 million in 1998, representing a 26 % increase in a five-year period (Table 2.2). Figures show a reversal of the trend in household expenditure on beef sausage over the same period, with a drop of over 40 %. In fact, household consumption of beef sausage saw a decline of about 36 % (Table 2.3) between 1995 and 1997. The drop in beef sausage popularity has probably brought about the tilt in favour of the pork sausage dominance of the market.

Interestingly, overall estimated household consumption has not been in any way affected negatively by this reversal in beef sausage consumption. In fact, the total estimated household consumption figure for uncooked pork and beef sausages (Table 2.3) in 1993 was 184 000 tonnes, whereas in 1998 the figure had increased to 187 000 tonnes. Looking at figures generally, sausage production seems to offer a good and steady prospect in the processed meat market in the UK. What is even more positive is the as yet unexhausted new product opportunities within the sector, which can add more excitement and eating satisfaction to the product. Understandably, household consumption and expenditure on sausages indicate the

Table 2.1 1992 share of retail sales by recipe type

	Tonnes	%
Pork	56 931	41.2
Pork/beef	62 316	45.1
Beef	8 064	5.8
Other	10 912	7.9
Total	138 223	100.0

Source: adapted from AGB as published by MLC, *Meat Demand Trends* (1993).

Table 2.2 Estimated household expenditure on sausages

	1993	1994	1995	1996	1997	1998
			£ millions			
Pork sausages (uncooked)	289	283	307	389	418	392
Beef sausages (uncooked)	146	141	141	114	99	87
Sausage rolls, ready to eat	43	55	59	71	66	72

Source: adapted from MLC National Foods Survey Data, *Meat Demand Trends*, December 2000.

Table 2.3 Estimated household consumption of sausages

	1993	1994	1995	1996	1997	1998
			Thousand tonnes			
Pork sausages (uncooked)	112	111	121	146	152	146
Beef sausages (uncooked)	72	75	70	50	45	41
Sausage rolls, ready to eat	14	19	19	23	22	24

Source: MLC, based on National Food Survey Data, *Meat Demand Trends*, December 2000.

primary endorsement of the product as an essential food component for families and individuals alike.

British sausages have moved on from just being a major breakfast type food to a meal component eaten by many as lunch and dinner. New sausage products have offered a revolution in terms of a wide variety of colour, size, texture and appearance, which suit the ready meal market and add further value to sausages. Cooked sausages provide the desired level of convenience needed by the busy working population of consumers.

Prices of best pork sausage are fairly steady in England and Wales (Table 2.4), indicating an insignificant level of price change between November 1999 and November 2000. An interesting trend is shown in Table 2.5 of about a 5 % change in 1999 over the previous year's figure for sausages as a whole and about 9 % for

Table 2.4 Retail prices of sausages in England and Wales

	1999 Nov	Dec	2000 Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	% change Nov 00/99
	Pence per kg													
Sausages														
Best pork	367	369	367	372	373	368	363	365	369	369	369	369	370	–0.8

Source: MLC, *Meat Demand Trends*, December 2000.

Table 2.5 Changes in household purchases (by value) of sausages

	1996	1997	1998	1999
	Percentage change on same period a year ago			
Sausages	–9.9	+4.3	–5.1	+4.9
Of which:				
Beef	–39.1	–9.8	–13.2	+1.6
Pork	–33.7	+9.2	–0.1	+8.9

Source: Taylor Nelson Sofres, as published by MLC in *Meat Demand Trends*, December 2000.

Table 2.6 Profile of household purchases (by volume) of sausages

	1996	1997	1998	1999	2000
			Per cent		
Sausages	100.0	100.0	100.0	100.0	100.0
Of which:					
Beef	1.7	1.5	1.3	1.3	1.2
Pork	69.1	72.1	73.3	77.0	77.4

Source: Taylor Nelson Sofres, as published by MLC in *Meat Demand Trends*, December 2000.

pork sausages. Household purchases of pork sausages increased between 1996 and 2000 while those of beef sausages declined (Table 2.6). Sales of pork sausages and sausage rolls steadily increased between 1988 and 1998 while beef sausage sales showed a downward trend (Table 2.7).

There is an inverse relationship in consumers' expenditure on pork and beef sausages over ten years (Table 2.8). While the expenditure on pork sausages more than doubled in ten years it reduced more than twofold on beef sausages. Interestingly, consumers' expenditure on sausage rolls more than doubled between 1988 and 1998; and over 67 % of this increase is represented by the second half of the decade.

Table 2.7 Trends in retail consumption

	1988	1993	1998
		Thousand tonnes, product weight	
Pork sausages	96	112	146
Beef sausages	113	72	41
Sausage rolls	11	14	24

Source: MLC National Foods Survey Data, *Meat Demand Trends*, National, December 2000.

Table 2.8 Trends in retail expenditure on sausages

	1988	1993	1998
		Thousand tonnes, product weight	
Pork sausages	96	112	146
Beef sausages	113	72	41
Sausage rolls	11	14	24

Source: MLC National Foods Survey Data, *Meat Demand Trends*, National, December 2000.

Table 2.9 Loose and packed purchases of sausages

	Purchases		Expenditure	
	1995	1998	1995	1998
	Per cent		Per cent	
Loose	20.5	15.8	23.7	18.4
Pre-packed	79.5	84.2	76.3	81.6
Total	100.0	100.0	100.0	100.0

Source: Taylor Nelson Sofres, as published by MLC in *Meat Demand Trends*, December 2000.

Data (Table 2.9) indicate that pre-packed sausages command an 84.2 % share of the market, while there is a decline in purchase of loose sausages. Supermarkets with pre-packed sausages seem to be having an increasing advantage over the butcher's shop. Supermarkets offer an increased shopping opportunity for many for socio-economic reasons, thereby putting a lot of pressure on the butcher's outlet.

Food safety issues within the meat industry have also influenced consumers' shopping pattern for sausages, resulting in an unprecedented drift towards a premium range of sausage products. What is important to note, however, is that pre-packed sausages allow for an availability of labelling and product information, offering consumers a wide range of choice based on the information available to

them. With the labelling requirements of the origin of meat, coupled with the current demand for nutritional information and declaration of ingredients, pre-packed sausages have a great potential to satisfy consumers' ongoing expectations.

There is still a scarcity of data on specialised range of sausages, making it difficult to estimate the likely future direction of these products within the UK market. It will be interesting to see new data in the next few years regarding specific market shares of, for instance, cooked, sliced, vegetarian and organic sausages. With new figures emerging on a variety of different types of new sausage products there is bound to be a shift, however insignificant, in the popularity of pork sausages in the UK processed meat market.

3

Product formulation

3.1 Recipe information

Sausage manufacture requires an assemblage of various ingredients in the right proportion to produce not just a desired quality and safe product but also a cost-effective one. To achieve this all the necessary ingredients have to be quantified to enable costing and establish a basis for the consistency of the product. The key tool for achieving these is recipe formulation. In formulating a recipe a number of important considerations must be made with regard to:

1 limits and compositional standards allowed by the meat product regulations (it is important to note that the minimum legal requirement allows a wide flexibility in formulation to achieve a quality product; certain parts of the regulation provide a framework for unambiguous labelling of products)
2 type, quantity and relative proportion of meat required by the customer
3 price per unit of product
4 type, quantity and relative amount of wet and dry components.

Ultimately, recipes should be formulated to satisfy a variety of purposes, including:

1 legal/regulatory requirements
2 information for costing
3 quality control
4 consistent product standards.

Changes in recipe, while being a common practice, should have a reliable system of control. This should be issued to the operators with production programmes and withdrawn at the end of the production or shift. Recipes should contain, among other information:

1 the recipe number and/or customer name
2 issue date
3 name and signature of the issuer
4 batch weight/size
5 meat content
6 name and relative weight of the ingredients
7 product name.

For the purpose of confidentiality, some manufacturers prefer to exclude the 'cost' aspect from the recipe issued to the operators. Recipes can be encapsulated and kept in a laminate form to ensure durability and ease of cleaning after use by the operators. It is possible for recipes to go mouldy owing to dampness. It probably will require the QA checklist to withdraw a recipe when this occurs for reissue.

A production system that allows issue of the recipe with the daily production programme may find it beneficial to include the following information (as a minimum) in the production programme:

1 customer name
2 product name
3 recipe number
4 sausage target weight/dimension
5 number of batches required
6 casing type and size
7 batch code
8 date/document reference number
9 name and signature of the issuer.

The rest of this chapter includes recipe information for a skinless frankfurter and a premium pork sausage, together with methods for calculating meat content. The text has been laid out to ensure that particular recipe information and methods of calculation are kept on the same page to make them easier to follow. This layout means that there will be gaps between some sections.

3.2 Recipe information for a skinless frankfurter

Raw materials	% composition	Weight (kg)
Pork trimmings 80 vl	61.6	154.0
Back fat	13.4	33.5
Rind (35 % fat)	7.0	17.5
Water	11.0	27.5
Gelbind *containing* wheat starch wheat protein salt	2.05	5.1
Seasoning mix *containing* salt dextrose sucrose vitamin E antioxidant (E300) natural spices flavour enhancer (E621)	2.25	5.6
Farina	1.20	3.0
Cure *containing* salt sodium nitrite sodium nitrate	1.20	3.0
Liquid smoke	0.20	0.5
Tomato powder	0.10	0.3
Colours *containing* E120, E150c	Trace	Trace
Total	100.00	250.0

Colour treatment may require a mix of colours and water at an acceptable ratio.

Ingredients list for frankfurter

Until July 2003 the ingredients list for the above recipe is arranged as follows:

> Pork (82 %), water, salt, farina, wheat starch, wheat protein, dextrose, sucrose, vitamin E, antioxidant (E300), spices, sodium nitrite, sodium nitrate, smoke flavour, tomato powder, flavour enhancer (E621), colours (E120, E150c).

Following the New Meat Regulations 2003 the following declarations apply:

Pork (71 %), water, pork fat, pork rind, salt, farina, wheat starch, wheat protein, dextrose, sucrose, vitamin E, antioxidant (E300), spices, sodium nitrite, sodium nitrate, smoke flavour, tomato powder, flavour enhancer (E621), colours (E120, E150c).

It is important that the ingredients declaration is arranged in descending order based on quantity as required by the regulations.

3.3 Recipe information for premium pork sausage

Raw materials	% composition	Weight (kg)
Pork trimmings 80 vl	58.0	145.0
Back fat	10.0	25.0
Rind (35 % fat)	7.0	17.5
Water	10.2	25.5
Rusk	8.2	20.5
Farina	3.8	9.5
Seasoning mix *containing*	2.5	6.3
salt		
wheatflour		
stabiliser (E451)		
ground spices		
flavouring		
vitamin E		
antioxidant (E300)		
Tomato powder	0.3	0.7
Rapeseed oil	Trace	Trace
Total	100.0	250.0

Ingredients list for pork sausage

Prior to the enforcement of the new meat regulations the ingredients list for the above recipe would have been:

> Pork (75 %), water, rusk, farina, salt, wheatflour, stabiliser (E451), tomato powder, spices, natural flavouring, vitamin E, antioxidant (E300), rapeseed oil.

For the ingredients list based on the new meat regulations refer to page 25.

Dextrose may be included to darken the cooked product colour as desired. Browning could be improved by prolonging the time between filling and cooking.

Mechanically recovered meat (MRM) is well known in sausage manufacturing and substantially used in formulation of a wide range of sausages, especially the economy type products.

3.4 New meat regulation

The EU Directive enforceable in July 2003 gives a new definition of meat for the purpose of harmonisation of the definition of meat among member states and for the quantitative ingredients declaration for labelling.

The current proposal excludes ingredients from mechanical separation of meat that remains on bone following boning for the purpose of breaking down the cellular structure of the meat.

It also excludes skeletal muscles of mammalian and bird species with total fat and connective tissue content exceeding the stipulated limits.

The successful implementation and establishment of a defence in relation to the directive, in force from July 2003, will require beforehand a definitive quantifiable chemical technique to distinguish meat from offal and MRM in a multiple meat product, and also control parameters for the management of fat and collagen levels in sausage formulation.

The new EU meat definition allows for a maximum fat content of 30 % for pork, 25 % for the rest of mammals and 15 % for birds and rabbits, with a maximum connective tissue content of 25 % for the rest of mammals and 10 % for birds and rabbits.

Owing to the restriction on levels of fat and connective tissue, the excess resulting from both will need to be declared. Removal of offals such as liver, kidney and MRM in meat content calculations will change the meat contents of many of the existing products utilising those components, thereby allowing for a reformulation. The real implications of this change in the UK sausage formulation are that:

- declared meat contents will reduce. For instance, the current 65 % typical pork recipe will reduce to 42 % meat and typical pork/beef from 50 % to 32 %
- owing to their varying compositions in terms of fat and connective tissue levels and associated restrictions, availability of meat cuts for recipe formulation will be reduced.
- restrictions will apply to cuts with high levels of fat and connective tissue, unless they were separately declared.

To evaluate the levels of connective tissue in sausage formulation the British Meat Manufacturers' Association (BMMA) has issued a guideline (P006) standard for acceptable levels of pork rind and other collagenous material in meat products. This is a useful practical tool in calculating collagen/protein ratios of different cuts of meat. To assist members to comply with the new EU meat definition the BMMA has undertaken a joint venture with Lawlabs to simplify the relevant calculations and provide detailed information to facilitate recipes and meat content evaluation.

The two recipes on pages 17 and 19 utilise multiple pork components at different proportions, as is the norm in sausage manufacture, to achieve the specified percentages. As a practice the knowledge of the correct visual lean (vl) of each of the relevant meat components is crucial to enable meat content calculations.

A sausage manufacturer may find that most of his or her recipes in the light of

the new meat regulation will carry a lower meat content than allowed by the meat and spreadable fish regulation, simply because the levels of fat and collagen have become restrictive, 25 % and 30 % being the maximum for connective tissue and fat respectively for pork sausages; the figures are even lower for other species. Most producers will be faced with two options:

- removal of the excess fat and collagen from the recipe (reformulation) or
- declaration of both in the list of ingredients (relabelling).

The calculations to follow, which are based on the premium pork recipe on page 19, use the format and formulae provided in the draft guidelines on labelling and declaration of meat content in meat products – the Meat Products Regulations 2003 from the Foods Standards Agency (FSA). Typical values for protein, fat and connective tissues used in all calculations below are also based on the data published by the FSA in the same document.

3.5 Meat content calculations: fat-free meat

(*N.B. These calculations are based on the premium pork recipe on page 19.)*

	kg	Fat (kg)	Fat-free meat (kg)
Lean trimmings 80 vl	145.0	39.7	105.3
Fat	25.0	19.6	5.4
Rind	17.5	6.1	11.4
Total meat ingredients	**187.5**	**65.4**	**122.1**
Water	25.5		
Rusk	20.5		
Farina	9.5		
Seasoning	6.3		
Tomato powder	0.7		
Total	250 kg		

Fat-free meat = total meat – total fat

= 187.5 – 65.4 = 122.1 kg.

3.6 Meat content calculations: connective tissue

$$\textbf{\%tage connective tissue} = \frac{\text{total collagen in meat ingredient}}{\text{total protein in meat ingredient}}$$

	Collagen (%)*	Collagen in recipe (kg)	Meat protein (%)*	Protein in recipe (kg)	Connective tissue (CT) (%)
Trim	3.4	4.9	17.0	24.6	
Fat	3.7	0.9	5.1	1.3	
Rind	13.20	2.5	22.0	3.8	
		8.3		29.7	27.9

(* Typical levels as published by FSA, 2002.)

$$\textbf{Total connective tissue} = \text{\%tage connective tissue} \times \text{fat-free meat}$$

$$= \frac{27.9}{100} \times 122.1 = 34.1 \text{ kg.}$$

$$\textbf{Fat-free, connective tissue-free meat} = \text{Fat-free meat} - \text{total connective tissue}$$

$$= 122.1 - 34.1 = 88.0 \text{ kg.}$$

To include allowed CT:

$$\text{Fat-free, connective tissue-free meat} \times \frac{100}{(100 - \text{limit for CT})}$$

$$= \text{fat free meat with CT allowance}$$

$$= 88 \times \frac{100}{74} = 118.9 \text{ kg.}$$

$$\textbf{Excess CT} = \text{Fat-free meat} - \text{fat-free meat with CT allowance}$$

$$122.1 - 117.3 = 4.8 \text{ kg.}$$

$$\textbf{\%tage excess CT} = \frac{\text{Excess CT}}{\text{total weight of product}} \times 100$$

$$= \frac{4.8}{250} \times 100 = 1.9\ \%.$$

3.7 Meat content calculations: allowed meat

To determine excess fat (*limit 30 % for pork*):

$$\textbf{\%tage of fat present} = \frac{\text{total fat}}{\text{total meat} - \text{excess CT}} \times 100$$

$$= \left(\frac{65.4}{(187.5 - 4.8)}\right) \times 100 = 35.8\ \%.$$

To include allowed fat and determine allowed meat:

$$\textbf{Allowed meat} = \text{Fat-free meat with CT allowance} \times \frac{100}{100 - \text{limit of fat}}$$

$$= 117.3 \times \frac{100}{70} = 167.6 \text{ kg.}$$

$$\textbf{Quantity of excess fat} = \text{total fat} - (\text{allowed meat} - \text{fat-free meat with CT allowance})$$

$$= 65.4 - (167.6 - 117.3) = 15.1 \text{ kg.}$$

$$\textbf{\%tage excess fat} = \frac{\text{excess fat}}{\text{total weight of product}} \times 100$$

$$= \frac{15.1}{250} \times 100 = 6.04\ \%.$$

$$\textbf{Allowed meat} = \text{fat-free meat with CT allowance} + \text{total fat}$$

$$\textbf{QUID requirement} = \frac{\text{allowed meat}}{\text{total weight of product}} \times 100$$

$$= \frac{167.6}{250} \times 100 = 67\ \%.$$

where QUID = Quantitative Ingredient Declaration.

3.8 Using meat content calculations

Ingredient list

> Pork (67 %), water, rusk, pork fat, farina, pork rind, salt, wheatflour, stabiliser (triphosphate), tomato powder, spices, natural flavourings, vitamin E, antioxidant (E300), rapeseed oil.

Owing to the presence of excess fat (6 %) and excess CT (1.9 %) in the above recipe, which do not count toward the meat content, the 75 % meat content has been reduced to 67 % leading to a relabelling of the product.

Using the same format to calculate the meat content in the skinless frankfurter recipe on page 17 a total meat content of 71 % with excess fat (8.4 %) and excess CT (2.1 %) have been achieved instead of the original 82 %, also requiring a relabelling.

A producer who had acquired a massive stock of pre-printed labels might be compelled by environmental concerns and cost factors to reformulate the skinless frankfurter using 90 vl instead of the original 80 vl, to achieve 82 % meat without any need of relabelling. Apart from the risk of losing the original product characteristics the decision to reformulate to maintain such a high meat content poses the risk of product relocation from its market position in a long run.

Defining meat as muscle meat and placing analytical limits on fat and collagen is not new to a country such as Germany where the system already recognised these limits. Complying with this new definition is certainly not without a cost to UK producers as well as those of other European countries that may be affected by the new requirements. The obvious long-term benefit to the stakeholder is however increased competitiveness with other European producers.

3.9 Functional ingredients/additives in sausage manufacturing

3.9.1 Wet, semi-dry and dry ingredients

Sausages can be made with a wide variety of wet, semi-dry and dry ingredients. Meat ingredients among others would include pork cutting fat, pork shoulder trim, pork back fat, liver, venison, rind, mechanically recovered chicken or turkey meat.

A large number of ingredients can be combined together in varying proportions as required to form seasoning mix. Such ingredients include dextrose, salt, herbs, sugar, spices, preservatives, onions, leek pieces, flavour enhancers, antioxidants, stabilisers, hydrolysed vegetable protein, yeast extract, parsley, pepper and flavourings (natural, nature identical or artificial).

Various dry ingredients such as rusk, gelbind, potato starch, wheat flour, farina, cornflour, soya and rice have been used as binders.

Different flavours, and probably texture, can be derived from the addition of tomato, egg, milk powder, milk protein, apricot, strawberry, beer, stilton cheese, and even a variety of meat extenders and analogues.

Protein products derived from vegetable sources such as soya beans have been used as meat extenders and analogues. Meat analogues, replacers or extenders have great potential in vegetarian sausage options.

3.9.2 Antioxidants

Ascorbic acid (E300) is among the most used antioxidants in sausage production. The purpose is to prolong the product's shelf life by preventing fat rancidity and colour change that is caused by exposure to oxygen in the air.

3.9.3 Preservatives

Preservatives are used in a very small quantity to keep food safe for longer by preventing the growth of microbes that cause spoilage and food poisoning. Sausages made without preservatives would have a very short shelf life. Some preservatives are used to give and keep the colour of the product. Among the most commonly used are E221 and E223. See a list of other preservatives in Appendix 1.

3.9.4 Flavour enhancers

Flavour enhancer reinforces the flavour inherent in the product by its effect on the taste buds. Monosodium glutamate (E621) is among the most used in sausage manufacture. Following consumer concerns the use of E621 has decreased in popularity.

3.9.5 Flavourings, spice and herb extracts

Advances in product development have led to the use of various herbs and spice

extracts to enhance flavour or as flavourings in sausage manufacture. Sage, parsley, coriander, paprika, rosemary, nutmeg, leek, apricot, cranberry, tomato, stilton, onions and mint are among the ingredients used as flavourings, spices and herbs in sausages. These are packed either separately or as a seasoning mix in the correct proportion to go into the batch at mixing point. Sausage making has undergone an evolution in terms of diversity in natural ingredients and extracts preferred by customers, which in turn drives new product development. This interest is inseparable from consumers' interest in cutting down on the E-numbered ingredients that go into foods in modern times.

3.9.6 Salt

The ability of salt to enhance the flavour, preservation, water absorption, protein solubilisation and retention capability of the meat has been well utilised in sausage making. Salt is added as NaCl at the rate of about 0.5 % either directly or as part of the seasoning mix that can be batch packed. It is important to take into consideration at recipe formulation point that the level of sodium in the final product will be greatly influenced by salt added directly at the mixing point and that from other ingredients such as rusk, gelbind, cure compound and seasoning mix. If a low salt/low sodium product is required it would be reasonable to work out initially how much salt goes into other compound ingredients before deciding on the quantity of added salt. Some customers prefer the low salt option while requesting a new product formulation, and there is constant expansion of the product line towards this direction. This will call for a great deal of adjustment of other additives to achieve a desired functionality with less salt.

3.9.7 Emulsifiers-stabilisers

Emulsifiers–stabilisers enhance the intimate holding of oil, fat and water as a mix. The most commonly used stabilisers in sausage making include diphosphates (E450) and triphosphates (E451). The phosphates promote the functionality of salt and antioxidants in sausage making.

3.9.8 Non-meat binders

Exudate formation may not always be easy to achieve in recipes which are high in fat and low in lean meat content. What is easy to achieve though through such recipes is the inclusion of other non-meat ingredients capable of setting at heat to produce or enhance binding ingredients for a sausage producer. These include milk powder, soya protein isolate, egg white, starches and whey powder. Of course, good recommended functional levels of inclusions of these binders are required since they do not count towards the recipe meat content.

4

Production stages

4.1 Raw material procurement

Sausage is a food product resulting from the assemblage of proper ingredients in the right proportion coupled with a structured design and controlled process (see Fig. 4.1). The quality of the product, therefore, will almost always be a reflection of the status of the raw materials and the process. If the process has been carefully designed, developed, approved, implemented and monitored, then the raw materials have to be up to standard to achieve the expected level of quality. It is a well-known fact in sausage production that a good quality sausage is made from a good quality meat. Hence, every raw material for sausage making should measure up to requirements for quality, functionality and a wide range of specified criteria.

To achieve quality the raw material source has to be verified and approved. Approval is, or should be, based on the capability to supply the needed material on time and up to expected standard. A system of approval of suppliers that relies on their satisfaction of these specified criteria should exist. Some producers use a pre-audit questionnaire for meat (see Appendix 2) and animal welfare information to assess initial suitability of potential suppliers.

Once approved, the supplier becomes a part of the approved suppliers' list. Record of performance and a reaudit will in the majority of cases establish the level of reliability to consistently supply a quality material. As a matter of good manufacturing practice, raw material procurement should be restricted to approved sources only.

Every raw material should have a specification. Specification should give details of all important criteria for the raw material and service that affect the quality of the product. It should define all physical, chemical and microbiological requirements including agreed tolerances and critical and process control checks

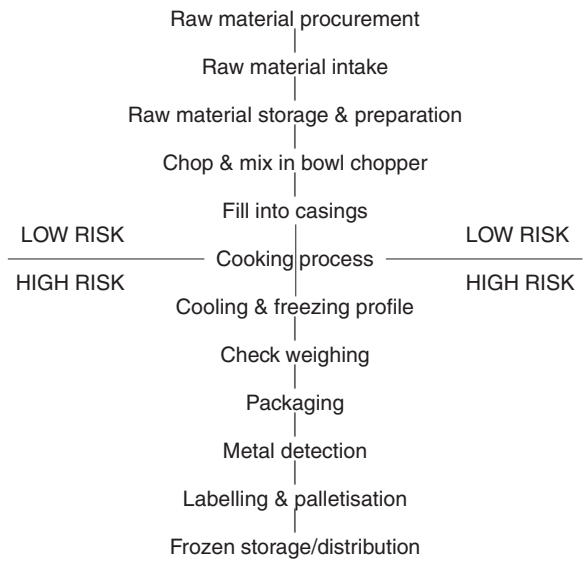


Fig. 4.1 Production and packaging process for deep fried sausages.

as a minimum. Suppliers should be made aware of all the necessary checks that will be carried out at goods intake, including parameters and their limits. It is always recommended that all the parties should sign off every specification. Specification could be as extensive as each of the parties require. The majority of the meat specifications seen by the author require random immunological assay to confirm that the meat is solely of the species required. Visual lean and fat contents are among the most important required information on a meat specification. It is a requirement now that the origin of the meat becomes a part of the labelling information.

With recurrent food scares involving meat of various origins, it is also recommended that the management adopts a robust meat raw material source and approval system that is highly flexible and varied as a back-up.

Water source and quality are very important. They should be monitored and should comply with the regulations.

4.2 Raw material intake

Raw material intake is a critical control point in sausage production since it acts as a barrier or filtration stage preventing goods of inferior quality entering the process. The goods intake operator needs specific training to do the job efficiently. Such training should include parameters to check for in every sausage raw material received and a follow-up action in case of non-conformance. There should be a procedure in place to ensure that the materials received are up to specification.

Some producers, while accepting meat on positive release, also pick up samples randomly at delivery for microbiological analysis.

All records regarding traceability should be transferred on to the in-house intake record (see Appendices 3, 4 and 5) and rotation code assigned to every pallet or unit pack as the case may be. Signs of damage, infestation, temperature and the hygiene condition of the vehicle should be checked before offloading a delivery. All the specified parameters (e.g. visual, analytical, physical or organoleptic) should be checked at the point to ensure compliance. Results of the checks should be attached on the goods intake record for the particular material.

The following parameters may be included on the meat inspection checklist as a basis for rejection:

1 presence of hide, hairs, bone, gristle, inspection dye mark, sinew, glands, high connective tissue and blood clots
2 presence of bruises, discoloured fat and lean, Pale, Soft Exudative or PSE, Dry, Firm, Dark or DFD, taints, off odour and rancidity
3 extraneous foreign body and polythene entrapment
4 wrong cut, visual lean, freezer burn and free water.

4.3 Raw material storage and preparation

Storage and preparation is the area where good housekeeping skills and manufacturing practice come in handy. Meat storage temperature and conditions should be specified, since it is often received in frozen blocks at –18 ºC to –22 ºC. Meat is often stored in chillers over-night for tempering to achieve –5 ºC. To avoid species cross-contamination, areas in the tempering room should be designated and marked for different species of meat.

In storage rooms pallets should be stacked a few inches away from the wall to permit easy access for pest control and cleaning purposes. Dry goods, meat and packaging should be stored separately to avoid contact and cross-contamination. All packaging materials should be removed before materials are transferred to the preparation area. Traceability codes should also be transferred to process forms. Some producers find it convenient to batch pack their seasoning to be added at the mixing point. If this occurs materials released should be controlled. Some practices use a mincing, pre-breaking or flaking machine to increase the surface area of the meat before chopping. Others use a bandsaw to cut blocks of meat before transfer to the chopping stage. In any case:

- Ingredients should be properly measured according to approved weights on recipe.
- Procedure to avoid species cross-blending should be followed. A well-planned production programme will specify which meat species should be on top of the list and which to follow. For instance, pork sausage to be followed by pork with chicken MRM sausage without a need to clean out the machines on account of cross-blending whereas machine cleaning and positive release will be recommended otherwise.

After de-boxing and sawing, the meat is weighed and assembled into stainless steel containers (totebins). The ice/water is weighed into a designated container. Some bowl choppers can automatically meter out water into the mix. Seasonings if not batch packed should be weighed out into appropriate containers waiting to go into the mix.

4.4 Bowl chopping

Bowl chopping is one of the key processes in sausage production (see Fig. 4.2). A set of blades is fixed to a slowly rotating bowl that progressively comminutes meat and reduces it to a fine paste-like consistency. It is at the bowl chopping stage that other raw materials are mixed simultaneously with comminuting. Size reduction of ingredients takes place as sharpened blades typically rotate at about 1000 rpm. This production stage is critical as the quality and consistency of products can vary tremendously with the level of chopping.

The mechanical and massaging actions produced on the meat mass by the rotating blades during bowl cutting and mixing, especially in the presence of salt, are capable of:

- creating a larger surface area of the meat ingredients and enhancing the penetration, mixing and interaction with functional ingredients such as salt, phosphates and seasoning.
- generating a satisfactory chopping temperature within the regions of –1 °C to 22 °C; achieving the desired temperature will depend more or less on the length of chopping time. Coarse textured sausages are the least chopped and are sometimes minced and mixed, whereas finer textured sausages are chopped for longer, followed by emulsion sausage such as frankfurter which can easily ‘snap’ as a result of an almost total lack of fibrous tissues.
- forming exudates exacerbated by salt dispersion and interaction with the lean meat. Exudate is a term often used to refer to a solution of salt and salt soluble proteins arising from the protein solubilisation and extraction process. Such proteins include myofibrilla and sarcoplasm. Differences in meat types and even in species may cause large variations in the magnitude of exudate formed. While pork may be prone to large exudate formation it is known that mutton produces less, given the same set of processing conditions. Exudate formation in sausages destined for slicing requires an excellent level of control to achieve not just a sufficient level of binding but also a good post-cook texture for ease of slicing and the ultimate integrity of the sliced portions.

  Exudates formation enable the binding action of the lean meat with water, free fat and the entire product together resulting in water and fat retention, reduced shrinkage at cooking and increase in cook yield including the cohesiveness of the final product.

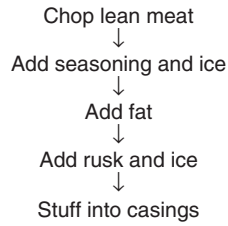


Fig. 4.2 Process steps and material flow at bowl chopping.

4.4.1 Physico-chemical changes at bowl chopping

At bowl chopping a number of physical and chemical changes take place among which comminution and size reduction are paramount. The physical and chemical nature of comminuted products is explained in great detail by Varnam & Sutherland (1995). Comminution is a term widely used in the food industry as well as in sausage making to mean use of force to bring about size reduction in solid form. Homogenisation or emulsification are used interchangeably when liquid is concerned. Fellows (2000), while mentioning that size reduction and emulsification have little or no preservative effect, indicated that they are used to improve the eating quality or suitability of food for further processing and to increase the range of products available. He further mentioned the benefit of size reduction to include the increase in the surface area-to-volume ratio of the food that increases the rate of drying, heating or cooling and improves the efficiency and rate of extraction of soluble components.

In sausage making, comminution occurs at the bowl chopping/mincing stage while size enlargement takes place at filling/portioning stage. Comminution in sausage making, according to Acton *et al.* (1982), is conducted with meat in the presence of a salt concentration sufficient to give an ionic strength to induce swelling, water binding and partial extraction of the myofibrillar protein component. The objective of the total sequence of reactions caused by comminution as highlighted by these authors is low moisture loss and shrinkage and no fat coalescence into lakes or loss through rendering. The protein functionality of comminuted product is derived from salt extractability of the myofibrillar component of the meat.

Extensive research has been done in the past to indicate the relationship between comminution temperature and thermal stability of the products. Research findings have varied tremendously as to which comminution temperature is acceptable in achieving optimal stability. What is certain, though, is that high cooking losses occur as a consequence of emulsion breakdown/fat melting caused by increased comminution temperature. Emulsion breakdown at temperatures above 18 ºC and dramatic cooking losses at temperatures above 20 ºC are common knowledge. Some researchers have confirmed achievement of optimal stability of emulsion at comminution temperature below 18 ºC. Townsend *et al.* (1971) found

that at chopping temperatures of 18.9 ºC and 29.5 ºC cooking losses of 11.1 % and 40.7 % respectively were recorded; while Brown & Ledward (1987) recorded 6.5 % and 18 % losses at similar temperatures.

However, Brown & Ledward (1987) mentioned that emulsion stability is not entirely and completely governed by comminuted temperature since other interrelated factors are involved. Their report included the following factors:

1 type of fat
2 severity of comminution
3 fat : protein : water ratios
4 degree of protein denaturation
5 fat and water binding capacities of the ingredients
6 ratio of myofibrillar to collagenous proteins in the mix.

4.4.2 Process steps and raw materials at mixing and bowl chopping

Care should be taken with regard to the order in which ingredients are added at the bowl chopping stage. Frankfurters are very finely comminuted cured products with much of the fat in free form, leaving the mixture bound in a stable form. If frankfurters are made, lean meat or mechanically recovered chicken and seasoning are added at a slow speed and then cure compound and liquid smoke. Ice is then added and chopped to about 8 ºC before pork fat is added and chopped to about 14 ºC–15 ºC. The mix is then offloaded into stainless steel totebins to wait for filling.

Lean meat

Lean meat is chopped first before adding the seasoning and the ice. The salt in seasoning extracts myofibrillar proteins enhancing binding and emulsification. The mechanical action on lean meat and salt imparts the binding properties to the product, leading to low fat and water losses and low shrinkage at cooking. The degree of chopping is equally critical. There is a relationship between fat and water losses and the splitting of sausage casings on cooking.

Ice/water

Product temperature at chopping can rise quite rapidly, and the addition of ice or iced water is to avoid the temperature rising too quickly. The protein is also further solubilised by water in the recipe. However, excess addition of ice could be detrimental to quality, since some may remain unmelted at the end of chopping, leading to:

- damage to fatty tissue resulting in increased fat losses
- poor binding properties of the emulsion and uneven level of salt distribution in the final product.

Addition of fat

There is a link between fat and flavour of the final product, since different types of fat impart varying attributes. Pork back fat is known to have a higher melting point than pork flair fat, while beef fat is firmer in texture and lamb fat gives unpalatable flavour especially when cold. Addition of fat occurs much later to keep the chopping time to a minimum and reduce the degree of cell wall damage. The purpose is to reduce fat loss. In addition to using soft fat rather than hard fat, frozen fats should be thawed thoroughly before comminuting. Also, to reduce cell wall rupture, fat should be chopped in the presence of water.

Addition of rusk

Rusk is a baked and ground material made from wheat flour with a range of sizes. There are coarse, granules, pinhead and superfine rusks. Rusk has been known to have a high water absorption capacity of about 3–4 times its weight, especially with a slight increase in temperature. The higher the surface area the quicker the water absorption rate. Since its function includes absorption of 'free' water in the recipe, it is advisable to delay its addition in the mix until later. This also prevents excessive abrasive force on fat tissues before they become soaked. Allowing the mix to wait before filling utilises the function of rusk in contributing stability and texture to the mix. Alternatives to the use of rusk as a binder include cornflour, flour, farina, soya, egg, rice and oatmeal.

4.5 Vacuum filling

After bowl chopping the mixture is vacuum filled into natural or artificial casings. The two most important objectives of sausage filling are to achieve portioning accuracy and evacuation of air pockets from the product. The mix from the filler hopper is fed through the nozzle by a piston pump.

Some fillers are capable of producing up to 720 sausages per minute with exactitude in portion weights. Fillers are available in the market to cover the portioning as low as 5 g.

Evacuation of air from the product enhances colour stability and the visual effect of the sausages. It also reduces fat oxidation and bacterial action and prevents proteolysis. A longer shelf life of sausages is therefore achieved by vacuum filling.

Sausages can be filled as soft, less compact and compact in consistency depending on the producer's requirement.

Achievement of good product dimensions and speed are among the critical requirements in choosing a vacuum filler. Fill out dimensions and weight are among the parameters to be controlled, monitored and recorded at this point. Modern systems now employ co-extrusion of comminutes by using collagen dough.

4.5.1 Casings

Casings, also known as skins, used in sausage manufacturing achieve their primary significance in portioning. They are broadly divided into two types, namely natural and artificial.

Intestines of pigs or sheep are used in making natural casings. Most products made of natural casings come out with a curve after filling and cooking. Natural casings are often spooled to the required units as specified by the customer and packed in approved food containers containing about 80–100 % brine solution, or packed in salt. To avoid microbial contamination natural casings should be stored at temperatures not above 4.5 ºC. The use of animal intestines as sausage casings is not popular in high throughput. Handling problems, splitting and difficulty in standardising the weight and dimensions of sausages made from natural casings are among the constraints in automated large-scale production.

Artificial casings are now made with collagen, cellulose and plastic materials to suit a wide range of applications. Through a series of mechanical and chemical actions, collagen is extracted from the connective tissue of animals and used for manufacturing casings. Considerable development work has been put into making artificial casing to simulate the chewing sensation provided by natural casings.

Apart from providing the required sausage shape, casings also increase product shelf life by providing high moisture and oxygen resistance properties with a seal strength and density. Casings therefore contribute in minimising product weight loss during cooking.

Casing sizes for sausage vary tremendously. While some are as small as 17 mm others could be up to 38 mm diameter and 300 mm in length. A balance between high resistance to splitting coupled with easy dissolution in the mouth while eating are among the prime considerations in the choice of casing.

4.6 Cooking

Cooked sausages have become a relatively recent addition to traditional British breakfast type sausage. The popularity of this type of product is becoming increasingly high given the added convenience it provides in the sandwich and ready meal sectors.

The design of a cooking line would take into consideration a physical barrier between the low and high risk areas to avoid cross-contamination. Some producers use a cooking line to form the needed demarcation.

Various cooking methods and programmes are now used in sausage cooking. Oven cooking employing steaming, smoking, drying or a combination of all, and deep fat frying are among the methods employed. Whichever method is used should have a common characteristic and capability of achieving ambient and product core temperature requirement. Efficient cooking requires a standardised programme based on cooking temperature, product size and residence time. For instance, at an oil temperature of 160 ºC a 100 g sausage could be cooked to a core

temperature of between 85 ºC and 95 ºC in six minutes. It is important to note that microbial spoilage of cooked sausages, among other factors, depends on initial microbial load, level of preservatives and the temperature of cooking and storage. Microbial spoilage of marginally cooked products (apart from its inherent safety risk) might be exacerbated by even slight post-processing handling and storage abuses.

4.7 Smoking

Use of smoke, either natural or liquid, to achieve the desired flavour, colour, antimicrobial, antioxidant and preservative effects is a common practice in sausage making. Natural smoke is derived from the use of wood (beech, oak, hickory, juniper, etc.) smoke to impart distinctive flavour to the sausage. Liquid smoke has been known to contain hundreds of compounds. Hansen (2000) classifies important smoking compounds into three categories, namely phenols, carbonyls and acids, which are mostly in a gaseous phase. He further highlights four ways to achieve a uniform smoke, namely:

1 ensure that the smoke application system works properly and consistently
2 ensure a uniform product surface condition before smoke application
3 ensure moisture or lack of it on the surface, which is the most critical determinant of smoke colour
4 colour setting immediately after smoking to prevent the development of a mottled, streaky surface appearance.

4.8 Peeling

In the UK the frankfurter is the most common form of emulsion sausage, sold precooked and reheated by the consumer. Cellulose casings are often used in frankfurter sausage, which are peeled off after cooking and showering. The products are removed from the oven after cooking to a core temperature of 85 ºC, and showered or soaked for about twenty minutes. The strings are normally run through a peeler to remove the skin and the product assembled in trays to chill to 5 ºC maximum. It is important that the time and temperature (product and environmental) are controlled in this process to prevent the product being left in an ambient atmosphere for an excessively long period of time. The hygienic condition of the skin peeler is critical since peeling allows extra amounts of handling of the product. Additionally, every single unit of product has to run through the peeler. In-house cleaning procedures should recommend daily cleaning and sanitising of the peeler at a certain level of concentration before use. Positive release of the skin peeler may be recommended in view of the microbiological risk it can pose. A properly prepared frankfurter will break with a ‘snap’ after cooking.

4.9 Packaging, labelling and palletisation

Packaging materials for sausages whether primary or secondary should be good enough to offer an acceptable visual and structural presentation of the product to the customer. The most important criterion is probably that packaging materials are able to form a barrier against physical abuse, contamination and damage to the product.

Care should be given to selection of primary and secondary packaging materials to ensure that they are food grade and that while directly in contact with the food they do not carry or transfer contaminants. Some manufacturers who supply catering and food service sectors use blue liners as primary packaging for cooked frozen sausages while corrugated cartons are used for secondary packaging. Vacuum packaging is used on saveloys, frankfurters and cooked sliced sausages to prolong shelf life, and there is an increasing popularity of its use in cooked, chilled and frozen products. Of course, vacuum packaging of sliced sausages is ideal for the sandwich and meal sectors if the packs are passed through a sterilising or sanitising unit before use within the process. Some operations use tamper-proof, heat-sealed plastic trays to pack fresh sausages to a specified weight and then place them in multiples in cardboard cartons.

A few producers have successfully used wax-coated pre-printed cartons with sleeves between layers for frozen, cooked and uncooked sausages and frankfurters. Whatever packaging material and method is agreed in the specification, it is important that consistency is achieved and maintained with regard to all specified parameters.

Carton strength and integrity might be affected by dampness owing to improper storage. Carton collapsing on pallets is a very common phenomenon, not just in sausage operation but in the food industry as a whole. The choice of carton with proper strength and integrity will be based on the quantity and type of products as well as the downstream activities leading to distribution. Reinforcement might be made at the four corners of the pallet, filling cases to capacity and robust shrink-wrapping of the pallets.

Good packaging management, while not a key operation for a sausage manufacturer, as a good housekeeping practice requires proper storage of materials in damp and pest-free conditions, stock rotation and use of the right material as specified for the product. Some manufacturers make it their practice to include packaging details on production instructions and packaging programmes on every shift. The QA checklist should include control and monitoring of packaging materials as well as instructions.

Below is a brief manual of packaging instruction for frankfurters from a small-scale operator:

1 Pack 50 chilled frankfurters according to specification in a case using inter-sleeves to divide layers.
2 If vac packing is required then put 15 frankfurters in a clear bag to be vacuum packed and pass it on to a vac pack operator.
3 Record weight of three boxes at random every 30 minutes.
4 Tape seal (using coded blue tape), attach label and then metal detect each box.

If there is any reject by the detector inform the QA and your supervisor immediately.

5 Use 2.5 mm Fe, 2.5 mm Non-Fe and 3.5 mm S/S test sticks every 30 minutes to check the metal detector. Stack on stainless steel mobile racks and blast freeze.
6 Freeze down to –18 ºC and palletise the required number of cases.
7 Remove to cold store and hold at –23 ºC until ready for distribution.

Small-scale operators find it convenient to pack their products manually, which in a way is a compromise of conflicting requirements. Manual packing of sausages, while increasing the visual inspection and retraction of non-conforming products, in turn maximises handling, which can pose the risk of cross-contamination to the product. If manual packaging is done, the time and temperature control and monitoring have to be put in place. Products must not be allowed in ambient conditions for over 30 minutes. The packing room temperature should not be allowed to exceed 10 ºC.

Packaging operators and supervisors need training, tools and a good working environment to be able to handle their job efficiently since they are at the final stage before the product leaves the factory and goes to the customer. The training components should cover details of packaging materials, dimensions and visual parameters of the product. Operators of automatic systems of freezing and weighing must ensure that visual checks and cleaning are achievable during the line change to avoid a non-conforming product. A few new designs of packaging line allow a conveyor belt space between a continuous cooker and cryogenic freezing tunnels for a pre-inspection and also a space between the tunnel and the auto check-weigher for visual checks before the products are sealed in cases.

Documentation of operational and quality parameters at the packaging point provides a good basis for traceability and compliance with legislative requirements.

Labels placed on packs and outers should carry all the basic information and be not less than the minimum required by regulation. Currently the labelling requirement of the origin of meat may extend to cover sausage production. A few meat suppliers have already complied with this requirement. Label information should be controlled to ensure that Quantitative Ingredient Declaration (QUID) requirements are met and that there is no ambiguity. Some producers operate an in-house label printing system to minimise waste when changes are required on label information. Others feel the need to concentrate on the primary responsibility of making sausages and contract out the label design and printing. Whichever system is adopted it is important that label information is sufficient for effective traceability of the product. Ingredients declaration (including percentage meat content), batch code, best before date, product name, plant EC number and address, and product weight are the minimum details that should appear on the label.

4.10 Metal detection

The metal detection system should be sensitive to 'ferrous', 'non-ferrous' and stainless steel metals, and this should be specified. All units of the product must be passed through a suitable metal detector at the point of isolation from further possible contamination. Any packs failing on the first pass must be isolated and undergo approved recheck procedure. All packs failing metal detection must be broken down by the QA department to determine the reason for failure.

4.11 Frozen storage/distribution

Producers want their products to reach the intended recipients at the right time without any temperature or physical abuse. For the purpose of traceability many manufacturers specify a 24-hour temperature-monitoring chart and tracking system as a primary requirement in selecting transport and distribution of their product. A temperature log is completed on leaving the despatch and also at delivery point for possible traceability should there be a temperature abuse.

5

Sausage quality and safety management

Consumers worldwide are increasingly demanding to know not only what goes into their food but also the origin of these ingredients. They want to feel that reasoned principles and concepts are employed as an approach to ensure food safety and prevent hazards. These concerns on safety and quality are genuine and well-founded considering the series of recent food safety scares – salmonella, BSE, dioxin, *E. coli*, allergenic reactions and a host of other food safety issues facing the meat industry.

The effect of food safety crisis is a chain reaction often starting and ending with the consumers. Their confidence in a product drops, prices from alternative sourcing of ingredients go up, ultimately affecting the price of final product, the affected sector reaches almost a standstill and the Government in some cases is required to come in with subsidy for the worst-hit producers.

Safety issues have warranted a stringent system of traceability of raw materials. This requirement is another challenge to sausage manufacturers who have to deal with the EU-wide measures to manage the BSE issue, requiring removal of older animals from the food chain unless they were tested and the ban on use of animal protein in livestock feed. To add to that is the requirement to label the origin of the meat.

The above issues highlight the significance of a robust Hazard Analysis Critical Control Point (HACCP) and quality management systems, which are constantly evolving to cope with consumers' new expectations and safety challenges.

5.1 Sausage quality management

It is probably more important now than ever to adopt more stringent measures in

selecting the most competent and qualified individuals for technical/QA responsibilities. An effective QA system requires good interpersonal skills and sound judgement of the QA personnel to create a balance between firmness in implementing best practice and ensuring that workers remain committed and motivated.

In the face of seeming over-enthusiasm on the part of the production team and management, it does seem as if there is some element of apathy to the QA team, who always seem more interested in quality than mass production. Any sausage manufacturer with a balanced attitude towards QA requirements and production targets is likely to survive the increasing challenges the industry is facing from all directions. A successful QA system evolves as every staff member recognises the top management and director's support. Any QA initiative should be led from the top and allowed to be central to every operation of the company, since any such initiative can hardly succeed without top-level commitment. If quality considerations are allowed to be at the very heart of the business it soon endures to become a culture in the day-to-day running of the company. It therefore becomes natural that QA instructions and work procedure are taken seriously. It might be necessary to engage the production team in continuous professional development so that they can really appreciate the work of QA and understand what it really stands for. This will help in maintaining simple hygiene rules like hand washing and sanitising. A good quality system will only work if it applies to everyone from the top down.

It is important to realise that technical innovation drives commercial innovation and vice versa. It cannot be said often enough that food companies that are dynamic and have future prospects in an increasingly competitive industry can gain tremendous benefit from the level of innovation the technical, NPD and QA personnel can collectively offer:

1 They provide and utilise the vital information that can determine the direction the business can follow.
2 They translate consumers' expectations into a real product and service that offers excitement and sensory satisfaction.
3 They provide the real fulfilment a company requires to penetrate and remain in new areas of business with confidence, as well as the technical and legal framework it has to utilise in the business of producing food.

It makes more economic/commercial sense to produce a pallet or two of sausages that are satisfactory to the customer than seven pallets that are going to be returned owing to the presence of listeria or colour variation. But why do companies make the same mistakes all the time? Why are products returned on account of foreign bodies, skin splitting, temperature, excessively high total viable counts (TVC)s, high extrusion, short count, low weight, short size, pink middle or wrong code? Most problems relate to sacrifice of quality to meet volume. Any operation that develops the concept of volume at the expense of quality in a competitive food environment is helping itself out of the business quicker than even its competitors could.

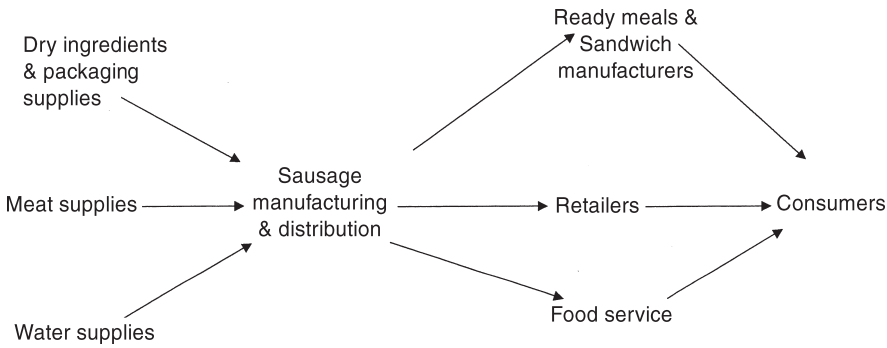


Fig. 5.1 Interrelationship of the stages of sausage manufacturing.

Quality can cost a lot of money if it is not right the first time. Since the technical/QA personnel cannot engineer quality into a finished product on a pallet, it therefore becomes imperative that the design of a process and quality system allows quality to be built in at every stage of the production process. Sausage production is just an integral part of the general food production chain, as shown in Fig. 5.1.

Contamination of sausages by a foreign body or food spoilage organisms could be caused by one or a combination of the following:

1 contamination of the water source
2 microbial level and foreign body entrapped in the meat
3 microbial and foreign body entrapment in dry ingredients
4 contamination at storage of ingredients
5 a host of factors leading to process contamination
6 contamination at distribution.

A defective process design and distribution systems will exacerbate the situation. Some of these problems may be carried over by the meal manufacturers, retailers or food service sectors until they are passed on to the consumers who ultimately pay the price.

A good quality management system will set up controls and monitoring measures to detect and prevent food safety hazards. Chan (2000) recommends the adoption of the HACCP and Current Good Manufacturing Practice (CGMP) concept for manufacturing, design, implementation, supervision and ongoing evaluation of such practices to achieve the food safety goal. He further identifies six goals CGMP adoption can achieve:

1 adhering to a current general standard of manufacturing
2 meeting the intended products specification
3 promoting products that meet intended specification
4 maintaining integrity of manufactured product
5 maintaining integrity of the manufacturer
6 preventing non-permissible residue levels.

5.1.1 Sausage quality

What is a quality sausage? Whatever their life's endeavour everyone is a customer. When goods and/or services are delivered we can immediately tell whether we are satisfied or not. It is the satisfaction that defines the quality expectation of a customer and vice versa. Since this expectation can vary tremendously from one person to the other depending on their position in the chain of production and consumption, it therefore becomes more difficult to define quality than to explain it. A meal manufacturer who uses sausage as a meal component might accept a light colour sausage as a quality one, while the other buys a darker colour as top quality. If you pick up a good book on 'quality', regardless of which product or service it pertains to, you will most likely come across a variety of the following terms in trying to explain quality – excellence, conformance, reliability, satisfaction, consistency and customer requirement. BS 4778: part 2 (1991) – ISO 8402 has given the following definitions of quality and related concepts:

Quality
The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

Quality policy
The overall quality intentions and direction of an organisation as regards quality, as formally expressed by top management.

Quality management
That aspect of the overall management function that determines and implements the quality policy.

Quality assurance
All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

Quality control
The operational techniques and activities that are used to fulfil requirements for quality.

Quality system
The organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

Quality plan
A document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project.

Quality audit
A systematic and independent examination to determine whether quality activities

and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

Quality system review
A formal evaluation by top management of the status and adequacy of the quality system in relation to quality policy and new objectives resulting from changing circumstances.

5.1.2 Raw material, process and product specification

The ultimate goal of any sausage manufacturer is, or should be, the delivery to customers of products with guaranteed quality and consistency. Good financial returns come as a result of trust and reliability over a period of trade relationship. To achieve this goal raw material, process and products specifications are needed, among other factors. It is a well-known fact that the quality of the raw material has a resultant effect on the finished product quality. Therefore, in sourcing for meat consideration should be given to the status of the animals at slaughter to ensure that they are:

1 disease-free (health)
2 stress-free (welfare)
3 clean (hygiene).

Pre-slaughter stress can affect the shelf life, texture, flavour and colour of the meat.

Once the animal is slaughtered two of the most important parameters that need control include:

- product and environmental temperature conditions
- microbial status of the meat surface.

The above parameters could be effectively controlled by minimising handling and maximising controls relevant to processing time and product environment.

5.1.3 Quality system design and maintenance

More and more responsibilities on safety and quality of products are now placed on food business owners, warranting a correspondingly large number of audits and surveillance visits from retailers, environmental health officers and customers in general to food plants. This increased level of accountability probably originates from consumers' increasing curiosity not just in what constitutes their food, but also its origin and how the food has been handled. This concern of the consumer is communicated to food businesses through retailers and Government directives and regulations. With mounting expectations of safety and quality the onus has been placed on food businesses to design and put in place robust and satisfactory food systems to satisfy stakeholders. Any satisfactory and robust food system must be based on a recognised standard. Some sausage manufacturers are not just employing state-of-the-art equipment to assure safety and quality but are

aggressively and rigorously managing controls relating to every stage of manufacturing and supply chain operations. Some are now looking at the impact of the structural design, nature of the material, air quality on foreign body controls, housekeeping, product flow and safety. Many experienced manufacturers, being aware of the level of interruptions a large number of audits can pose on their production plans, are keen to put in place a system that follows principles in industry's recognised standards with a view to reducing visits and conflicting audit recommendations to the barest minimum.

Audits

Mention of the word 'audit' in the food manufacturing plant elicits different responses depending on people's responsibilities in plant. As yet, the best-known objective way of establishing compliance or suitability for purpose of a system is auditing. Through audits confidence can be gained in knowing that not only have the statutory requirements been met but also that the system and product performance are adequate and up to specification. Far from being a meaningless, time-consuming exercise, audits can become a positive, progressive exercise for a food business as well as the customer. A well-designed assessment process that gains the cooperation of all the parties can identify and eliminate unnecessary practices in the process as well as stimulate new thinking and cost-effective procedures. New process technologies are recommended, changes are made and overall system improvement are often looked at following systems and technical audits. There are many different types of audits, but the main ones include the following.

External. External audit is often referred to as a supplier audit. According to Dix (2001), audit under this category could further be grouped into two broad types as follows:

1 Routine:
   - approval of a new supplier
   - regular check on an existing supplier to ensure continued compliance with the previously approved quality management system. This is usually described as a 'due diligence' audit and is carried out by the retailer or retailer's agent.
2 Non-routine, for the following reasons:
   - serious interruption of supply
   - variable product quality noticed
   - high customer complaint level
   - adverse microbiological trend reported
   - adverse media reports
   - anonymous tip-off
   - product withdrawal.

The key requirement for this type of audit is the existence of a documented system in the form of a manual for the quality system as well as HACCP for the safety system. In addition to the existence of procedures on types of controls and

monitoring including methods and frequencies, a sausage manufacturer will be expected by the auditor to demonstrate that the documented procedures are translated into real working practice and that records of these activities are kept for the purpose of 'due diligence'. A checklist for this type of audit is presented in Dix (2001).

Supplier audits may go beyond demonstration of compliance to codes of practice and guidelines regarding safety and quality to environmental and ethical issues, logistics, capability and expertise to handle the required or expected volume.

Apart from legal requirements on traceability a customer who is conscious of their reputation would like to be satisfied during the audit process that the traceability system in place is capable of accounting for quantity and source of rework, source of meat and other ingredients from intake through to finished product dispatch. The bigger and probably tougher requirement is the traceability prior to intake relating to the welfare of the animal before slaughter, kill date, slaughtering and cutting plant status, handling through to the chill/frozen chain and distribution.

The aim of this exercise is to demonstrate the ease of recalling all the affected units of product in a case of serious health or quality problem.

Third-party audit. Third-party audit is normally carried out by a representative of the customer, regulatory officers' visits such as environmental health officers (EHOs), a trading standards officer or agent etc., and a third party audit. Some organisations define and set up their standards while also acting as third party to audit against their standard. One of such organisations is the European Food Safety Inspection Service (EFSIS), offering over thirty different sets of requirements across a range of areas such as safety, plant structure, product recall and waste management. Accreditation is granted based on satisfactory level of compliance as defined by EFSIS. Audit frequency is determined by the nature of the business and the associated risk level. The British Meat Manufacturers' Association (BMMA), on the other hand, sets guidelines and Codes of Manufacturing incorporating the BRC standard as a critical requirement for the meat industry but uses the EFSIS auditing service for assessment and verification against the BMMA standard.

When a third party is used to establish compliance to a specified standard it is vital that all the parties are made familiar with details of the requirements of the standard used. Although many customers and retailers still rely on a large pool of their auditing team the obvious benefits in use of third-party auditing include the efficient use of the audit team resources, establishment and maintenance of impartiality, quality and consistency of the audit process (Dillon & Griffith, 2001). In addition to the above benefits, it is worth mentioning that many small food businesses can ill afford the tremendous cost involved in conducting an audit of their material sources, especially when some of the sources are located outside the country in which the product is made and used. Many of such businesses are beginning to rely increasingly on third-party audit reports.

Dillon & Griffith (2001) attribute the expansion of third-party accreditation and

the BRC technical standard not just to the overwhelming and increasing need of retailers to have to employ a large team of auditors to cover their international suppliers' network, but also to resolve the issue of often conflicting requirements and recommendations generated by different auditors.

Internal. Internal audit is carried out in house to compare the actual working practice with the controls stipulated in working procedures to ensure that the system in place is capable of empowering the consistent production of safe and quality food. This is probably the most powerful tool in verifying system compliance as well as managing the control and monitoring of food safety and quality systems.

This would be capable of picking up issues beforehand and provide necessary internal indicators for external audits. If the internal audit is well-structured and used as a management tool to satisfy stakeholders' requirements then non-routine audits may be reduced, if not completely removed. Internal audits can challenge many practices by utilising complaints trend analyses information to get to the root of problems with the aim of preventing a recurrence. For instance, an increasing trend in foreign body entrapment, bone and gristle in sausages can lead investigations towards the source of the meat, the housekeeping, the portioning, butchery and possibly filleting standards. It can actually pinpoint a particular supplier who has introduced the quality problem. This finding can redefine the intake inspection methods and recording. Investigation into this type of a problem may also reveal the quality of the existing traceability system.

In-house audits may pick up serious safety problems leading to an undercooked product or a quality problem resulting from an overcooked item. Investigation may lead to failure either of the controls caused by measuring instruments or cooking equipment or a lack of adequate training of the operator. Internal auditors are able to find real satisfaction in being able to get to the root cause of the breach of quality and safety standards since this is the first step of restoring control and preventing a recurrence.

Whether in-house, external or even third party, the auditing process enables or allows businesses to establish compliance to a system, regulation or customer through establishment and maintenance of effective food controls and monitoring. The audit technique used would differ depending on the type but to be effective all would require standardisation.

A good and progressive food system must, however, always provide a good balance between regulatory and consumers' needs, and the industry's objectives. If parameters that determine quality and consistency are measurable, then mechanisms for controlling those parameters are needed to achieve quality goals. Effective control systems will ultimately lead to a reduction in cost, resulting from chop back and goods rejection as well as establishing the culture of having it right the first time. It is important to note that it takes a whole lot of ideas, initiative and design to achieve quality whereas only a slight alteration or variation of the process could lead to the loss of it. Hence, ongoing maintenance and review of the process to the specified requirements is necessary to preserve quality and safety attributes.

Standards. Many people in food businesses are already familiar with the existence of many different standards, guidelines and codes of practice with often conflicting requirements, leaving a sausage manufacturer to wonder which set of standards would best suit its business. While there are no simple answers, it is interesting to observe that some of the most recognised standards have incorporated BRC standards to increase their relevance, and many sausage manufacturers have actually gone for standards that are above legal and regulatory requirements.

Apart from the British Retail Consortium (BRC) technical guidelines there are many quality standards and initiatives already existing in the industry, such as EFSIS, BMMA with EFSIS as the accreditation and verification body, ISO 9000 (2000), HACCP guidelines and General Principles of Food Hygiene from the Codex Alimentarius Commission and Good Manufacturing Practice guidelines from IFST. Some manufacturers have actually set their own standards to amalgamate and condense existing relevant standards. While standards tend to simplify and bring together complex regulatory and market-led requirements relating to a particular food type, they are difficult and quite involving to set. For instance, standards applicable to sausage manufacture would include a range of regulations involving composition, hygiene, safety and labelling, including specific process, product and service quality requirements of customers. The GMP guidelines could be used as a part of in-house minimum standard for auditing. The advantage of in-house standards is that they may be set to incorporate organisational goals. Recognising the potential danger of inadequate food standards, Dillon (2001) outlined the following seven guiding principles in setting a standard type of audit:

- simplifying complex processes into a simply understandable model
- cooperating with relevant stakeholders to prevent conflicts in economic and social requirements
- providing clear guidance on required methods and approach to achieve implementation
- selecting to include as wide-ranging areas and subjects as necessary to ensure relevance
- regular revising and updating to encompass new knowledge, techniques, regulations and requirements
- determining compliance by stipulating control parameters and monitoring criteria and
- ensuring it is legally enforceable.

Even with the best standards it is possible to lose the effectiveness in implementation as a consequence of resistance to change, lack of commitment, limited resources and increased training needs (Dillon, 2001).

Whichever standards a sausage manufacturer decides to design his quality management system to suit is entirely his prerogative. However, such a decision should take into consideration customers' preference and perception in addition to

experience, new knowledge and development. It is certain that achievement of certification that is satisfactory from a customer's point of view will increase confidence in the quality commitment of the producer.

5.1.4 Specific quality parameters for cooked skin-on sausages

Organoleptic properties

Texture. Customers' expectations of texture are numerous and varied, and include: a uniform coarse texture with a slightly resistant inner filling. A good texture will require a product devoid of toughness, stringiness, bone, bone fragments, hide, cartilage or other connective tissues.

Flavour. In specifying flavour, customers of pork sausage, for instance, will expect the characteristic flavour of good-quality fresh pork sausage meat, with mild, evenly distributed herb (if used in the recipe). Good flavour should be devoid of sourness, mouldiness, yeastiness, spoilage, rancidity, off-flavours or taints.

Colour. The visual appearance of cooked sausages is an essential sensory property by which consumers assess quality. For uncooked breakfast type sausages it probably is not much of a problem as it is combined with cooked product. Colour is a highly important quality requirement for a cooked operation since even a slight deviation from a specified shade of colour can cause a rejection.

The standard for cooked sausages in general requires that the colour is golden brown. For the purpose of presentation and appearance, some customers using sausages as a meal component would require specific colour details to be stated as pale, medium or dark brown. Pale colour sausages are associated with insufficient cooking while dark brown is often considered overcooked. Some products' specification for a few customers would require just a uniform and homogeneous pale brown–beige-coloured filling with a well-cooked appearance.

Cooked sausage colour management is becoming a very specialised function of a cooked operation. The time in which the mix is traditionally allowed to wait before cooking, residence time in the cooking medium and even the concentration of certain ingredients like dextrose in the mix may be overridden by the ultimate product colour considerations.

Apparently, colour standards for sausages vary tremendously as there is no nationally accepted standard for cooked sausages. However, for the purpose of monitoring and specification, many manufacturers have developed their own in-house reference standards for colour.

The most currently used standard for cooked sausages is the USDA colour standard for French fries.

Once a colour standard has been achieved then consistently meeting the standard becomes a critical requirement. Appearance should be devoid of discoloration, blemishes and distinct fat globules.

Physical properties

Products should be free from oil, grease and extraneous foreign matter. It is a good practice to agree with the customer on specification the acceptable percentage for split skins and extrusion.

Product dimensions, including weight, should also be agreed with the customer at specification stage.

Microbiological standards

Every sausage manufacturer would readily agree that one of the most scrutinised records in their premises during supplier and third-party audits is the environmental and product micro results. Micro results from a product test offer a summarised indication of the hygiene status of the whole process, including handling and contact surfaces. It is one of the most authoritative bases for offering positive release and assuring product safety. It is the supplier's due diligence record and the basis for assessment of compliance.

During specification micro standards are classified into three levels, showing the target, maximum and reject levels. Agreement must be reached with the customer at what point or level they should be informed of the micro status. High micro counts on finished products may point to a variety of issues in the plant such as the micro status of the raw material especially meat, variation from specified process, the handling (method, time and frequency), the cleaning (material, method, chemical dosage and contact time), including the post-cook handling and temperature when the item was subjected to heat treatment.

All cooked sausages in GMP should have a low micro count. However, microbiological standards should be agreed on specification with customers, and not lower than that required by the regulation. Some customers would like micro results from an accredited laboratory to go with every batch of sausage supplied. Others would require results at an agreed frequency. High micro levels on finished products will certainly lead to a high level of product deterioration and loss of stated shelf life. Loss of reputation leading to loss of custom is an associated danger in losing hygiene controls in the process. Most commonly required tests on microbes by customers include TVC, coliforms, *E. coli, Staph aureus*, yeast and moulds, salmonella species and listeria species.

5.1.5 Quality defects

Extrusion

A portioning machine would normally leave the ends of a sausage with a reasonable twist allowing an adhesion between the meat and the skin. Extrusion (product protrudes at filling ends) can take place if that does not occur. Another reason for extrusion could be an incorrect recipe. A good recipe would minimise excessive fat loss, which can create a lubricant between sausage meat and the skin. It is the resultant lubricant that can cause extrusion.

Skin splitting

Skin splitting is one of the major quality defects at cooking. In extreme cases the casing splits longitudinally and falls off completely. There are a number of causes of this defect. Excessive fat and water losses due to low proportion of lean meat in the recipe is one of the major causes of splitting. In deep frying, all sausages in cooking baskets should, of course, be completely immersed in the oil, but if there are too many products in the basket cooking may not occur uniformly, thereby causing splitting. Shaking of cooking baskets frequently and sticking to the specified cooking time and temperature are the known good practices to reduce skin splitting. A percentage tolerance on skin splitting should be agreed with the customer on specification for the purpose of good monitoring.

Cooking losses

Percentage cooking loss should be established during product development using the cooking system that is agreeable to the customer, since such losses could vary tremendously with each system. Tolerances should also be agreed as other major quality parameters with the customer on specification for the purpose of monitoring. In functional products, in which individual product dimensions and weight are critical, inability to control cooking losses could ruin the enormous commercial prospect for the product. High cooking losses can affect appearance owing to a high level of product shrinkage.

Cooking losses could be caused by:

1. *Incorrect recipe:* a good proportion of lean meat in the recipe will give a product of good quality and low cooking losses. The type of fat used could be another reason. Beef fat is considered less variable whereas pork fat is classified into soft (jowl), medium (back) and hard (flare). In unfrozen/thawed conditions soft fat would give the least cooking losses.
2. *Temperature at comminution:* during comminution the chopping temperature could rise rapidly. If this occurs beyond a certain level without control, the thermal stability of the product would be affected, leading to high cooking losses. This effect was extensively discussed in chapter 4.
3. *Cooking system:* considering evaporative loss before freezing, percentage cooking loss in a cook-chill-freeze system can vary tremendously from that of the continuous cook-freeze environment.
4. *Cooking time:* this is probably the most important factor affecting the percentage cooking loss. In-house cooking procedure should thoroughly specify cooking time relative to size and product type, as overcooking not only affects the cooking loss but also the eating quality.

Calculations. Product and process specifications should indicate this particular quality parameter showing the acceptable limits. Cooking loss is considered a function of the quality of the mix and may be calculated as a percentage as follows:

%tage cooking loss or shrinkage

$$= \frac{\text{Unit weight after filling} - \text{Unit weight after cooking}}{\text{Unit weight after filling}} \times 100$$

Pinky middle
Apart from nitrite contamination, undercooking is the main cause of pinky middle (uncooked appearance in sausages). Cooking oil temperature, core temperature target (85–95 ºC) with absolute minimum of 72 ºC and cooking time should be properly monitored to avoid this defect. Product size should determine the cooking time in which the core temperature is achieved.

Dark crispy skin
Assuming that the quality of the skin material is good, the dark crispy skin defect could be caused by overcooking. The eating quality would be equally defective. Overcooking can be avoided by controlling cooking time and temperature.

5.1.6 Quality checks

A quality system should be made to include monitoring of other parameters such as raw material checks (defect level, tempering and micros), storage temperature, recipe formulation and blending, fill weight and dimensions, frying temperature, product core temperature, cooling profile, frozen temperature, carton fill weights, metal detection and sensitivity, storage and distribution temperature, product environmental and microbiological testings.

5.1.7 Specific quality parameters for frankfurter type sausage

Physical quality
Physical quality should ensure that the products are consistent in size, shape and general appearance, and should be:

1 Free from misshaped or damaged products.
2 Free from all extraneous foreign matter.
3 Free from gristle, bone splinters and pieces of fat. Since meat is received in frozen blocks, some of the foreign matter would come from the raw material source, and it is difficult to visually detect them on reception. Producers should therefore agree on raw material specification levels of tolerance of any possible quality defect.
4 Free from discoloration and blemishes that materially detract from the appearance. The appearance of a frankfurter is from dark pink to brown in colour.

'Kiss' marks are pale areas of the surface where frankfurters have touched on cooking.

Indentation on the end of a sausage may be caused by hanging on smoking racks.

Organoleptic qualities
Appearance. Uniform shaped skinless frankfurters with no colour change and splits in cooking.

Colour. Even colouring of red/brown exterior, pink interior.

Texture. Good firm bite with a close, firm, succulent texture, 'snap' to outer surface.

Flavour. Well-seasoned pork with a well-developed strong smoke flavour. To be free from off-flavours or taints.

Analytical standards
Chemical analysis should specify typical meat and maximum fat contents as a percentage.

Bacteriological standards
Apart from those required by the customer, these should include all microbes required by the regulation at minimum.

5.2 Sausage safety management

5.2.1 The Food Safety Act 1990

If food operators were allowed to produce without their activities being regulated by the Government, then the consuming public's health and safety would be put in serious jeopardy. Food safety issues are extremely wide-ranging and are broadly classified into physical, chemical or biological. In the constant busy schedule peculiar to the production environment food operators could easily lose sight of these issues if they were not employing a systematic approach recommended by Good Manufacturing Practice. Food law then becomes an effective instrument used by Government and its regulatory apparatus in establishing responsibility in issues of food safety.

The Food Safety Act 1990 is a legislative instrument that aims at reducing food contamination/poisoning by protecting the public not only from food unfit to eat but also food that is misleadingly described or even produced by unhygienic practices. Achievement of this aim undoubtedly offers protection for the rights of any individual involved in food preparation, production/processing, storage, sale and distribution on the one hand and the rights of the consumers on the other. The Act is directed to food activities or businesses in all commercial and some non-commercial situations and excludes food prepared at home for domestic uses.

The substance of the Act contains provisions for food businesses to take 'all reasonable precautions' and exercise 'all due diligence' to avoid committing an offence under the Act. Of course, the right of a food operator is protected if he or

she has satisfied the requirement for 'all reasonable precautions' and 'all due diligence' by providing a substantial level of demonstration not just of acceptable industry recognised measures employed but also the effectiveness of their application. Needless to mention that in an offence committed under the Act a food operator may be required to prove that all hazards and their associated risks were identified, removed or a protection was built to seclude the hazard from causing food contamination. A good documentation system showing records of activities relating to a systematic approach to food safety including staff training may prove invaluable in a due diligence defence.

The Food Safety Act has enabled the existence of a wide range of UK regulations including:

- The Meat Products (Hygiene) Regulations 1994
- The Fresh Meat (Hygiene and Inspection) Regulations 1995
- Food Safety (General Food Hygiene) Regulations 1995
- The Food Safety (Temperature Control) Regulations 1995.

These regulations contain details of requirements on suitability and maintenance of food premises, equipment, facilities, temperature control, date marking of foods and even the enforcement of the law. Other requirements cover food composition, hygiene and safety management including safety and quality responsibility.

5.2.2 Traceability

Traceability in the meat processing sector is a well-known practice and probably one of the most controversial. Traceability is within the core requirement and a very efficient tool in food safety management. Increasing expectations of food safety and informative labelling to enhance consumers' choice are constantly refining the standards for traceability. Globalisation of food trade has also introduced a wider approach and challenges in standards of traceability. Traceability is a legal requirement in food businesses but many sausage manufacturers have already established their traceability system beyond the regulatory requirements.

Meaning and scope

Food traceability relates with tracking to establish the link of ingredients to the finished and ready-to-eat food. It is a two-way process allowing for forward tracking of ingredients from the source to the end user and from the end user to the source. Traceability allows accountability of the state of a food's ingredients and food through all stages of production, processing and chains of distribution. Traceability can be basic or as complex as the nature of the business requires.

The basic requirements of traceability for a sausage manufacturer is the complete record of customers and the distribution chain as well as suppliers and the supply chain. A consistent and well-monitored network has to be maintained to establish effectiveness of practice. Risk assessment of individual business is essential to establish the proportionality of a traceability system required with the

associated risk level. The modern sausage manufacturer is now bombarded with requests for information relating to meat sources, such as:

- source and origin of the meat
- specific cuts of meat used
- animal feed from which the meat is derived
- status of any animal feed ingredients implicated in genetic modification
- welfare system and status of the animal up to slaughter
- kill date of the animal
- EC number of the slaughter house, cutting and processing plant
- distribution chains, including handling methods and temperature.

Retailers and certain customers require additional information regarding:

- heat treatment residence time and temperature where applicable
- status of the dry and compound ingredients in terms of the extent of genetic modification
- micro results of environmental swabs and finished products enabling positive release of each batch
- analytical information relating to meat content and other chemistry and nutritional parameters of the sausage
- process temperature and handling time and temperature for each batch.

Certain retailers may restrict sausage suppliers to only a limited number of plants in their approved list to source meat.

Traceability will then require all relevant and meaningful captured information in relation to the above and other requirements. For effective traceability such information must be accurate, available and easily accessible.

Benefits of traceability

Benefits of traceability can be broadly assigned to two groups, namely businesses and consumers.

Business benefits

- good traceability gives businesses the basis for ‘due diligence’
- it satisfies legal requirements
- it enables and facilitates accurate labelling information
- apart from efficient management of business risk, supply and distribution chains, it enables businesses to act promptly in cases of safety incidence requiring recall and product withdrawal
- the cost of managing crises is reduced since the precise quantity of non-conforming items can be established
- businesses can be promoted to offer premium price of products owing to established confidence and trust
- it discourages fraudulent business practices thereby increasing business prospects and promoting good manufacturing practice within the sector

- it satisfies BRC, BMMA/EFSIS and other third-party requirements thereby allowing complying businesses to gain approval and win the custom of retailers and large customers.

Consumer benefits

- well-informed food choice based on informative labelling regarding source and type of ingredients used
- good basis for confidence in a product safety
- allows for good management of health and allergies
- decisive action in the event of safety crises.

Cost of traceability

Setting up, implementing, monitoring and reviewing a traceability system can be very costly, especially to sausage manufacturers who are predominantly small businesses. Each business is required to set up the basic traceability required to satisfy legal requirements. Of course, a traceability system will always change to embrace new sets of information required as a business expands and progresses to require a third-party and supplier approval. New personnel, training of existing personnel, consultancy, adoption of information technology where necessary, storage and handling of traceability information may be required to go beyond the basic requirements. These are not without real cost implications to a small sausage manufacturer. Well-managed businesses will probably adopt proper risk assessment tools to determine the level of traceability required to prevent oversubscription and cut down cost. Perhaps the assumption that traceability will drive and promote a business can act as an incentive for a small business to adopt and maintain an effective traceability system.

What is often overlooked is the fact that lack of traceability puts businesses in a very high level of risk and can cost an insurmountable amount, with loss of custom, time and reputation/image. Since consumers are the instigators as well as the ultimate beneficiaries of the output of a robust, safe and quality food system there seems to be no question of who bears the cost of traceability.

5.2.3 Good Manufacturing Practice (GMP)

Even though the law seeks to protect the right of the producers in doing everything reasonable to prevent food safety problems occurring and the right of the consumers to be provided with safe food, the main responsibility of food safety rests solely on those involved in manufacturing and selling food. It is reasonable to expect sausage manufacturers to deliver the highest possible food safety standards since doing so is a key tool in enhancing and maintaining consumer confidence in the various sausage and meat products offered by the industry.

In sausage manufacturing, as with other food products, a wide range of legal requirements involving compositional/nutritional components, hygiene, safety, formulation, shelf life, packaging and presentation in addition to consumer-led

requirements such as the flavour, texture, appearance, convenience, length, weights, colour and perhaps more importantly cost have to be met (IFST, 1998). The standardised and systematic approach employed to deliver these requirements forms Good Manufacturing Practice (GMP). Hence, the interrelationship between or perhaps condensing of the food manufacturing operations, quality assurance and safety as directed by the industry recognised standards are central to GMP (Donaldson & Early, 1996; IFST, 1998).

5.2.4 Cleaning system and staff health and safety

Microbial attachment to surfaces is a well-studied and known biological process in food science. Any design of a food safety and hygiene system would as a matter of priority utilise the available body of knowledge of how micro-organisms behave. The cleaning system is or should be a key consideration in HACCP formulation. Implementation of a cleaning system will therefore recognise and make available among other things the four principal requirements, namely:

1 time
2 mechanical or kinetic energy for necessary abrasion
3 chemical energy
4 thermal energy.

A good cleaning system is safe and efficient in reducing food-borne pathogens and cleaning chemicals to a level that poses a minimal risk in a food processing plant. A safe cleaning system does not cause residue/contamination problems to the food being produced and does not present undue hazards to the health and safety of the operators in the food production environment.

To achieve this an effective cleaning and disinfection system will include the following essential stages:

1 initial rough cleaning
2 cleaning with detergent
3 pre-rinsing with cold water followed by hot water
4 applying disinfecting agent
5 leaving for 10 to 15 minutes
6 final rinsing usually with cold water.

Some users are tempted to allow the excitement of the hygiene potential of cleaning chemicals to overwhelm an important consideration of staff health and safety. Operators' protection from hazards from use of cleaning chemical or combination of chemicals should be as paramount as solving plant hygiene problems.

Smith (2000) highlights potential dangers associated with the use of superchlorinated water sprays, especially at high temperatures, or combination with trace amounts of other chemicals (including ammonia and organics), leading to the production of aerosols that may contain chloroforms, trihalomethanes and chloramines. He mentioned that while chlorine is effective and safe if used

correctly in controlling salmonella and *E. coli*, sensitive individuals could show reactions to them even at very low concentrations.

Education of staff and operators to create awareness of hazards related to use, safe levels, residue problems if any, handling, storage and delivery systems should form a part of the complete assessment of the effects of chemicals used in cleaning. Recommendations should also include use of protective equipment and corrective actions in cases of breach of procedure and incorrect application. In some companies, the Control of Substances Hazardous to Health (COSHH) implementation contains a substantial amount of information that could enhance such awareness.

5.2.5 Allergens and challenges in sausage manufacturing

Allergens is an area a sausage manufacturer has a little or no control over, but he or she will listen to and monitor trends of consumption with a view to new product development and adaptation to the needs of the market. Two types of allergic sensitivity to food have been identified by Woollen (2000). These are immunologic and non-immunologic. Immunologic involves reaction of the immune system to a food ingredient to which it is sensitive, while the non-immunologic involves the averse reaction of the digestive system. With the increasing media attention and consumers' awareness of allergic reaction to certain food ingredients manufacturers stand a great risk of litigation. The British Meat Manufacturers' Association (BMMA) has published a standard for the use of additives in meat products and products containing meat (007). This booklet identifies risks in the use of certain additives and provides a general consumer's view, including useful recommendations.

5.2.6 Hazard Analysis and Critical Control Point (HACCP)

The HACCP system, originally developed by the National Aeronautic and Space Administration in the USA, is a well-established concept, which has been adopted and widely applied in the food industry for many years. The HACCP system allows necessary process controls to be placed at stages or steps in the manufacture of sausages whereby lack of them could lead to contamination and pose a danger to public health. Its principles are scientific and have formed an effective management tool that offers a systematic and practical approach to safety problems in a food production system. The principle goes beyond the identification of hazards in a food production process to include the assessment of the level of risk they can pose.

Risks that hazards pose could be classified into:

1 microbiological (pathogens)
2 chemical (lead, cleaning agents, toxins)
3 physical (foreign bodies such as plastic, glass, metal, wood, equipment and contact surfaces).

The uniqueness of the HACCP system is that it can be employed to control hazards of economic and public health significance in a food production environment.

Formulation of the HACCP system should reflect a tremendous demonstration of senior management support; and the team should be made up of staff at different levels of the production process. Knowledge of an experienced production team in designing HACCP is indispensable. Such knowledge takes into account the history of line problems, limits of the process and likely hazards, should control be lost at certain stages of the production operation. Probably the most required key personnel in the team are the technical and QA, the production and the engineering staff, given the significant level of interrelationship of their functions in delivering a safe food manufacturing system.

In formulating a HACCP system it is imperative that the following seven steps are taken into consideration.

1. Conduct a hazard analysis

A HACCP analysis is carried out using the seven principles as provided in Codex Alimentarius or other recognised standards by identifying all the hazards peculiar to a particular food processing system that might affect food safety and indicate how to control them. A few examples would include microbial load of the raw meat, plastic entrapment and bone presence in frozen meat. It is recommended that team effort be used in conducting hazard analysis and producing the HACCP plan. Where there are observable technical deficiencies in the team such expertise should be provided. It is essential that every member of the team is involved in the brainstorming exercise and process flow to identify hazards of public health significance. The team must be able to identify not just the obvious forms of hazards associated with the food or the process but also those hazards that are less obvious and can increase in levels over time.

2. Identify critical control points (CCPs) in the process

Many hazards are brought into the food plant with the incoming raw materials, and some are associated with the product flow and the process. These hazards are not always and they do not have to be controlled at the point at which they originated or were identified. Show points or stages in the production process where hazards could be more appropriately prevented, controlled or removed to a safe level. Such points would include raw meat intake/storage, sausage cooking and chilling stages. Understandably, the number of hazards and their points will vary from one sausage plant to the other depending on the diversity of product, process and procedure, among other factors.

3. Establish preventive measures with critical limits for control points

Apply scientific control parameters and regulatory requirements to establish the upper and lower limits and tolerances, including targets for conditions at the CCPs. These limits and tolerances should cover elements of biological, physical and chemical hazards. These may include cooking temperature for oven/oil and sausage core temperature and residence time in the oven/oil. The key point is that values are assigned to conditions or control parameters at CCP in a way that allows

the individual(s) doing the monitoring to decide on what value(s) is acceptable and what is unacceptable.

4. Monitor procedures for the CCPs

Explain precisely how the controls are to be monitored and assign responsibilities. As important as the how, what and whom is the frequency in which the critical controls are monitored. The operators should be trained and actively involved in understanding the HACCP plan and how it relates to their specific job responsibilities. QA may be assigned to obtain a certificate of analysis of every raw meat delivery with a clear understanding of its bearing on the HACCP plan. The operators should be assisted and supervised to be able to employ monitoring procedures in real practice within the process.

5. Establish corrective actions when monitoring indicates loss of control at any CCP

Actions required when a non-conforming product or process occurs. This becomes applicable when there is a deviation from the specified limits within the process. It could be the readjustment or re-evaluation of the continuous inline fryer to prevent a recurrence. It could also be the holding, recheck or disposing of metal-contaminated product. The important principle is that the operators are clear on what actions are appropriate and necessary to take and are able to take them as promptly as required. The individuals monitoring must be familiar with levels of responsibility and be able not just to take action but also know the right individual to contact for follow-on actions.

6. Verify process of the HACCP system

Relevant test instruments require QA checks and verification to ensure their accuracy and effectiveness of monitoring of controls. All thermometers require calibration when necessary. A less frequent but additional test of the food safety controls should be carried out beyond and on top of these normal routine checks. The resultant verification or analysis data should be able to demonstrate the effectiveness of the HACCP plan. The verification could be in the form of an annual system or record review. The obvious benefits of this exercise lie on the possibility that a process change might have occurred along the line rendering inadequate the relevant controls in place. Such observations would normally lead to an introduction of an improved new process method or system.

7. Establish effective record-keeping for documentation of HACCP system

Record should be kept of hazards and corrective actions taken in a food production system, including records of non-conforming material, product and process placed on hold, the reason for holding and the person responsible for their releases. Also important is the record of periodic review of the HACCP system to ensure that the intended controls and methods are effective. In fact, all safety control records and related actions taken on non-conforming situations are involved and require safe-keeping for regulatory and possible 'due diligence' reasons. Record-keeping

becomes a reference point in case of complaints investigation and traceability, especially when long shelf life products are involved.

Changes in the process should be noticed and the HACCP plan made to accommodate those changes. The HACCP system varies tremendously among companies and product ranges. Some companies are able to design and document an impressive HACCP system that is not very practical to their process. A simple, practical and tested HACCP will probably reduce the risk of hazard within a system more effectively than a comprehensive system on a shelf which has not been proven or does not directly apply to the process in question.

A HACCP system in a cooked sausages company should detail various stages of the process and identify CCPs using a flow diagram (see Appendix 6). Controls being monitored at CCPs indicate corrective actions (see Appendix 7). The HACCP flow chart and plan (Appendices 6 and 7) could be viewed as generic for cooked sausages, and may not be entirely and completely applicable to all plants since every plant is different.

HACCP principles should be evolving and flexibly put in place to eliminate or reduce hazard in the process, or protect the product from hazard at various stages of the production operation.

Establishment of control limits and their monitoring are crucial to the effectiveness of the HACCP system. Equally crucial is the proper understanding of the nature of the hazard if monitoring of the controls is aimed at reducing them.

A periodic review of the HACCP system is necessary to accommodate changes brought about by new product and process development, including information derived from customer complaints trend analysis. A functioning and well-proven HACCP system satisfies legal requirements, furnishes evidence of due diligence as well as indicating presence of a good manufacturing practice.

Effective HACCP implementation has many benefits, among which are:

1. A clear demonstration of compliance with regulatory requirements such as health and safety and due diligence.
2. Consumers' confidence in safety of food is assured, considering their concerns about contaminants such as lead, pathogens and foreign bodies in food.
3. Being an international concept, individual countries and companies are able to compete effectively with similar products in the international market.
4. With the phenomenal growth and expansion of the sausage sector in the processed meat industry, coupled with the inherent diversity of product and process, the HACCP system therefore becomes ever more significant in delivery of safe food to consumers.

6

Novel products

6.1 New sausage product development

The lifeline of many food businesses and probably the determinant of their continuity rest to an ever greater extent on new product development. The hallmark of a successful new product development probably lies primarily in introducing a sausage that maintains the traditional taste and appearance while removing the ingredients that are not entirely acceptable to the customer. If, for instance, the flavour enhancer (containing monosodium glutamate), preservatives, antioxidants and perhaps hydrolysed vegetable protein are removed, will the product still taste like a sausage? Will consumers accept the product as it is as a consequence of lack of these ingredients? The answer to these questions is, obviously, no. Consumers want to eat sausages with a traditional taste even with the removal of ingredients they feel averse to. Handling allergenic issues as well as constantly meeting customers' requirements are among the challenges of developing new sausage products. However, changes in consumption trends driven by consumers' increasing awareness of availability of choice provide ample new sausage development opportunities. Knowing that the future of many food companies relates to new product development, some manufacturers have adopted the proactive approach to development in the face of the almost constant food scares facing the meat industry.

Fuller (1994) has mentioned new food products as major avenues open to a food company to be profitable and to survive. In his book five dominant forces are mentioned as driving new food product development:

1 All products have life cycles. That is, they enter the marketplace, flourish for an indeterminate time, then die, and must be replaced.

2 A company's management may adopt a policy that requires an aggressive growth programme to satisfy long-range business goals.
3 The marketplace may change, requiring new products more suited to respond to the changes.
4 New technology may make new food products more suited to the lifestyle of today's consumers.
5 Changes in government legislation, health programmes, agricultural policy or agricultural support programmes may dictate that development of new products be pursued.

6.2 Organic sausages

Organic food and farming lay emphasis on a sustainable system that relies upon the natural life cycles nurtured by the earth and reduces the use of various chemicals, pesticides, organophosphates, fertilisers and genetically modified organisms (GMOs). Respect for animal welfare and minimal processing or use of additives are also among the fundamental requirements for organic food and farming.

The UK's leading organisation in promoting the highest standards in organic food and farming is the Soil Association; more than 70 % of organic food sold in the UK bears its organic symbol. The association's comprehensive standards for organic food and farming explain and define the principles, practices and requirements for organic foods and farming.

Raw materials used in manufacturing sausages must therefore be sourced with consideration to the above requirements. Manufacturers who declare organic on their packaging must have the endorsement and approval of the Soil Association. Such production practice will take into consideration complete segregation of organic from non-organic ingredients. Certification would allow such manufacturers to use the Soil Association organic mark on their packaging.

There is evidently an increasing trend in public demand for organic sausages since they are being viewed and promoted as the ultimate in food safety assurance. Their increasing popularity is unprecedented in view of food safety scares like BSE and dioxin contamination of livestock feeding sources. The Soil Association has a list of various producers of sausages and other foods who have been approved to declare that their food is organic.

6.3 Vegetarian sausages

The series of food safety crises affecting the meat industry in recent years has led more people to lose confidence in meat as a protein source, thereby allowing the NPD in the sausage sector to aim at utilising alternative protein sources and other ingredients to make sausages for this particular market. Vegetarian sausages have a relatively small share of the sausage market but there is an increasing trend in popularity. Meat extenders and/or analogues are used with dry ingredients to

achieve a premium product for this particular market. There is an obvious eating experience as the succulence, texture and firmness are different from those of traditional recipes.

6.4 Low fat sausages

Sausages have a poor health image, being perceived by some as too fattening. Evolution of low fat sausages has come about as a result of consumer health consideration and conception. Cutting back on fat content requires a formulation that increases lean meat content and reduces the fat level. Visual lean (vl) characteristics of the meat used are critical in achieving a low fat product. Apart from the level, the type of fat in sausages could also be varied. This possibility is illustrated in research in Greece on fermented sausages with a high content of saturated fatty acids and cholesterol. Bloukas *et al.* (1997) worked on a partial replacement (up to 20 %) of pork back fat with emulsified olive oil without a change in appearance, firmness, odour or taste.

6.5 Low salt/sodium sausages

Low salt/sodium sausages are also premium products that have evolved as a result of consumers' health considerations. Salt levels in the final product are controlled at the recipe formulation either by avoiding adding salt directly or by reducing it from the seasoning mix and other compound ingredients such as gelbind and cure compound. An increasing number of customers are requesting new product development in this direction to widen their range of low salt products. Low salt/sodium sausages are basically a product reformulation to create a new market niche for existing products.

6.6 Exotic/gourmet recipes

As the world of food is shrinking owing to travelling, immigration and understanding of the rest of the world's food culture, sausage making has evolved further to utilise various flavours and ingredients from all parts of the world to suit the organoleptic perception of specific consumers. Such ingredients include haggis, garlic, wine and pepper (white, black and red). New sausage products with exotic ingredients have an enormous opportunity of creating a fresh market niche that has not been fully explored by the industry.

The majority of new product ideas in the exotic and gourmet range do not require major equipment purchases any more than reformulation of existing products to include the variant ingredient(s). Sometimes the effort, time and money required for formulation, assemblage of ingredients and the actual trial run to submission of the prototype might be incomparable to those required to

source and acquire exotic ingredients from verified sources. Reformulation of sausages should consider the ease of acquiring new ingredients from a trusted source and the cost impact on the final product to achieve a good margin in a competitive industry.

Appendix 1

List of permitted food additives with their serial numbers (EC numbers)

The list covers food additives allowed in the UK for all categories of food as of 2003.

E100 Curcumin
E101 (i) Riboflavin
(ii) Ribovlavin-5′-phosphate
E102 Tartrazine
E104 Quinoline Yellow
E110 Sunset Yellow FCF, Orange Yellow S
E120 Cochineal, Carminic acid, Carmines
E122 Azorubine, Carmoisine
E123 Amaranth
E124 Ponceau 4R, Cochineal Red A
E127 Erythrosine
E128 Red 2G
E129 Allura Red AC
E131 Patent Blue V
E132 Indigotine, Indigo carmine
E133 Brilliant Blue FCF
E140 Chlorophylls and Chlorophyllins:
(i) Chlorophylls
(ii) Chlorophyllins
E141 Coppr complexes of Chlorophylls and Chlorophyllins
(i) Copper complexes of Chlorophylls
(ii) Copper complexes of Chlorophyllins
E142 Green S
E150a Plain Caramel
E150b Caustic sulphite caramel
E150c Ammonia caramel
E150d Sulphite ammonia caramel
E151 Brilliant Black BN, Black PN
E153 Vegetable carbon
E154 Brown FK
E155 Brown HT
E160a Carotenes
(i) Mixed Carotenes
(ii) Beta-carotene
E160b Annatto, bixin, norbixin
E160c Paprika extract, capsanthin, capsorubin
E160d Lycopene
E160e Beta-apo-8′-carotenal (C30)
E160f Ethyl ester of beta-apo-8′-carotenic acid (C30)
E161b Lutein
E161g Canthaxanthin
E162 Beetroot Red, betanin
E163 Anthocyanins
E170 Calcium carbonate
(i) Calcium carbonate
(ii) Calcium hydrogen carbonate
E171 Titanium dioxide
E172 Iron oxides and hydroxides
E173 Aluminium
E174 Silver
E175 Gold
E180 Litholrubine BK
E200 Sorbic acid
E202 Potassium sorbate
E203 Calcium sorbate
E210 Benzoic acid
E211 Sodium benzoate
E212 Potassium benzoate
E213 Calcium benzoate
E214 Ethyl p-hydroxybenzoate
E215 Sodium ethyl p-hydroxybenzoate
E216 Propyl p-hydroxybenzoate
E217 Sodium propyl p-hydroxybenzoate
E218 Methyl p-hydroxybenzoate
E219 Sodium methyl p-hydroxybenzoate
E220 Sulphur dioxide
E221 Sodium sulphite
E222 Sodium hydrogen sulphite

E223 Sodium metabisulphite
E224 Potassium metabisulphite
E226 Calcium sulphite
E227 Calcium hydrogen sulphite
E228 Potassium hydrogen sulphite
E230 Biphenyl, diphenyl
E231 Orthophenyl phenol
E232 Sodium orthophenyl phenol
E233 Thiabendazole
E234 Nisin
E235 Natamycin
E239 Hexamethylene tetramine
E242 Dimethyl dicarbonate
E249 Potassium nitrite
E250 Sodium nitrite
E251 Sodium nitrate
E252 Potassium nitrate
E260 Acetic acid
E261 Potassium acetate
E262 Sodium acetate
(i) Sodium acetate
(ii) Sodium hydrogen acetate (sodium diacetate)
E263 Calcium Acetate
E270 Lactic acid
E280 Propionic acid
E281 Sodium propionate
E282 Calcium propionate
E283 Potassium propionate
E285 Sodium tetraborate (borax)
E290 Carbon dioxide
E296 Malic acid
E297 Fumaric acid
E300 Ascorbic acid
E301 Sodium ascorbate
E302 Calcium ascorbate
E304 Fatty acid esters of ascorbic acid
(i) Ascorbyl palmitate
(ii) Ascorbyl stearate
E306 Tocopherol-rich extract
E307 Alpha-tocopherol
E308 Gamma-tocopherol
E309 Delta-tocopherol
E310 Propyl gallate
E311 Octyl gallate
E312 Dodecyl gallate
E315 Erythorbic acid
E316 Sodium erythorbate
E320 Butylated hydroxyanisol (BHA)
E321 Butylated hydroxytoluene (BHT)
E322 Lecithins
E325 Sodium lactate
E326 Potassium lactate
E327 Calcium lactate
E330 Citric acid
E331 Sodium citrates
(i) Monosodium citrate
(ii) Disodium citrate
(iii) Trisodium citrate
E332 Potassium citrates
(i) Monopotassium citrate
(ii) Tripotassium citrate
E333 Calcium citrates
(i) Monocalcium citrate
(ii) Dicalcium citrate
(iii) Tricalcium citrate
E334 Tartaric acid (L(+)-)
E335 Sodium tartrates
(i) Monosodium tartrate
(ii) Disodium tartrate
E336 Potassium tartrates
(i) Monopotassium tartrates
(ii) Dipotassium tartrate
E337 Sodium potassium tartrate
E338 Phosphoric acid
E339 Sodium phosphate
(i) Monosodium phosphate
(ii) Disodium phosphate
(iii) Trisodium phosphate
E340 Potassium phosphates
(i) Monopotassium phosphate
(ii) Dipotassium phosphate
(iii) Tripotassium phosphate
E341 Calcium phosphates
(i) Monocalcium phosphate
(ii) Dicalcium phosphate
(iii) Tricalcium phosphate
E350 Sodium malates
(i) Sodium malate
(ii) Sodium hydrogen malate
E351 Potassium malate
E352 Calcium malate
E353 Metartaric acid
E354 Calcium tartrate
E355 Adipic acid
E356 Sodium adipate
E357 Potassium adipate
E363 Succinic acid
E380 Triammonium citrate
E385 Calcium disodium ethylene diamine tetra-acetate (Calcium disodium EDTA)
E400 Alginic acid
E401 Sodium alginate
E402 Potassium alginate
E403 Ammonium alginate

E404 Calcium alginate
E405 Propane-1,2-diol alginate
E406 Agar
E407 Carrageenan
E407a Processed eucheuma seaweed
E410 Locust bean gum
E412 Guar gum
E413 Tragacanth
E414 Acacia gum (gum arabic)
E415 Xanthan gum
E416 Karaya gum
E417 Tara gum
E418 Gellan gum
E420 Sorbitol
(i) Sorbitol
(ii) Sorbitol syrup
E421 Manitol
E422 Glycerol
E431 Polyoxyethelene (40) stearate
E432 Polyoxyethylene sorbitan Monolaurate (polysorbate 20)
E433 Polyoxyethylene sorbitan Monooleate (polysorbate 80)
E434 Polyoxyethelene sorbitan Monopalmitate (polysorbate 40)
E435 Polyoxyethylene sorbitan Monostearate (polysorbate 60)
E436 Polyoxyethelene sorbitan Tristearate (polysorbate 65)
E440 Pectins
(i) Pectin
(ii) Amidated pectin
E442 Ammonium phosphatides
E444 Sucrose acetate isobutyrate
E445 Glycerol esters of wood rosins
E450 Diphosphates
(i) Disodium diphosphate
(ii) Trisodium diphosphate
(iii) Tetrasodium diphosphate
(iv) Dipotassium diphosphate
(v) Tetrapotassium diphosphate
(vi) Dicalcium diphosphate
(vii) Calcium dihydrogen diphosphate
E451 Triphosphates
(i) Pentasodium triphosphate
(ii) Pentapotassium triphosphate
E452 Polyphosphates
(i) Sodium polyphosphate
(ii) Potassium polyphosphate
(iii) Sodium calcium polyphosphate
(iv) Calcium polyphosphates
E460 Cellulose
(i) Microcrystalline cellulose
(ii) Powdered cellulose
E461 Methyl cellulose
E463 Hydroxypropyl cellulose
E464 Hydroxypropyl methyl cellulose
E465 Ethyl methyl cellulose
E466 Carboxy methyl cellulose
Sodium Carboxy methyl cellulose
E470a Sodium, potassium and calcium salts of fatty acids
E470b Magnesium salts of fatty acids
E471 Mono and diglycerides of fatty acids
E472a Acetic acid esters of mono and diglycerides of fatty acids
E472b Lactic acid esters of mono and diglycerides of fatty acids
E472c Citric acid esters of mono and diglycerides of fatty acids
E472d Tartric acid esters of mono and diglycerides of fatty acids
E472e Mono and diacetyl tartaric acid esters of mono and diglycerides of fatty acids
E472f Mixed acetic and tartaric acid esters of mono and diglycerides of fatty acids
E473 Sucrose esters of fatty acids
E474 Sucroglycerides
E475 Polyglycerol esters of fatty acids
E476 Polyglycerol polyricinoleate
E477 Propane-1,2-diol esters of fatty acids
E479b Thermally oxidised soya bean oil interacted with mono and diglycerides of fatty acids
E481 Sodium stearoyl-2-lactylate
E482 Calcium stearoyl-2-lactylate
E483 Stearyl tartrate
E491 Sorbitan monostearate
E492 Sorbitan tristearate
E493 Sorbitan monolaurate
E494 Sorbitan monooleate
E495 Sorbitan monopalmitate
E500 Sodium carbonates
(i) Sodium carbonate
(ii) Sodium hydrogen carbonate
(iii) Sodium sesquicarbonate
E501 Potassium carbonate
(i) Potassium carbonate
(ii) Potassium hydrogen carbonate
E503 Ammonium carbonates

(i) Ammonium carbonate
(ii) Ammonium hydrogen carbonate

E504 Magnesium carbonates
(i) Magnesium carbonate
(ii) Magnesium hydrogen carbonate

E507 Hydrochloric acid
E508 Potassium chloride
E509 Calcium chloride
E511 Magnesium chloride
E512 Stannous chloride
E513 Sulphuric acid
E514 Sodium sulphates
(i) Sodium sulphate
(ii) Sodium hydrogen sulphate

E515 Potassium sulphates
(i) Potassium sulphate
(ii) Potassium hydrogen sulphate

E516 Calcium sulphate
E517 Ammonium sulphate
E520 Aluminium sulphate
E521 Aluminium sodium sulphate
E522 Aluminium potassium sulphate
E523 Aluminium ammonium sulphate
E524 Sodium hydroxide
E525 Potassium hydroxide
E526 Calcium hydroxide
E527 Ammonium hydroxide
E528 Magnesium hydroxide
E529 Calcium oxide
E530 Magnesium oxide
E535 Sodium ferrocyanide
E536 Potassium ferrocyanide
E538 Calcium ferrocyanide
E541 Sodium aluminium phosphate, acidic
E551 Silicon dioxide
E552 Calcium silicate
E553a (i) Magnesium silicate
(ii) Magnesium trisilicate
E553b Talc
E554 Sodium aluminium silicate
E555 Potassium aluminium silicate
E556 Calcium aluminium silicate
E558 Bentonite
E559 Aluminium silicate (Kaolin)
E570 Fatty acids
E574 Gluconic acid
E575 Glucon-delta-lactone
E576 Sodium gluconate
E577 Potassium gluconate
E578 Calcium gluconate
E579 Ferrous gluconate
E585 Ferrous lactate
E620 Glutamic acid
E621 Monosodium glutamate
E622 Monopotassium glutamate
E623 Calcium diglutamate
E624 Monoammonium glutamate
E625 Magnesium diglutamate
E626 Guanylic acid
E627 Disodium guanylate
E628 Dipotassium guanylate
E629 Calcium guanylate
E630 Inosinic acid
E631 Disodium inosinate
E632 Dipotassium inosinate
E633 Calcium inosinate
E634 Calcium 5′-ribonucleotides
E635 Disodium 5′-ribonucleotides
E640 Glycine and its sodium salt
E900 Dimethyl polysilxane
E901 Beeswax, white and yellow
E902 Candelilla wax
E903 Carnauba wax
E904 Shellac
E912 Montan acid esters
E914 Oxidised polyethylene wax
920 L-cysteine hydrochloride*
925 Chlorine*
926 Chlorine dioxide*
E927b Carbamide
E938 Argon
E939 Helium
E941 Nitrogen
E942 Nitrous oxide
E948 Oxygen
E950 Acesulfame K
E951 Aspartame
E952 Cyclamic acid and its Na and Ca salts
E953 Isomalt
E954 Saccharin and its Na, K and Ca Salts
E957 Thaumatin
E959 Neohesperidine DC
E965 Maltitol
(i) Maltitol
(ii) Maltitol syrup
E966 Lactitol
E967 Xylitol
E999 Quillaia extract
E1105 Lysozyme
E1200 Polydextrose

*no E prefix

E1201 Polyvinylpolypyrrolidone
E1404 Oxidised starch
E1410 Monostarch phosphate
E1412 Distarch phosphate
E1413 Phosphated distarch phosphate
E1414 Acetylated distarch phosphate
E1420 Acetylated starch
E1422 Acetylated distarch adipate
E1440 Hydroxyl propyl starch
E1442 Hydroxyl propyl distarch phosphate
E1450 Starch sodium octenyl succinate
E1505 Triethyl citrate
E1518 Glyceryl triacetate (triacetin)

Appendix 2

Supplier information and evaluation form

Supplier Name:	
Supplier Address:	
Contact Person(s)	
Telephone No:	Fax No:
Material Description/Code	

Does the company have a written food safety or product quality policy?	Yes/No
Does the company operate a full traceability procedure? If yes, provide full details of the same and attach to this form _____	Yes/No
Does the company have a written product due diligence warranty?	Yes/No
Does the company hold any accreditation certificates?	Yes/No
Does the company operate a fully documented HACCP system? If yes, provide full details of the same attached to this form _____	Yes/No
Is the company able to supply fully documented agrochemical information for the ingredient supplied?	Yes/No
Is the company able to supply fully documented vegetarian and nut policies for the ingredient supplied?	Yes/No
Does the company operate a fully documented pest control system? If yes, please detail inspection regime and give name of contractor _____	Yes/No

Does the company operate a clearly defined product recall procedure? If yes, provide full details of the same and attach to this form _____	Yes/No
Does the company have a documented system for customer complaint? If yes, provide full details of the same attached to this form _____	Yes/No
Does the company have a glass exclusion policy in its manufacturing operation? If yes, provide full details of the same and attach to this form _____	Yes/No
Does the company operate its own supplier evaluation procedure? If yes, provide full details of the same and attach to this form _____	Yes/No

Does the company carry out its own microbiological screening?	Yes/No
Does the company operate a microbiological or other positive release procedure?	Yes/No

Does the company carry out and document regular chemical analysis of raw materials and products? Yes/No

Do all products pass through a foreign body detection system? Yes/No

Are raw materials and products protected from external contaminants at all times? Yes/No

Does the company test its water supply? Yes/No

Are raw materials bought to a specification? Yes/No

Does the company have a written specification for all finished products Yes/No
If yes, provide the specification for the raw material to be supplied _____

How many people does your company employ? _____

How many staff are directly involved in food handling? _____

Do new staff undergo an induction training? Yes/No

Do new staff undergo any medical examination? Yes/No

Are staff suitably trained for their duties under Health & Safety At Work Reg 1992? Yes/No

Are cleaning staff trained to comply with COSHH Reg 1998? Yes/No

Does your company have a written cleaning schedule? Yes/No

Is protective clothing cleaned and supplied by a contractor? Yes/No

Does your company operate a working shift system? Yes/No

Is the maintenance of machinery and equipment documented? Yes/No

Does your company have a GMOs policy? Yes/No
If yes, supply details _____

Do you warrant that all goods manufactured by your company will comply with all relevant legislation in force at the time of sale? Yes/No

Do you warrant in your opinion that your company takes all reasonable precautions and exercises all due diligence to avoid the commission of an offence by itself or any person under its control? Yes/No

Please provide following product liability details.

Insurer:

Policy number:

Details of person responsible for quality assurance

Name:

Position:

Tel No.:

Details of person who we can contact in an emergency

Name:

Position:

24 hrs Tel No.:

Signed:

Position:

Date:

Please do not write below this line

Comments:

Signature:

Date:

Appendix 3

Delivery inspection record for meat

Delivery Date:	Rotation Code:
Delivery Company Name:	Palletisation Standard:
Vehicle Registration No:	Inspector Name:
Note Vehicle Condition:	Delivery Note No.:

Material Description:	
Visual Lean:	
Supplier Name:	
Country of Origin:	Plant EC No.:
Unit Weight:	Total Weight:

Kill Date:	Packing Date:
Storage Temperature:	Best Before Date:
Temperature between Pack:	Material Core Temperature:

Visual Appearance of Material:	Type/Condition of Packaging:

Quality Assurance Remark: Physical/Chemical/Microbiological Reject/Hold/Pass: *(Give reason)*	
QA signature:	Date:

Appendix 4

Delivery inspection record for dry goods

Delivery Date:	Rotation Code:
Delivery Company Name:	Palletisation Standard:
Vehicle Registration No:	Inspector Name:
Note Vehicle Condition:	Delivery Note No.:

Material Description:	
Supplier Name:	
Country of Origin:	
Unit Weight:	Total Weight:

Storage Conditions/Comments:
Shelf Life:

Type/Condition of Packaging:

Quality Assurance Remark: Reject/Hold/Pass: *(Give reason)*	
QA signature:	Date:

Appendix 5

Delivery inspection record for packaging

Delivery Date:	Rotation Code:
Delivery Company Name:	Palletisation Standard:
Vehicle Registration No:	Inspector Name:
Note Vehicle Condition:	Delivery Note No.:

Material Description:	
Supplier Name:	
Country of Origin:	
Unit Size:	Total Quantity:

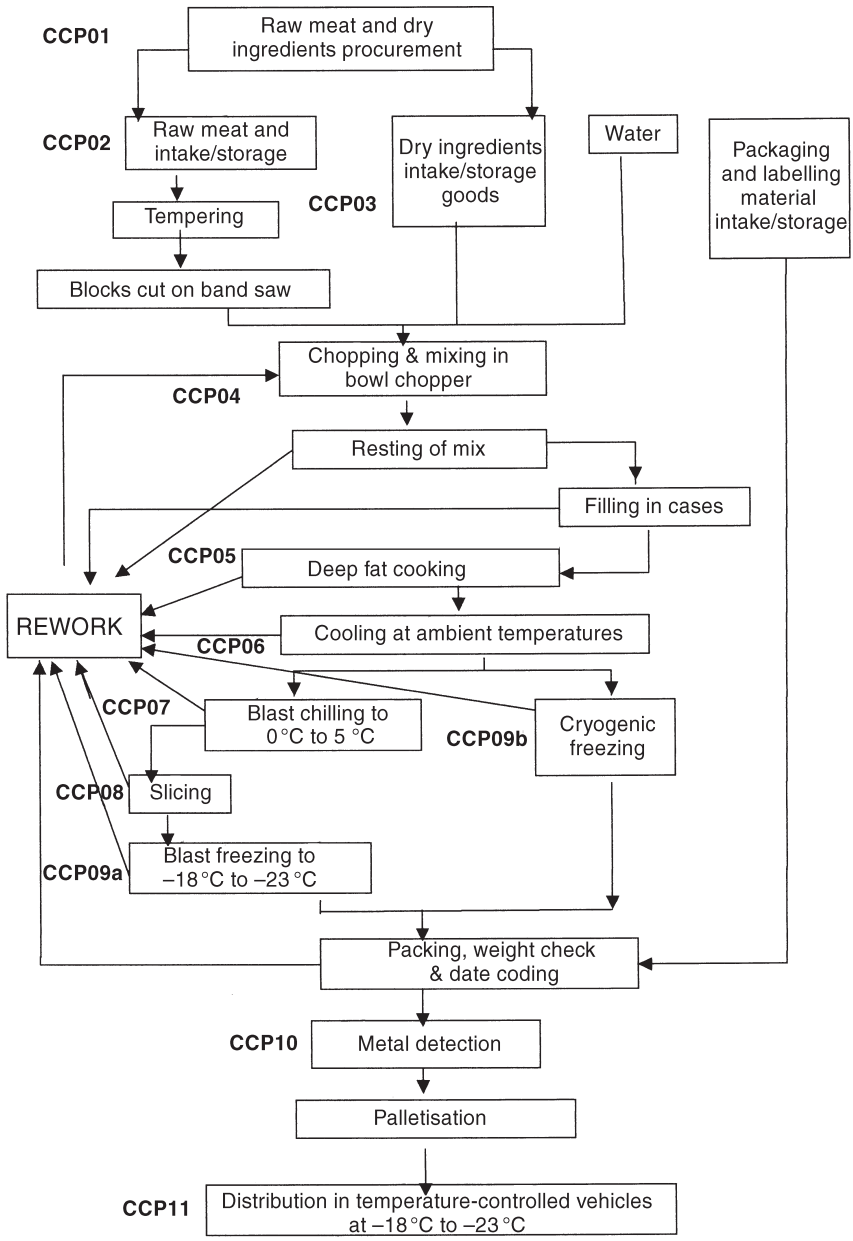
Storage Conditions/Comments:

Type/Condition of Packaging:	Shelf Life:

Quality Assurance Remark: Reject/Hold/Pass: *(Give reason)*	
QA signature:	Date:

Appendix 6

HACCP process flow diagram: cooked sausages



Appendix 7
HACCP plan for cooked sausages

Process stages	Hazards	Preventative (control) measures	Critical Control Point	Limits tolerances	Monitoring	Corrective action
Meat and dry ingredients procurement	Biological – Pathogens Physical – Foreign body contamination	Agree on written specification for all materials Suppliers' assurance Buy from approved suppliers only	CCPO1	Tolerances as shown on specification – includes bacterial standards for raw meat and sieving and metal checks for dry ingredients	Routine supplier audit. Warranty/certificate of conformance/certificate of analysis/positive release where necessary by the QA	Hold raw material that deviate from specified limits tolerances Contact suppliers Reject materials from unapproved suppliers
Raw meat intake and storage	Biological – Growth of spoilage bacteria is very likely Physical – Metal, plastic and bone contamination	Store material at or below temperature level sufficient to inhibit growth of pathogens Ambient and material temperature control at reception and storage Visual inspection of deliveries	CCPO2	–18 ºC to –23 ºC for frozen meat. 0 ºC to 5 ºC for chilled meat and ambient for tempering No polythene, bone or metal entrapment	Ambient and material temperature checks at reception and storage recorded by goods-in supervisor. Visual inspection by goods-in supervisor. QA to verify the accuracy of the thermometers and calibrate them when necessary	Reject load if above –18 ºC Reject if foreign body is present. Hold until certificate of conformance/analysis/positive release is issued Contact supplier
Dry goods intake and storage	Biological – Growth of spoilage bacteria is likely if in contact with moisture Physical – Contamination by metal, wood, plastic, glass, pest and other foreign bodies	Check dry goods against specification. Visual inspection, sieving, baiting. Avoid contact with moisture	CCPO3	As specified. No foreign body presence. Free from infestation. No wet package/consignment	Warranty/certificate of conformance to QA. Record of visual inspection. Pest control. Goods-in supervisor to check store humidity	Reject load with foreign body. Reject load contaminated owing to contact with water. Contact supplier. Hold material until certificate of conformance is issued

Appendix 7 cont'd

Process stages	Hazards	Preventative (control) measures	Critical Control Point	Limits tolerances	Monitoring	Corrective action
Chopping and mixing at bowl chopper	Biological – Spoilage bacteria, *E. coli*, *Salmonella, Staph aureus*. Prolonged holding in uncontrolled ambient temperature may result in unacceptable high levels of pathogens. Physical – Foreign bodies including metal, glass, plastic and dirt	Good Manufacturing Practice (GMP) including glass and foreign body/exclusion procedure to be followed by all operators. Effective hygiene programme of equipment and contact surfaces using approved sanitisers. Preventative maintenance of equipment and process by site engineers, work instructions and process control instruction	CCP04	No listeria on contact surfaces. No foreign body contamination of product and process. Micro standards as specified for product and process	Visual inspection by operators and QA. QA to observe cleaning operation. Hygiene swabs by QA to verify the effectiveness of cleaning chemicals and sanitisers on target pathogens. Engineering inspection daily. Daily QA of control system and traceability	Re-evaluate and adjust cleaning procedure, materials and schedules when and where applicable. Hold products back to last cleanup. Dispose of contaminated products
Cooking	Biological – *E. coli*, *Salmonella, Staph aureus* Bacterial contamination from raw to cooked sausages and through potential survival and/or growth owing to insufficient cooking are very likely	Complete segregation of raw and cooked products by the operatives Control of temperature/time of cooking by the operators Training of operators on low/high risk discipline	CCP05	No contact of raw/cooked product. Cooking oil temp of 160 ºC–170 ºC for 4–6 minutes' cooking. Target core temp 85 ºC–95 ºC, with 72 ºC absolute minimum	QA to monitor the temperature/time controls are effective. QA to verify the accuracy of time/temperature measuring devices and calibrate them as specified. Daily audit by QA. Cooking temperature logged	QA to hold product to determine whether to rework or dispose. QA to reassess the process to determine the cause of the defect, including recommendation. The engineers to carry out the necessary repairs or process change
Cooling at ambient temperature (if applicable)	Biological – Contamination by pathogens	Time – Temperature control and profiling by QA and operators	CCP06	Cooling time less than 30 mins. Ambient temperature no more than 10 ºC	QA to observe operators check time, ambient and product temperatures QA to verify the accuracy of thermometers and calibrate when necessary	Hold and dispose of non-conforming products

Process stages	Hazards	Preventative (control) measures	Critical Control Point	Limits tolerances	Monitoring	Corrective action
Chilling to 0 ° to +5 ºC	Biological – Growth of pathogens and spoilage bacteria	Time – Temperature control of product and chiller	CCP07	Chill to 5 ºC in 90 minutes	QA to check and verify time and fridge temperature 2 times in a shift to ensure compliance. QA to verify the accuracy of thermometers used and calibrate them when necessary	Contact engineer if temperature is above 5 ºC
Slicing (optional)	Biological – Recontamination of sausages by spoilage and pathogenic organisms	Keep high-risk area and slicing room temperature at 8 ºC–10 ºC and product temperature at 5 ºC. Stop and clean/sanitise slicing machine hourly. Use gloves and avoid excessive handling	CCP08	Slicing room temperature 8 ºC–10 ºC Product temperature not more than 5 ºC	QA to observe and verify accurate check and record of product and room temperatures for every batch of product. QA to operate positive release of slicing equipment thereby verifying the effectiveness of cleaning agents and sanitisers on contact surfaces	QA to investigate cause of the defect and recommend action. Engineer to perform necessary maintenance and repairs if room temperature is above 10 ºC. QA to hold and dispose of non-conforming products as necessary
Blast freezing (if applicable)	Biological – Post cook contamination and growth of pathogens	Product and freezer temperatures control	CCP09a	Temp.: –18 ºC to –23 ºC	QA to check and verify the accuracy of freezer temperature record chart 2 times in a shift. QA to verify the accuracy of thermometers and calibrate them when necessary	Contact engineer if freezer temperature is above –18 ºC Hold product depending on time and temperature deviation QA to investigate cause of the non-conformance and prevent a recurrence

Appendix 7 cont'd

Process stages	Hazards	Preventative (control) measures	Critical Control Point	Limits tolerances	Monitoring	Corrective action
Cryogenic freezing (if applicable)	Biological – Growth of spoilage and pathogenic bacteria Physical – Contamination by foreign bodies	Time/product and tunnel temperature control and visual inspection	CCP09b	Temp.: –18 ºC to –23 ºC Speed of the tunnel belt to be established based on product size and temperature level	QA to observe check and record of time and temperature of product entering and leaving tunnel every hour	Hold product up to the last check. Contact engineer if there is a breakdown. Adjust process time and speed of the belt and re-pass product through tunnel QA to investigate cause of the non-conformance and prevent a recurrence
Metal detection	Metal contaminants	Preventative maintenance of band saw, bowl chopper, and other equipment in contact with food. Cover in process food. Specify sieving of dry goods	CCP10	3.0 mm Ferrous 3.0 mm Non-ferrous 4.0 mm Stainless steel	QA to verify the accuracy of metal detector and calibrate when necessary. Metal detection of every product batch	On test failure, hold product, reset detector sensitivity and recheck all products back to the last check
Cold distribution	Growth of spoilage bacteria and pathogens	Product and vehicle temperature Hygiene control of transport vehicles	CCP11	Temp.: –18 ºC to –23 ºC	Product and vehicle temperature checked and recorded prior to leaving. Visual inspection of hygienic condition of vehicle	Do not despatch if product temperature is above –18 ºC QA to investigate cause of the non-conformance and prevent a recurrence Contact engineer for necessary repairs

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