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Dear consumer: this article attempts the almost impossible task of reporting results from a major European food research programme called FLAIR in language meaningful to the lay person. So be patient, excuse the complex words and PLEASE read on!

The word FLAIR has connotations of dynamism and creativity and is an apt name for a major research programme (1990-1993) of the European Union on food quality, safety and wholesomeness. As consumers 'we eat to live' but many of us also 'live to eat' - we love and relish our food and demand greater diversity and freshness. The food industry has responded to this demand, and in many cases has created it through promotion and advertising. The outcome is an increasing array of highly attractive foods and food products in the supermarket. Consumers have also become increasingly discerning and are concerned about what the food industry 'may have done' to the foods and they need re-assurance that foods are safe, wholesome and nutritious. This article highlights some aspects of the contribution of the FLAIR programme to this assurance.

Absolute safety does not exist!
In our imperfect world absolute safety does not exist and it is always a case of minimising potential risk. Man accepts this in everyday life as he crosses the road, goes for a swim, plays contact sports, smokes, and eats food. And yet people often apply a different standard to food, i.e. they expect absolute safety and are aggrieved and vocal when they are told it is not achievable. So let's be clear - food is the same as any other aspect of life - it is a case of minimising risk. However, the assurance can be given that national and international research efforts relating to ensuring food quality, safety and wholesomeness are unparalleled in extent with European effort via the FLAIR and follow-up programmes to the fore.

What is FLAIR?
FLAIR is the acronym for 'Food Linked Agro-Industrial Research' and is the first research programme of the EU dedicated to food. The themes food quality, food safety and food wholesomeness were chosen as they are major concerns of the food industry and others in the food chain including consumers; an additional aim of FLAIR was to improve the competitiveness of the European food industry. The FLAIR programme commenced in 1990 and concluded in 1993 and embraced 33 major projects each with participants from different countries thereby combining the best expertise - over 500 persons - in Europe. For the purpose of this article the FLAIR projects are grouped under five headings. However, a number of the projects can be classed under more than one heading, e.g. under hazards and quality. Some of the many achievements and results are as follows:

Eliminating the hazards
The most 'popular' project in FLAIR - based on requests for more information - is the one on hazard analysis, a system that can be equally well applied from a small kitchen, to the largest food factory. A hazard user-guide has been produced enabling the critical points in a food process or the food chain to be pinpointed - for example, places where contamination is likely to occur, or where there is a danger of over or under cooking, i.e. any place where things are likely to go wrong. The systematic approach of hazard analysis virtually eliminates risks, and extensive follow-up training programmes are now in operation to ensure that there is a large uptake by industry.

Five other FLAIR projects had the goal, either directly or indirectly, of eliminating or reducing the number of bad (pathogenic) bacteria in foods. Firstly, a project on preventing and controlling potentially pathogenic bacteria in poultry and poultry meat processing has proved very successful.

Focus on the origin of infection, flock management, and methods of sampling and detection prevents the infection of live birds. Production and operational hygiene procedures have been derived as have protocols for good hygienic practice during slaughtering, dressing and processing of the birds. Implementation of the findings is in progress and will ensure safe poultry products at a time when the consumption of poultry meat is increasing in Europe.

Build-up of material/bacteria (called 'foul') in stainless steel pipes (especially at bends and in pumps) through which milk or other fluid products are being pumped is a potential problem. In order to avoid pieces of foul breaking loose and contaminating the final product,
the pipes have to be dismantled according to a schedule to determine the build-up of foul. Thanks to a FLAIR project\(^2\) this hit-and-miss time-consuming practice can be eliminated and sensors have been developed which are attached to the pipes at strategic locations and alert the operator when cleaning is necessary. A combination of biotechnology and electronics has been used to develop a sensing system\(^4\) for detecting bacteria in foods which is rapid and can detect specific bacteria. The importance of rapid testing cannot be overemphasised as traditional methods can take a number of days. This development will give added confidence to the hygienic quality of food products in the market place. Predicting how bacteria will behave in foods during preparation, processing, storage and retailing is very important for determining product shelf life. ‘Predictive models’ have been generated\(^6\) by collating data on the growth and survival of bacteria under varying conditions of heat, cold, acidity, etc., and the greater the amount of data used to make the model the better the output or prediction from the model will be. The ‘user’ end of the models has been developed as a simple system on a personal computer and not as heavy-weight computing.

Cheese such as Camembert, Manchego, Taleggio, and Herve must be made from raw milk in order to develop their characteristic flavour. Results from a project on the safety\(^7\) of this product indicated that the contamination rate of milk on-farm by the bacterium Listeria is small and that good hygiene and tear cleaning during milking are of paramount importance for a safe product. Special filtering techniques can also be used to remove bacteria from the milk but the bacteria responsible for the characteristic aroma of raw milk Camembert have been re-inoculated into Camembert made from such microfiltered milk. Furthermore, lactic acid bacteria which inhibit Listeria have been tested in the processing of raw milk cheeses with some encouraging results.

The fifth project on eliminating hazards deals with the detection of residues\(^1\) in foods, for example hormones in beef by ‘real time analysis’. This ‘fancy’ expression means that the results of the residue test are available now and not in a week from now as was the case when using traditional analytical procedures. This means that raw material entering a factory can be ‘diverted’ based on a rapid test result rather than a week later when it has been processed into consumer products.

The use of genetic engineering has led to the introduction of a number of traits (for example, disease resistance, or extended shelf life) into several important crops. The tomato is a practical example since it is one of the first transgenic crops likely to be commercialised. It was for this reason that a FLAIR project\(^*\) was initiated to look at the safety of food products derived from transgenic (i.e. genetically engineered) food crops. One aspect was to study the toxicity of the so-called Bt-gene which has been introduced to make tomato crops insect resistant. The transfer of such a gene to tomatoes automatically means the introduction of a foreign protein, i.e. Bt-protein and the possible toxicity of this was screened. The results indicate that Bt-protein in concentrations up to 4000 times the maximum likely to be ingested (1 kg of tomatoes per day) by man has no harmful effect on the growth of mice after exposure for 28 days.

**Maintaining and enhancing food quality**

The development of procedures for measuring food quality was the subject of two FLAIR projects with the first focusing on sensory aspects\(^3\) such as visual evaluation and taste testing and their relationship to consumer food choice and to laboratory tests. The second project used spectroscopy\(^8\) for the rapid analysis of foods. In simple terms, energy or a magnetic field is applied to a food sample and this produces a series of signals that are converted into results for moisture, protein, fat content etc. This technique was used successfully in another FLAIR project to guarantee the authenticity\(^11\) of fruit juices, e.g. to prove that fresh orange juice is fresh orange juice and not an adulterated or watered-down version.

The development of a probe to rapidly count the number of a specific bacterium in raw milk\(^2\) which is responsible for gas production in mature cheese represents a major advance in that milk with high numbers of this bacterium can be diverted from cheese production. Prior to the rapid test the cheese produced from such milk had to be sold prematurely as ‘young cheese’ at a reduced price. This demonstrates the very practical outcome of this FLAIR project and its benefit to the dairy industry. Reducing or eliminating artificial food additives, or replacing them with natural ones is a subject close to the heart of every consumer and was investigated in two FLAIR projects. For example, friendly bacteria (lactic acid bacteria) obtained from dairy and other foods can be used to inhibit bad (pathogenic) bacteria in a range of food products, i.e. they are natural preservatives\(^4\). Similarly, in another FLAIR project, it has been shown that natural enzymes called oxidases\(^5\) can be used to control the development of rancidity, i.e. off-flavour, in oily foods in place of artificial antioxidants—these are exciting and welcome developments.
Five FLAIR projects studied quality improvement in traditional foods, i.e. herbs, ready-to-use fruits, olive oil, wine and wheaten breads in addition to the study already mentioned above on raw milk cheeses. The enzymes responsible for quality deterioration in parsley have been identified and blanching and the removal of oxygen, both offer a means for retaining the aroma of frozen parsley. Blanching must be done in a sealed sachet to conserve the aroma.

Ready-to-use chilled apple slices, kiwi and citrus fruits with a good shelf life have been prepared by packaging in low to very low oxygen atmospheres. The apples are pre-steeped in vitamin C solution to prevent browning while ethylene (a ripening gas produced by the fruits) must be virtually eliminated from the packs for both apple and kiwi slices.

Potential users of the results from this FLAIR project include consumers, caterers and food processors. Research on 16 virgin olive oils showed that the variety of olive grown had the biggest influence on olive oil quality followed by degree of ripeness. Results of consumer preference tests showed that UK and Italian consumers have different sensory preferences and no olive oil exists that is preferred by everyone. Sulphur dioxide has been used for centuries to control yeasts and lactic acid bacteria in wine thus maintaining its quality. However, the amount of sulphur dioxide used has now been optimised thanks to a FLAIR project. The results show that low levels of sulphur dioxide control lactic acid bacteria but higher inclusions are needed to control yeasts. The project on bread quality investigated the effect of including lactic acid bacteria (as sour doughs) in the bread formula as a means of producing wheaten bread with a high and consistent quality, an improved flavour, a prolonged freshness, and an enhanced resistance to mould growth. The results showed that an increased sour dough to dough ratio, or a flour with a high mineral content, both gave more acid-tasting breads with a good loaf volume and a softer texture. The inclusion of sour dough only inhibits mould development to a limited extent and the flavour is considered good in Germany and Denmark where consumers are familiar with sour products; however, consumers in other countries will have to become accustomed to the sour taste.

New and improved food processing technologies

New technology and hi-tech are buzz words of our time and it is not surprising that five of the FLAIR projects relate to new or improved methods for processing food. In three of the projects the emphasis is on safety and on short or gentle heating which does minimal damage to vitamins, minerals and to the sensory quality of the food. This is achieved by using computers to predict the minimum heat needed to sterilise the food in the can or glass jar or by sterilising the foods by pumping them gently through specially designed heated pipes (a high food temperature is achieved for a short time) and then packing in pre-sterilised pouches, cans or jars. Formerly this technology was only available for liquids like milk (i.e. in pasteurisation) but is now applicable to viscous foods containing particles, e.g. dairy desserts, fruit purees, jams, stews, etc. This has given rise to a whole generation of high quality heat processed foods in attractive packs which have a shelf life (unopened) of months at room temperature. Sous-vide cooking, which means gently cooking under vacuum - is another technology of note and gives products of very high quality. It is particularly suited to caterers and one of the FLAIR projects has developed computer software which controls/monitors the sous-vide process and its safety including meal formulation, cooking times and storage duration and temperature; sous-vide foods must be stored at chill temperatures.

‘Hurdle technology’ is the rather unusual title of another FLAIR project and literally means placing barriers or hurdles (as in a race) in the way of bacteria at which they will eventually ‘fall’, i.e. food preservation is achieved by a combination of hurdles or processes. Examples of hurdles include heat (to kill bacteria), cold (to retard their growth), salt, acid, etc. For example, pickles in a jar receive a heat treatment, they contain salt and vinegar, and the jar is stored in the fridge after opening, i.e. four hurdles. Pickles are an example of a traditional food preserved by a combination of processes but the hurdle principle is being applied to the preservation of many other foods.

More and more foods are being packed in a modified atmosphere package called MAP for short - to prolong shelf life. The food is held in a sealed prepack in which the ratio of oxygen to carbon dioxide to nitrogen (these are the gases we breathe - no ‘nasties’ are used) is changed with the oxygen being reduced and the nitrogen and carbon dioxide increased. Results from a project on the safety and quality features of MAP indicate that an atmosphere of carbon dioxide and a chill temperature are best for extending the shelf life of lamb and beef.

Are all dried foods the same? - everyone who has dissolved instantised and non-instantised powders knows that they are not. An instantised powder is an example of a quality improvement achieved through technology and highlights the importance of the FLAIR project on optimising food drying processes in order to retain quality and nutrients in the dried product while achieving other important goals such as ease of reconstruction.
intestine which is rich in probiotic (good) bacteria and devoid of bad bacteria (pathogens). This gives industry the opportunity of producing a range of new foods with enhanced probiotic properties. Of course probiotics are not new - the probiotic properties of yoghurt have been recognised for centuries. The last of the eight nutrition projects dealt with the complex issue of food intolerance\(^6\). One aspect has been to prepare and purify eight allergens from cow’s milk. This has led to much improved screening of allergic patients.

**Human nutrition aspects**

No food research programme on food is complete without a significant input on human nutrition and the FLAIR programme has eight international projects on the topic. One of the projects has the attractive title of ‘Eurofoods Enfant’ and is on harmonising procedures\(^5\) for collecting information on food intake and food composition so that data collected in one country are compatible with those from other countries thus permitting valid comparisons between countries. A second project looked at the availability\(^7\) of minerals and vitamins from foods, i.e. even though they are in a food they may not be available to us or we may not absorb them.

Procedures for measuring the availability of minerals and vitamins in foods have been compared and new ones developed and the results will have special application in fortified foods, i.e. the availability and absorption of nutrients added to foods, e.g. extra calcium or vitamin A. The third project is studying resistant starch\(^7\) which occurs naturally in starchy foods such as beans, potatoes, bread, etc., and is also formed during cooking and cooling of foods, i.e. a portion of the starch is resistant to digestion by humans thereby rendering some foods less calorific than thought previously. The resistant starch also contributes to the dietary fibre content of the food. Methods for measuring resistant starch have been devised and its content in a range of foods determined. Resistant starch is not new - it always existed but has only been found recently thanks to improved testing methods.

Two projects deal with enhancing the nutritional profile of foods. The first relates to the extraction and purification of dietary fibre\(^8\) from a number of fruits, vegetables and cereals. These fibre preparations are then added to other foods to enhance dietary fibre status and also to confer, in some cases, improved sensory quality. The second project has developed reduced or low fat cereal products\(^9\), e.g. biscuits with a fat content reduced from 35 to 18%. This has been achieved by replacing fat with carbohydrates which confer the same mouth feel and flavour as that given by fat.

Studies on the complex topic of the bacterial flora in the human intestine have been ongoing in two projects. Many plant foods contain proteins called lectins\(^10\) some of which have the ability to attach themselves to the wall of the gut thereby blocking the attachment of harmful bacteria. The beneficial lectins are being identified and the long term aim is to use them as natural agents to combat pathogenic bacteria in humans. The second project has developed a number of unique bacterial strains with probiotic\(^\ast\) properties, i.e. they have the potential to restore a bacterial flora in the small intestine which is rich in probiotic (good) bacteria and devoid of bad bacteria (pathogens). This gives industry the opportunity of producing a range of new foods with enhanced probiotic properties. Of course probiotics are not new - the probiotic properties of yoghurt have been recognised for centuries. The last of the eight nutrition projects dealt with the complex issue of food intolerance\(^6\). One aspect has been to prepare and purify eight allergens from cow’s milk. This has led to much improved screening of allergic patients.

**Spreading the good news**

Spreading the results from the FLAIR programme to the food industry and other end-users is of paramount importance and has been ongoing throughout the duration of the programme via a specialised highly successful dissemination project in 17 countries called FLAIR-FLOW EUROPE\(^\ast\), i.e. the flow of information from the FLAIR programme across Europe. FLAIR-FLOW EUROPE is supported jointly by the EU FLAIR and VALUE programmes. The latter is located in Luxembourg and promotes the dissemination and exploitation of EU R and D results. Many of the results from FLAIR are already being used by the food industry and by health professionals while the uptake of others is more in the long term, i.e. some of the projects are termed ‘precompetitive’. The results presented in this pamphlet only represent a fraction of the total output from the FLAIR programme which has harnessed the best expertise in Europe into a major collaborative research effort aimed at helping industry to produce foods of the highest quality, safety and wholesomeness and also to be competitive. This effort has not ceased with the conclusion of the FLAIR programme - far from it - it has been expanded in the ongoing successor to FLAIR, called AAIR and will be increased further in the AAIR II programme which commences in 1995. We are in good and safe hands!

This article was compiled by Dr. Ronan Gormley of the FLAIR-FLOW EUROPE project in collaboration with colleagues in the FLAIR programme and EU officials. For more information on EU food research and development programmes contact Mr. L. Bressl at the European Commission, Directorate General for Science, Research and Development, Agro-Industrial Research (DG XII-E-2, 2126), Brussels. Phone: +32 2.295.0477; Fax: +32 2.295.4322 or Dr. Gormley at the National Food Centre, Dublin 15, Ireland. Phone: +353-1 838 3222; Fax: +353-1 838 3684. For information on the VALUE programme contact Dr. C. Gezinger at the European Commission, Directorate General for Telecommunications, Information Market and Exploitation of Research (DG XIII-D-3), Luxembourg. Phone: +352 4301 33887; Fax: +352 4301 34129.

\(^{\ast}\)The small numbers in the text identify each of the 43 FLAIR projects. Please quote the project number when requesting further information.