The challenge of quality

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Summary

The great change in our Society is that the farming and agri-food sectors are faced with a general saturation of food markets in Europe and with an increasing demand by consumers for high-quality products. The major current questions are thus how to define quality, and how to increase the quality of animal products to satisfy the new consumer requirements.

To achieve the above objectives, the producers and sellers of animal products now need indicators for quality. This is the reason why the Cattle Commission of the European Association for Animal Production (EAAP) had a specific session on this topic in its Annual Meeting, held in Bled (Slovenia) in September 2004.

All the review papers and the short communications presented in this session are in this EAAP publication entitled “Indicators of milk and beef quality”. Additional papers from invited authors were written in 2004 and then added to complete the publication although not all topics related to quality indicators are covered in the present publication. Review papers aim to describe the state of the art in different disciplines including genetics, physiology, nutrition, biochemistry as well as social and economic aspects. Short communications are recent and new results given as examples of the research done in these different areas. All the papers were peer-reviewed by international experts.

This introduction to our EAAP publication aims to remind readers of the history of Cattle in the World, the milk and beef production features in the European Union, and finally the definition of quality for food products and especially for beef, milk and cheese. Parts of this Introduction are based on previous discussions during the EAAP Round Tables, which were held over the last three years during EAAP meetings.

Keywords: cattle, milk, cheese, beef, quality

The history of cattle products

Humankind began domestication of animals and plants at least 10,000 years ago and has been modifying species and agricultural practises ever since. Cattle were domesticated from ursus (B. primigenius) and aurochs 9,000 years ago. The domestication of cattle was simply for meat production at first. Then, about 6,000 years ago, humans started milking their cows. Thereafter, around 5,000 years ago, nomadism was developed. In this new way of life, humans and animals used to migrate together and humans used to depend on cow milk and not on meat (for review, see Tanabe, 2001).

The major objective of agriculture was initially to satisfy the needs of humanity quantitatively with respect to different food products. This objective was achieved at least in developed countries.
Cattle have indeed contributed to society over the millennia by providing food. However, out of a total world population of 6 billions, about 800 million people are nowadays malnourished, mainly in developing countries (EAAP Round Table, 2002).

The increasing development of trades and exchanges within and between countries during Antiquity, the Middle Ages and especially in our modern Society progressively increased the relative importance of economical factors in agriculture, and livestock management. Therefore, the production structure has changed significantly with the development of the market economy, especially during the last couple of centuries.

International trade issues are nowadays becoming increasingly important, as well as concentration of the companies. Globalisation is going ahead anyway and we cannot stop it. More recently, the huge increase in world-wide trade over the last ten years is due to Asia, which is now the new economic player in the World. In addition, imports of developed countries are increasing more than exports, which has increased the gap between developing and developed countries (EAAP Round Table, 2002).

As side effects, the real international prices of agricultural products, including beef and milk, have dramatically decreased during the last twenty years, although the prices at consumer level have not decreased in the same way (EAAP Round Table, 2002). In addition, intensive systems have been developed to a high degree in some countries. This has contributed to rural depopulation. Indeed the FAO reported in 2003 that about 4% of the population works in agriculture in the European Union as compared to more than 50% in Asia and Africa, 20% in the European new members of 2004 and only 2.2% in the USA. In addition, the increase in food supply and in fat content of the human diet has induced obesity in epidemic proportions in developed nations.

Thus, in today’s society in developed countries, changing lifestyles, increasing consumer demands, globalisation, opening of international markets and obvious differences in prices in different markets are forcing producers and sellers of animal products to rethink their business. The major change is that the farming and agri-food sectors are faced with a general saturation of food markets in Europe and with an increasing demand by consumers for high-quality products, especially in terms of healthiness.

The future of livestock in Europe depends mainly on economical and social factors. From an economical point of view, livestock production has to face the reality of free world trade and the progressive removal of import barriers. The question is how to limit the negative effects of globalisation, especially in developing countries, and how to increase its benefits. Producers and sellers must also take into account the consequences of the Common Agricultural Policy (CAP) reform within European Countries, and the enlargement of the European Union, which rose to 25 members in 2004. From a social point of view, environmental degradation is sometimes blamed on livestock. However, livestock provide means of managing our landscapes and of maintaining biodiversity. We must thus recognise the wider role in society of livestock (not only cattle) in providing food products to human beings, in providing products of high quality and in satisfying new consumer expectations in terms of healthiness, environment management, animal welfare, etc. This led Professor Margaret Gill in the Plenary Session of the EAAP Meeting in Bled (September 2004) to suggest that scientists have not been addressing the right questions in their research on livestock. We can also argue that globalisation must not be reduced to trade between countries, but must also include globalisation of environment, human poverty, sustainable agriculture, etc. (EAAP Round Table, 2002). This is the reason why improved sustainability in livestock farming systems became a priority, as integrated research, for scientists of the EAAP (Gibon et al., 1999a, 1999b).
Among the new challenges for scientists is also the necessity to better define quality of food products (including social aspects), and how to increase the quality of animal products to satisfy the new consumer requirements. To achieve this goal, the producers and sellers of animal products nowadays need quality indicators. This is the reason why a specific session of the EAAP meeting dealt with that subject.

**Milk and beef production in Europe**

The economic value of livestock production in the European Union has been recently reviewed by Liinamo and Neeteson-van Nieuwenhoven (2003), Chatellier *et al.* (2003) and OFIVAL (2004) from FAO data before the joining of 10 new countries in 2004. The major points are described below.

The majority of cattle in the World are in Asia (35% in 2002), South America (23%), Africa (17%) and North and Central America (12%). About 6% of cattle were found in the 15 countries of the European Union in 2002 and 4% in the rest of Europe. Among the 1,359 million head of cattle in the World in 2003, more than 160 million were in Brazil, 110-130 in China, 96 in the USA and about 80 in the 15 members of the European Union.

**Milk production and consumption in Europe**

The production of milk comes mainly from cattle in most countries (84% on average in the World, 97% in the European Union) except in India (42%) and Pakistan (31%) (FAO 2003 data). The European Union is currently the first bovine milk producer followed by the USA. They each represent 28% and 15% of the total World bovine milk production. Whereas the average milk yield per cow in the World in 2002 was 2,237 kg, it varied from 487 kg in Africa to 5,903 kg in Europe. Within Europe, Germany and then France and the United Kingdom are the largest producers of milk (24%, 20% and 13% respectively of total bovine milk production in the 15 countries of the European Union in 2003). The number of dairy cows on European farms in 2003 was on average 36 (ranging from 10 in Austria to 100 in the United Kingdom).

The European citizen consumes an average of 323 kg of dairy products (in kg of milk equivalent) per person (data 1999, 2000 and 2002). This is more than the USA and Australia, but less than New Zealand and Switzerland (FAO 1998 data). The European Union is self-sufficient for milk. The main exporters of dairy products in the World are the European Union, Australia and New Zealand.

**Beef production and consumption in Europe**

In 2003, the European Union was the second largest beef producer in the World (about 12%) after the USA (about 20%) and in front of Brazil (less than 12%) and China (less than 10%). The USA is one of the major exporters of beef, more than Brazil and than the European Union. Australia is, however, the country that exports the most beef on the World market. Within the European Union, France and then Germany and Italy are the largest producers of beef (22%, 19% and 16% respectively).

The highest consumption of beef is in Argentina (57.4 kg per inhabitant in 2003), followed by the USA, Australia, Brazil, Canada, Uruguay and Canada (32 to 42.6 kg) and then the European Union (20 kg per inhabitant). The European Union is self-sufficient for beef. However, in 2003, the
European Union imported about 500,000 tonnes equivalent carcass and exported (mainly to Russia) about 410,000 tonnes equivalent carcass.

In Europe, France is the first consumer of beef (27.1 kg per inhabitant per year). France is also the first exporter of beef especially to Italy (50.9%), Greece (12.4%) and Spain (10.1%). On the other hand, Italy is the first importer of beef, especially from France.

**The challenge for the future**

It is quite clear that world demographic development predicts more than 8 billion inhabitants in total for the year 2020. Longer-term forecasts are predicting increasing demand of food mainly from developing countries. Despite the increase in total population, the major cause will be growth in per capita consumption. Beef and milk consumption are forecast to increase by 2.1 to 2.3 fold respectively between 1993 and 2020 in developing countries. The increase in beef and milk consumption will be, however, only 7 to 9% in developed countries (Delgado *et al.*, 1999). Satisfaction of this international demand will require a 46% increase in world grain production. It was thus argued by Corbett (2001) that it would be prudent to enhance the contributions of grazing livestock to meet the increasing demand for products from cattle. Indeed, it will be important not to depend on crop-livestock and intensive systems of production to meet these new human population requirements for food products.

The European Union is, however, self-sufficient for most animal products, except for sheep and goat meat. In addition, different food crises (BSE, foot and mouth, etc.), with their effects amplified by the media, have decreased consumer confidence in animal products. Some consumers even do not accept some of the current agricultural practices. Therefore, European consumers will demand animal products of high quality and Scientists must develop socially acceptable food production methods (Gibon *et al.*, 1999a). The development of Quality Assurance Schemes, by addressing management issues from conception of the animals to the consumers’ plate (from farm to fork) is thus an important challenge to meet. In addition, land is increasingly a limited factor in populated areas of developed countries. Therefore, the management of natural resources and environment will remain an important issue. In developed countries, the majority of citizens is also urban and relatively well-educated. But many of them have little knowledge of agricultural principles, and increasingly ask for more accurate information on food products. So consumers are paying more attention to guaranteed quality, based for instance on environmental and animal-friendly production. It is thus essential to increase consumer awareness of information on agriculture principles and on properties of food and, when needed, to correct any consumer myths. Lastly, urban consumers ask also for convenience (Issanchou, 1996) and this is another important feature to integrate when considering the future of livestock.

Because Europe does not live in isolation, it is also clear that European Agriculture has to remain cost, price and quality competitive, while facing strong price pressures in the international market. In addition, European consumers spend only 16% of their income on food, and this proportion is decreasing. Customers are indeed used to paying low prices for food. But the extra-costs to guarantee the safety and the quality of animal products must be included in the agro-food economy (EAAP Round Table, 2003). Economists have drawn up several scenarios describing the Evolution of Livestock Production in the World and their consequences in Europe. The options depend on the strength of the World economy and the relative importance of Europe. High quality products and regional specialities may be good choices if the relative importance of cost prices does not increase (for review, see Liinamo and Neeteson-van Nieuwenhoven, 2003). Others think that parts of the market involved in the production of cheap food will move outside Europe, whereas Europe will focus on the quality market with high quality standards (EAAP round table, 2001). It is indeed
likely that the relatively high levels of income enjoyed by European citizens will increase the
demands for branded products rather than consumption per capita. Labelling is, however, viewed
as a trade restriction by some countries, whereas others, especially in the South of Europe, view
labelling requirements as an opportunity to brand high-quality products. The success of branded
products is often based on the assumption that many consumers, though not all, would be willing
to pay for transparency, traceability and quality assurance in food products.

The future of livestock is thus uncertain, but, to summarise, it is likely that quality of food
products, the evolution of consumers’ expectations and perceptions, as well as economical factors,
will play a major role in its future.

What does quality mean for bovine products?

The concept of quality

The concept of quality has been defined in many ways, and differs between countries. For northern
European countries, quality refers to health and hygiene aspects and to any other public norms.
Private companies think indeed that a product is of good quality if it follows pre-defined norms.
In the southern European countries, the concept of quality is much wider, including sensorial traits,
the geographical and human environment, any link to a specific region or to any specific method
of production. We will here consider quality as all the characteristics of food products valued by
the consumer. It implies stated and implicit needs of consumers. It is therefore a holistic and
multifaceted concept integrating safety, sensorial and nutritional traits, traceability, or social
considerations (public interest in environment management, animal welfare, etc.). Safety and
Health are however the two major expectations of consumers in developed countries (EAAP
Round Table, 2003).

Safety is the absence of any contamination in food products. It is not linked to the characteristics
of the product itself, except in some specific cases (BSE for instance). It is often linked to the
introduction of external pathogens at any stage of the food chain. It is therefore not always
included in the concept of quality and will not be discussed in this publication despite its increasing
importance for consumers.

Nutritional value or healthiness of food depends more on the product chemical composition. It
includes the type and amount of protein, carbohydrate, lipid, vitamins and minerals in food
products. Consumers in industrialised countries have displayed an aversion to a fatty diet and
therefore to food products with high fat contents. On the other hand, contents in proteins, vitamins,
and micro-nutrients may be positive indicators of the nutritional value of food.

Sensory quality can be defined as texture, flavour, taste and visual aspect. These traits depend
directly on the product characteristics in terms of structure and constitution.

Social considerations arise from changes in consumers’ attitudes towards food and ethical views
of animal and environmental management. This is especially true for cattle, which are supposed
to be reared at pasture in the simplistic view of most consumers. In addition, unlike monogastrics
and human beings, ruminants are able to convert renewable resources (uncultivated land, crop
residues, by-products) into humanly-edible food. Therefore, ruminants play a key role in
sustainable livestock production systems (Oltjen and Beckett, 1996). The perception of those
phenomena by consumers is also important.
Traceability is the ability to trace the food products back to the farm or animal of origin. In other words, the farming and agri-food sector is able to guarantee consumers the origin of the food products, including in terms of animal breed, farm where animals were reared, nutrition programme, etc. This concept differs from that of transparency (e.g. knowing that food products are produced without growth promoters, in respect of animal welfare, etc.). Traceability or transparency often mean quality for at least some consumers. This is not true because the origin of the product or its production conditions do not necessarily mean that it is of high quality (for instance, highly healthful, of good flavour, etc.). The confusion between these concepts is based on consumers’ subjective considerations or social aspects. For instance, consumers are sometimes convinced of possible adverse health effects of foods produced using intensive farming methods. This has reinforced the interest in the benefits of extensive-based systems, for instance at pasture. We will, however, discuss in this publication some aspects of traceability because it is often included as a quality criterion in some quality conventions between producers and consumers.

We must also keep in mind the fact that consumers’ wishes are not always logically consistent. For instance, consumers’ demands for low prices conflict with demands for high-quality products. In beef, demands for flavour tend to conflict with demands for wholesomeness and low fat. These apparent contradictions may be explained by an increasing diversity of expectations from consumers. This may reinforce segmentation of the market and the consumers’ demands for specifications. It is important to underline that the consumer’s expectations (including the different quality traits listed above) vary with consumer type and also with time. It varies depending on incomes, country, culture, consumer’s age, habits, etc. For instance, the price of beef has not declined as much as those for other meats during the last two decades; consequently, beef consumption is more and more correlated to incomes or consumed during festive meals in Europe (EAAP Round Table, 2003).

The concept of quality, and how it will be incorporated in the beef and milk industries, will however change depending on the future, which is itself subject to controversial issues. What will be the weight of the public attitude and wishes? What will be the nature of these wishes? What impact might international companies promoting new technologies have? How will Society meet the challenges of environmental issues and sustainable development? What is the future of local breeds and organic agriculture? None of these questions is simple to answer and therefore any forecasting is hazardous. The future of the livestock sector is thus not secure (EAAP Round Table, 2003). One point, which is however obvious, is that consumers’ needs and expectations must be satisfied.

How can quality traits be optimised and guaranteed to consumers?

Quality traits depend first of all on factors relative to live animals (Figure 1). These factors affect the quality of raw products (muscle for beef and milk for dairy products). They include breeding and rearing strategies, especially nutritional management.

Genetic improvement is quite effective because it is permanent and cumulative: indeed improvements made in one generation are passed to the next ones. Emphasis is nowadays put on genetics and genomics due to the sequencing of genomes from different species, the bovine one being available in the very short-term future (Lewin, 2003). This will have direct applications in genetic improvement and traceability with the help of DNA-based techniques.

On the other hand, functional genomics is likely to impact our knowledge of ruminant physiology. Genomics is indeed a new Science which aims to better understand how biological traits are determined from genes. Genomics is changing our scientific paradigm, because the global
expression of genes in cells and tissues will generate new biological hypotheses. We will thus move from hypothesis-driven research (where scientists test the relevance of biological hypotheses) to hypothesis-generation research (in which new biological hypotheses will appear from the gene expression profiles).

Many papers in this publication will thus deal with genetics and genomics. However, the advent of genomics will probably increase the gap between research and what the consumer can understand. In addition, this approach should not be confounded with genetic engineering, which is the science which involves deliberate modification of the genetic material of plants or animals (Uzogara, 2000). In fact, genetic engineering of food is developing rapidly, but it is more or less accepted. It is in fact rejected by most European consumers.

Figure 1. Quality traits of food products depend first of all on animal physiology and tissue characteristics. They also depend, on the other hand, on the process of muscle and milk transformation into beef and cheese respectively. These characteristics together with the economical and social context may help in the preparation of quality conventions. Consumers decide to purchase the food products depending on their expectations, the quality traits they recognise and the cost of the products.
Husbandry may also affect the quality of the products depending on growth paths, growth rate, nutritional level and the nature of food given to the animals. During the last decade, emphasis has been put on nutritional factors, due especially to the BSE crisis which developed due to the inappropriate type of food given to high-producing dairy cows. Nowadays, consumers are thus increasingly involved in how cattle are fed. Besides, the development of genomic tools now provides a powerful way to understand how production systems interact with Genetics.

Quality also depends on raw product transformation processes (the conversion of muscle into meat, the transformation of milk into cheese). In the case of beef, the conditions of animal slaughtering and carcass chilling play a major role in the determination of tenderness. Methods of muscle stretching have therefore been given increasing attention (Sorheim and Hildrum, 2002). More generally, it is important to develop control systems and techniques for monitoring processes for high quality added-value products. The idea is indeed to anticipate the final properties of food products by any method based on physics, biochemistry or anything else. In this way, emerging technologies (for instance, fluorescence, infrared spectroscopy, etc.), and their on-line applications, are expected to play a key role in predicting quality, and in providing the development of large-scale industrial routine methods.

Because consumers cannot spontaneously assess the quality of food products, the value of those products is recognised through “quality signals”. Brand name is the archetype of such signals. We have now Protected Denomination of Origin (PDO), Protected Geographic Identification (PGI), Traditional Speciality Guaranteed (TSG) or issued from organic farming. The credibility of those quality signals is based on promises for the future quality of food products. This is more and more difficult due to the increasing complexity of the concept of quality as discussed previously (Maze et al., 2001). Nevertheless, this implies the definition of a quality convention, which should specify rules to characterise the products. Various forms of quality conventions exist: they may include quality traits based on origin or animal breeds, on production methods, or on specific supply-chain structure. Quality conventions may also involve typicity (connection with a territory) especially in France and Italy (Sylvander et al., 2003). The success of these conventions can be assessed with different parameters including the market size, the price differential for producers or for consumers, or simply by raising consumer expectations in terms of typicity or quality. The market attractiveness, the economical factors and good co-operation within a production chain are important parameters to ensure the practical success of such conventions. Furthermore, signalling and guaranteeing the quality of a product to consumers require the information to be transmitted from the producers to the sellers and finally to the consumers. This implies good co-operation between all operators of the food chain (Maze et al., 2001).

**Conclusion**

Quality of food products is a very complex concept, which needs to be better defined. The consumers’ expectations and their evolution with time (including apparent contradiction between them) have to be the basis for this definition. We must also face various types of consumers with different types of demands and we must distinguish perceived quality prior to purchase (mainly determined by beliefs and attitudes), at the time of purchase (mainly determined by the product characteristics in interaction with its price) and upon consumption. The different scientific disciplines in Animal Science (Genetics, Genomics, Physiology, Nutrition, Husbandry, etc.) and the expertise in various fields of technical food processing (Physics, Biochemistry, etc.) should help to better define the different dimensions of quality. They are also essential in predicting quality, i.e. in anticipating the different quality traits of food products. Research has thus to be more interdisciplinary and practically oriented to satisfy the consumers’ demands, while fundamental research needs to be maintained for basic knowledge production. The economical
and social aspects remain key factors in the end to meet consumers’ expectations. Scientists have also to participate more in the social debates since consumers are asking for more “transparency”. To conclude, we have to stress the advantages of economic approaches and of consumer-oriented approaches in addition to biological and technical disciplines for the control and the improvement of food product quality. The future of dairy and beef production in Europe depends on this evolution.

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References


Indicators of milk and beef quality
