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The role of animal nutrition in designing optimal foods of animal origin as reviewed by the COST Action Feed for Health (FA0802)

Luciano Pinotti [(1*)], Ashild Krogdahl [(2)], Ian Givens [(3)], Chris Knight [(4)], Antonella Baldi [(1)], Vincent Baeten [(5)], Leonard Van Raamsdonk [(6)], Stephen Woodgate [(7)], Dolores Perez Marin [(8)], Joop Luten [(9)]

[(1)] Università degli Studi di Milano. Department of Health, Animal Science and Food Safety. Via Celoria, 10. I-20133 Milan (Italy). E-mail: Luciano.pinotti@unimi.it
[(2)] Norwegian School of Veterinary Science. BasAm NO-0033. N-Oslo (Norway).
[(3)] University of Reading. School of Agriculture, Policy and Development. Earley Gate Reading. United Kingdom.
[(4)] University of Copenhagen LIFE IBHV. Gronnegardsvej, 7. DK-1870 Frederiksberg C (Denmark).
[(5)] Walloon Agricultural Research Centre. Chaussée de Namur, 24. B-5030 Gembloux (Belgium).
[(6)] RIKILT. Institute of Food Safety. P.O. Box 230. NL-Wageningen (The Netherlands).
[(7)] Beacon Research. Kelmarsh Rd. Clipston LE16 9RX Market Harborough (United Kingdom).
[(8)] University of Cordoba. Department of Animal Production. Campus Rabanales. E-14071 Cordoba (Spain).
[(9)] Nofima AS 9-13. N-9291 Tromso (Norway).
*Feed for Health Action Chair

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This review provides an overview of the main scientific outputs of a network (Action) supported by the European Cooperation in Science and Technology (COST) in the field of animal science, namely the COST Action Feed for Health (FA0802). The main aims of the COST Action Feed for Health (FA0802) were: to develop an integrated and collaborative network of research groups that focuses on the roles of feed and animal nutrition in improving animal wellbeing and also the quality, safety and wholesomeness of human foods of animal origin; to examine the consumer concerns and perceptions as regards livestock production systems. The COST Action Feed for Health has addressed these scientific topics during the last four years. From a practical point of view three main scientific fields of achievement can be identified: feed and animal nutrition; food of animal origin quality and functionality and consumers' perceptions. Finally, the present paper has the scope to provide new ideas and solutions to a range of issues associated with the modern livestock production system.
Keywords. Feeds, foods, animal products, animal welfare, consumer behaviour, research networks.

Le rôle de l'alimentation animale dans l'amélioration du bien-être des animaux ainsi que de la qualité, de la sécurité et de la salubrité des aliments d'origine animale tel que révisé par le COST Action Feed for Health (FA0802). Cet article donne un aperçu des principaux résultats scientifiques d'un réseau soutenu par le programme « *European Cooperation in Science and Technology* » (COST) dans le domaine de la science des animaux, à savoir l'action COST « *Feed for Health* » (FA0802). Les principaux objectifs de l'action COST « *Feed for Health* » étaient les suivants : développer un réseau intégré et collaboratif de groupes de recherches qui se concentrent sur le rôle de l'alimentation et de la nutrition animale dans l'amélioration du bien-être des animaux ainsi que de la qualité, de la sécurité et de la salubrité des aliments d'origine animale ; de l'analyse des préoccupations et les perceptions des consommateurs en ce qui concerne les systèmes de production animale. L'action COST « *Feed for Health* » a abordé ces sujets scientifiques au cours des quatre dernières années. D'un point de vue pratique, trois principaux domaines de réalisation scientifique ont pu être identifiés : l'alimentation et la nutrition animale ; la qualité et la fonctionnalité des aliments d'origine animale et les perceptions des consommateurs. Cet article a pour finalité de présenter de nouvelles idées et solutions pour tout un éventail de questions relatives au système moderne de production de bétail.
Mots-clés. Aliments pour animaux, produit alimentaire, produit animal, bien-être animal, comportement du consommateur, réseau de recherche.

1. INTRODUCTION

Food of animal origin (FoA) contributes significantly to the supply of energy and nutrients in the current EU diet. The latest review of livestock production and trade (FEFAC, 2012) indicates that more than 45 million t of meat, and more than 135 million t of milk and 7 million t of eggs were produced in the EU in 2013. To sustain this scale of livestock production, about 470 million t of feedstuffs are required each year within the EU-28. Clearly, ensuring such high outputs of these traded products conforming to adequate quality standards is a major undertaking and it is fair to say that the EU has made significant progress in defining standards and promoting legislation in this area. As a consequence, the explicit and detailed formulation of the concepts of food/feed safety and food/feed quality, has given rise, within the EU, to legislation on the traceability, controls and labeling of both feed and food. However nowadays both feeds and foods must be considered not only in terms of their nutritional properties but also in terms of their ability to promote wellbeing and protect against chronic disease. Consequently, the role of animal nutrition in designing foods closer to the optimal composition for long-term human wellbeing is becoming increasingly important (Givens et al., 2004; Feed for Health MoU, 2008; Givens, 2010). Starting from these assumptions an integrated, multidisciplinary, and collaborative network (a COST Action) has been set up. The research groups involved addressed mainly two aspects:

– the roles of feed and animal nutrition in improving animal wellbeing and also the quality, safety and wholesomeness of human foods of animal origin;
– the perception of consumers as regards the effects of feed production processes on animal wellbeing and on the quality of the resulting food products.

The project has been supported by the European Cooperation in Science and Technology (COST), one of the longest running European frameworks supporting cooperation among scientists and researchers across Europe. COST does not fund research itself, but provides support for networking activities carried out within COST Actions such as FA0802. The Feed for Health project worked mainly through four Working Groups (WG): Feed and food for health (WG1), Feed safety (WG2), Feed supply (WG3), and Consumer concerns and perceptions (WG4) (see **Figure 1**). During its lifespan (2009-2013) the COST Action FA0802 promoted the acquisition and facilitated the dissemination of knowledge in these areas, and encouraged cooperation between various research fields. Accordingly, the aim of this paper is to provide an overview of the topics addressed by the Action (www.feedforhealth.org/) using some specific examples.

2. NUTRITION AND WELLBEING

In the field of feed and animal nutrition, the FA0802 Action provided the opportunity for addressing the impact of animal nutrition not only on animal wellbeing, but also on food products quality. In this context, feed additives are extremely important. They contribute in general to nutrition optimization and welfare of the animals and provide by this a certain standard of products quality. Some of the nutritional additives and sensory additives have an influence on both animal wellbeing and the characteristics and composition of food for human consumption, even if their formulation, dose and mode of administration, can differ influencing the effectiveness (Gropp, 2010). Vitamins, vitamin-like compounds, essential fatty acids, as well as probiotics

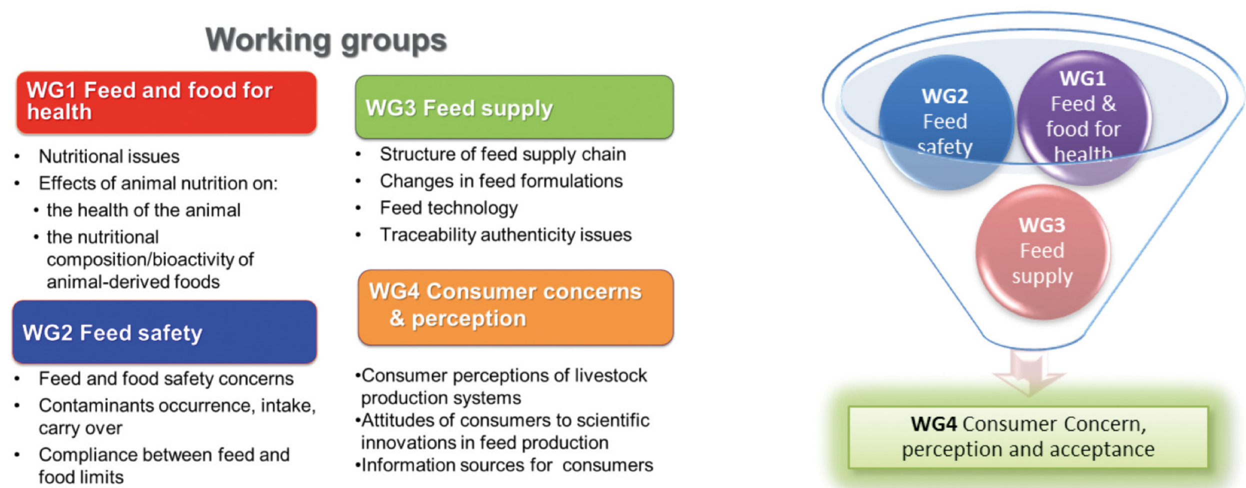

Figure 1. Feed for Health working groups (WG) network — *Réseau des groupes de travail (WG) Feed for Health.*

and nutraceuticals are under investigation by different groups, in order to evaluate their effectiveness in the animal (in improving nutritional status, metabolic balance, and production efficiency) and on the quality of FoA. An example in this context is choline for dairy ruminants. Choline has been classified as vitamin-like compound, and although its requirement for dairy cows is still unknown, higher choline availability (by feeding rumen-protected choline, RPC) can have a favorable effect on milk production, especially at the onset of lactation, when choline has been proposed as a limiting nutrient. Findings in transition and early lactating dairy cows, suggest that greater choline availability can improve not only milk production, but also lipid and methyl group metabolism and choline secretion in milk (Pinotti et al., 2010a; Pinotti et al., 2010b). From a metabolic and hepatic point of view, since choline is a lipotropic factor, it may be particularly beneficial at this time in view of the adipose and liver metabolism changes that occur during the transition from late pregnancy to early lactation. Choline at this stage may optimize the balance between fat retained and fat metabolized by the liver, thereby improving lipid metabolism in general (metabolic optimisation). Milk production response is often a consequence of these metabolic improvements (Baldi et al., 2006; Baldi et al., 2011; Pinotti, 2012).

With regard to FoA quality and functionality, the case of trace elements has been addressed in different species. For instance, as reviewed by Juniper et al. (2011), selenium (Se) is an essential trace element in the diets of both animals and humans; severe Se deficiencies have been associated with cardiomyopathies, whereas less pronounced shortfalls, although not manifesting themselves as clinical symptoms, result in sub-optimal expression of a number of Se dependent enzymes that are important for normal function and antioxidant status. Throughout much of Europe human Se intakes are well below levels needed to optimize the expression of Se dependant enzymes (Rayman, 2004). A number of methods can be adopted to address this shortfall; these include the use of dietary supplements, the use of Se enhanced fertilizers or the use of dietary supplements in food producing animals' diets. Animal feed supplements can contain either inorganic (sodium selenite) or organic (*e.g.* selenoyeast) Se. Organic sources are significantly less toxic and more bio-available than inorganic sources, principally because of differences in uptake and subsequent incorporation into animal proteins predominantly as selenomethionine (SeMet). SeMet in the body is not distinguished from methionine and is therefore actively transported across gut epithelial tissue by methionine transporter mechanisms and is either used for selenoprotein synthesis, *via* the selenide pathway, or incorporated non-specifically into body proteins in place of methionine. Conversely, the transport of inorganic Se across the gut epithelia is predominantly by diffusion and is then either utilized by the selenide pathway for selenoprotein synthesis or methylated and excreted. The rapid incorporation of organic Se into animal products can be demonstrated quite clearly in food producing animals, particularly in tissues and fluids that have comparatively high rates of protein inclusion or turnover such as muscle, liver and milk. In North America and in Europe, milk products contribute to 25% of total Se intake. With respect of the latter, analysis of estimates of Se intake and Se appearance in milk indicated that efficiency coefficients of transfer were greater in Selenium Yeast (SY) supplemented animals compared with sodium selenite (SS) (Juniper et al., 2006). Furthermore, coefficients of transfer were consistent between doses in SY supplemented animals (approximately 18%) but were markedly lower in higher dose SS supplemented animals (8.1% *vs* 11.3% in high and low SS dosage, respectively), indicating that as SS dose increases the efficiency of total Se transfer decreases. Regression analysis of the transfer efficiency of SeMet from feed to milk indicated that changes in milk total Se concentrations appear to be more a function of the SeMet content of the animals' diet, rather than total Se content. It is concluded that the use of higher doses of Se supplements that have comparatively low SeMet contents would result in greater levels of Se being excreted from the animal into the environment whilst conferring little additional benefit, with respect to shortfalls in Se intakes, to the consumers of these animal derived products (Juniper et al., 2011). By contrast, organic selenium administration can be useful strategy for increasing its content in milk and dairy products. Similar approaches have been developed for other farm animals including fish (Moran, 2010).

In addition to the role of specific feed additives, diet formulation and in some cases diet distribution can also affect quality and functionality of animal products. The case of the fatty acid profile of milk and dairy products from cattle on pasture *versus* conserved forage is a further example. Milk fatty acids (FA) are the group of compounds that have attracted the greatest interest in research in order to change in directions thought to reduce the risk of chronic disease in the consumer. Furthermore, FA content and composition, as well as the fat soluble vitamins are some of the compounds that are easiest to manipulate through feeding and through selection of animal breed. The main focus with respect to FA has been to replace a proportion of saturated FA with mono- (MUFA) and polyunsaturated fatty acids (PUFA) in accordance with the evidence that such replacement will provide benefit (Mensink et al., 2003; Siri-Tarino et al., 2010). It was however noted that there were very few randomized control trials with humans that tried to assess any benefits of such changes in FA profile. A focus on this issue took place and the outcome has been summarized by Livingstone et al. (2012). They reviewed the few studies carried out and concluded that most of the studies were underpowered in terms of subject numbers and diet exposure time. They also relied heavily on serum cholesterol as a marker of cardiovascular risk. It is now recognized that use of single risk markers can be very misleading (Astrup et al., 2011).

Metabolism of FA in the rumen and their transfer to milk is dependent on a great variety of factors, including accessibility of the lipid in the feed matrix, the extent of biohydrogenation in the rumen, absorption in the small intestine and transformation and utilization in the body. Fatty acids with a carbon chain length longer than 18 cannot be synthesized by the cow, therefore the occurrence and composition of these FA is highly dependent on the feed source. Typically, strategies based on lipid supplementation of high-concentrate diets are the most effective for altering milk FA composition, but these also result in significant increases in milk trans FA content. Forage based strategies, though less effective in absolute terms, have potential as a low-cost sustainable alternative, avoiding substantial increases in milk trans FA content. Thus, a detailed knowledge of the mechanisms involved in the metabolism of feed lipid, metabolism in the rumen and their transfer into milk fat as well as their interactions is of utmost importance in order to understand and control how the lipid composition of milk can be manipulated through the feeding. Likewise, the content of fat soluble vitamins is an important quality parameter in the milk both with respect to nutritional value and as simple antioxidant in order to protect PUFA (Baldi et al., 2008; Fievez, 2010; Savoini, 2010).

The research in dairy science has also yielded knowledge on how milk composition can be tailored to specific requirements, *e.g.* products targeted at risk groups, and milk for isolation and production of different bioactive molecules. Particular attention was paid to the diets of the elderly and the potential role of milk proteins for reducing the loss of muscle mass and strength (Pennings et al., 2011) and the risk of hypertension (Fekete et al., 2013). Both areas are of large strategic importance for the ability of the dairy and food industry to develop novel, competitive, and functional products (Jersen et al., 2011). Development of nutritional strategies to improve milk composition through sustainable means can be considered as an integral component of this overall strategy. In fact, because of the wide variety of available milk products and their high consumption, these products appear as an excellent matrix for new and functional products whose consumption may have a significant impact in human nutrition (Baldi et al., 2008).

The FA0802 Action however provided the evidence that in addition to milk, meat and eggs can also be redesigned, from a composition point of view, by animal nutrition and feeding. It is well established that the nutritional composition of chicken feed affects the nutritional value and quality of the chicken meat and may affect chicken welfare (Rymer et al., 2005). The most pronounced relationships relate to FA and trace minerals. When the diet content of the n-3 fatty acid and α-linolenic acid from oils such as linseed- and rapeseed oil is increased, the meat is enriched in this fatty acid, and some limited conversion towards the long chain n-3 fatty acids EPA, DPA and DHA also takes place. Supplementation of the diet with organic Se can give a meat product with a Se concentration as high as in fish (Krogdahl et al., 2011). In egg production it has been proven that vitamin E, carotenoids and Se, are efficiently transferred to the eggs. Therefore they can be easily enriched with vitamin E, Se and natural carotenoids to provide in a single egg the daily requirements for vitamin E (15 mg), 50 % RDA for Se (30-35 µg) and substantial amounts of natural carotenoids (mainly lutein and zeaxanthin) (Surai, 2011).

In beef production, modern livestock breeding, production and butchery techniques have reduced the levels of fat in red meat and both livestock feeding and breed can affect the fatty acids in red meat. Industry led studies have been carried out to assess the fatty acid content of red meat, to evaluate the manipulation of fatty acid profiles in a commercial setting, to explore breed differences and to assess consumers views on the key attributes of red meat (Maltin, 2011). The main advantage of increasing micro-constituents in FoA by animal nutrition rather than by postharvest fortification is that they can also safeguard the nutritional status of the animal and this is a primary factor determining the quality, safety and wholesomeness of FoA for human consumption. Furthermore, this ‘feed-to-food’ approach makes it possible to reposition animal products as key foods for the delivery of important nutrients into the human diet.

3. CONSUMERS’ PERSPECTIVES

Cost Action FA0802 has provided a unique opportunity for linking animal science with social science, working in the area of consumer perception (**Figure 1**). In order to address consumer expectations and concerns, it is necessary to investigate what determines consumers’ food choice. Motive and value fulfillment are in general major antecedents for consumer food decision-making, and the achievement of desired consequences, such as a nice, enjoyable meal or the expected health benefits achieved by eating specific foods, are important drivers for food choices (Brunsø, 2009). However, examining the perception of consumers as regards the effects of feed production processes on animal wellbeing and on the quality and safety of the resulting food products that consumers will be willing to purchase, is different. It is generally accepted that consumers prefer animal products from livestock systems that used animal feed which produced food safe for consumers, friendly to the environment and the animals (Krystallis, 2013). They also like to know that there is a traceable link between the animal feed industry and all the regulations related to food safety and quality. In animal production systems, the animal feed was perceived to be particularly vulnerable to contamination, with subsequent negative impacts for the whole chain (Frewer, 2009). Traceability was considered by consumers as a useful tool that offers the potential to improve consumer confidence in food safety. Based on the views of consumers, the optimal livestock production system is the one that would decrease feed costs, increase efficiency and add nutritional and ethical value. More realistically, they would prefer a balance between acceptable price and welfare conditions, with all detailed information available, but not directly to them, so as on the packaging (Frewer, 2009; Luten et al., 2009; Verbeke, 2009). All these features should match with taste. In fact, as very well addressed by Almli (2011) at the 3rd Feed for Health Conference in Denmark, consumers do not compromise on taste for other benefits. From a consumer perspective, healthy innovations are highly product specific, context specific and segment specific. Accordingly, n-3 fatty acids are not suitable for incorporation into all products, while innovations of beneficial character are more suitable for everyday use than for special occasion product consumption. Moreover, all types of innovations may be supported favorably by appropriate consumer communication (Almli, 2011).

Thus social science studies suggest that public interest in livestock production practices has increased while individual perceptions have worsened following consecutive food safety crises during the last decades, combined with a growing alienation from agriculture and farming. Issues of seemingly growing concern among the broader public pertain to the environmental impact, sustainability, and animal friendliness of livestock production, as well as the intrinsic quality and safety of the resulting end products. This evolution contrasts with the actual quality of practice in contemporary livestock production in Europe (Verbeke, 2009).

4. FEED SAFETY

Several issues have severely shaken the public's confidence in the quality and wholesomeness of foods of animal origin. As a result, farmers, nutritionists, industry and governments have been obliged to pay serious attention to animal feedstuff production processes, and have acknowledged that animal feed safety is an essential prerequisite for human food safety.

The ban on the use of growth promoters, processed animal proteins, as well as limitations on the use of genetically modified feed, and bio-fuel production have transformed the market of plant-based feedstuffs. Thus, an increasing amount of different novel feed and by-products is now available. However these products still require authentication and nutritional and safety verification. Feedingstuffs may contain several types of contaminants and degradation products that may affect animal wellbeing and productivity. Furthermore, the presence of anti-nutritional factors of various origins (non-starch polysaccharides and non-digestible oligosaccharides, peptides) may reduce feed efficiency and may have harmful effect on animal wellbeing. In this connection the reduction and control of feed contaminants such as mycotoxins, plant-produced toxins and residues, heavy metals, as well as other harmful biological agents (particularly pathogenic bacteria) and xenobiotics, including their possible carry over from feed to food have been addressed and reviewed (van Raamsdonk et al., 2009; Cheli et al., 2012).

A further output of the Action was to "mitigate" the distance between different countries on specific topics. For instance, in the "Feed-To-Food" / COST Feed for Health Joint Workshop held in Novi Sad, the section on animal proteins gave attention to a real situation, and researchers from the European reference laboratory for animal proteins have provided a timely update about this topic. In fact Veys et al. (2012), Fumière et al. (2012) and van Raamsdonk et al. (2012) have addressed the issue of reintroduction of processed animal proteins (PAPs) into feed in the European Union, and the progress in detection methods, providing in advance the contents of the new EU regulations on this matter (European Union, 2013).

5. EMERGING ISSUES

In the COST Action Feed for Health we tried to address the consumers perspective about the animal production chain by also involving keynote representatives from a large food retailer (*e.g.* Marks & Spencer plc.) and food chain stakeholders (*e.g.* Quality Meats Scotland). From their point of view feeding for "total quality", that can include functional properties, is an important topic, but its extensive application depends on efficiency, consumers' demands and in turn their acceptance to pay for a premium product. Scientific and market contributions from these stakeholders to the Action has however provided the opportunity to start a discussion about a "relatively new" topic *i.e.* sustainability of livestock production. Although, demand for FoA in the future could be heavily moderated by socio-economic factors, such as human wellbeing concerns and changing socio-cultural values, the global demand for livestock products is expected to double during the first half of this century, as a result of the growing human population, and its growing affluence. Over the same period, we expect big changes in the climate globally. In light of this animal production will increasingly be affected by competition for natural resources, particularly land and water, competition between food and feed and by the need to operate in a carbon-constrained economy (Thornton, 2010). For example, food, feed and fuel demands have accelerated the growth in demand for agriculture commodities (Pinotti et al., 2011). Among these the dramatic expansion of crop production for biofuels is already impacting on the resources available globally for food production, and hence on food supply and cost. Moreover, the entire European food supply chain, from plant breeding, feed crop production and feed formulation, to the production of meat, dairy products, eggs, and aquaculture products, is experiencing challenges created by competition from low production cost countries and restrictions imposed by national and EU regulations on environmental impact, animal welfare and traceability. There is considerable uncertainty as to how these factors will play out in different regions of the world in the coming decades. This scenario is likely to generate new trends in the feed sector and in the feed supply chain, as recently addressed by Pinotti et al. (2011). For example, in addition to the competition between sectors for raw materials, the availability of by-products from bio-fuels plants, such as distillers' grains and crude glycerol for use in feed, is likely to increase in the near future. This is why use of by-products in animal diets is a matter of research worldwide, in order to assess, not only economics and marketing issues, but also nutritional and safety facts and effects. One example in this field is represented by glycerol (Holtenius, 2011). It is an energy-rich by-product from bio-diesel production that may be used as additive to diets fed to cattle. In the adult ruminant, glycerol may disappear from the rumen by microbial digestion, absorption and outflow through the omasal orifice. It has generally been thought that glycerol is extensively metabolized in the rumen. However, Holtenius (2011) suggested that significant amounts of glycerol may be absorbed across the rumen epithelium by a passive, non-carrier mediated, diffusion. Absorbed glycerol is efficiently converted to glucose *via* the gluconeogenesis. Apart from the properties related to energy- and glucose metabolism glycerol also acts as substrate for *Lactobacillus reuteri*, a bacterial strain with probiotic properties in calves. Furthermore glycerol may alleviate dehydration. Glycerol of varying quality is available on the market. Crude glycerol, containing 80-90% glycerol but also water, mineral salts and methanol, appears to currently be the quality that is most commonly used in farm animal feeding. However, diets have also been supplemented with refined glycerol, containing >99% glycerol, which is more expensive. Results from an experiment with cows in an early stage of lactation consuming crude or refined glycerol indicated that glycerol quality did not affect total dry matter intake. Obviously, the bad taste and foul smell of crude glycerol did not affect the feed intake. However, intake of refined glycerol increased milk yield and the protein content in milk increased (Holtenius, 2011). Accordingly, it would be essential not only to integrate and collate knowledge on feed ingredients quality (including safety, see Feed for Health, 2011) and feed ingredients supply (market), but also to promote the acquisition and facilitate the dissemination and sharing of information about feedstuffs between research institutions, industry, farmers and consumer organizations. Proper production and use of these by- and co-products as feed ingredients have the potential to provide both the opportunity to formulate least-cost diets, and increase significantly their value.

A different situation exists in the case of seafood. It is generally acknowledged that fish is an important part of a balanced diet. A high level of interest among European consumers in healthy eating, higher living standards and a good overall image of fish have resulted in an increase in fish consumption. In view of that, the importance of safety and quality of fish feed, as well how consumers think about the origin of fish and aquaculture production, were key issues for the Action. Aquaculture is one of the livestock sectors that is growing rapidly. While most agree that fish from aquaculture is beneficial for human nutrition, concerns are raised about sustainability of the raw materials used for producing fish feed (Koppe, 2010). This implies that feed supply and availability of raw materials for aquafeed is another important issue in terms of choosing sustainable and safe ingredients. The main ingredients of feeds for farmed carnivorous fish species are fish meal (FM) and fish oil (FO), at inclusion levels of about 25% and 30%, respectively. These two ingredients supply essential amino acids and fatty acids required by the fish for normal growth. Although the inclusion rates of FM and FO in aquafeed have been progressively reduced in the recent past (in 1985 the inclusion rate was 60% for FM, and in 2005 the level of oil was 35-40%), at present over 50% of fish meal and over 80% of fish oil produced around the world are used in aquaculture. World annual production of fishmeal and fish oil is about 6.5 million t and 1.0 million t respectively, from 33 million t of whole fish and trimmings. Furthermore recently, small quantities of FM and FO (3-5% and 1-3%, respectively) have been included in feeds for omnivorous and herbivorous fish (Koeleman, 2009). In light of this, one of the most-frequently cited issues with the sustainable development of aquaculture is the capture of other fish as a raw material to be used as fish feed in the form of fish meal and fish oil. The supply of these ingredients (manufactured from wild-caught, small, bony/oily marine fish which are usually deemed not suitable for direct human consumption) is in fact expected to remain static, or even decrease, making the supply of alternative proteins and fat sources for aquafeed quite urgent. In this situation, new developments in fish nutrition find a progressive role for amino acids, especially taurine, inclusion of which promotes growth and production of aquatic animals (Schram et al., 2010). It is believed that dietary supplementations with specific amino acids (*e.g.* taurine) may be beneficial for:

- increasing the chemo-attractive properties and nutritional value of aquafeeds with low fishmeal inclusion;
- improving fillet taste and texture;
- enhancing immunity and tolerance to environmental stress and many more.

For instance, higher doses of taurine in feed provides higher taurine contents in fish (Schram et al., 2010), and this can contribute to human diets, even thorough the supply marine oils (*via* aquafeed) can be than limiting.

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6. CONCLUSIONS

Scientific results obtained across Europe as a result of the COST Action Feed for Health have suggested that in general, nutritional interventions in farm animal and fish may positively affect animal wellbeing and in several cases the quality, the safety and the functionality of food of animal origin. This 'feed-to-food' approach makes it possible to reposition animal products as key foods for the delivery of important nutrients into the human diet, even though there are some distinguish between traditional and innovative foods. Further aspects addressed by the COST Action Feed for Heath are that functionality and sustainability (linked to the environment and greenhouse gas emissions from farm animals) are issues that show both similarities and overlap with regard to products, consumer segments and consumer behavior. It has been shown that consumer segments typically identified as more involved with the issue of wellbeing also tend to buy "sustainably" indicating a strong link between the two issues (Aschemann-Witzel, 2011). All these areas are of large strategic importance for the livestock sector to develop innovative, competitive, and functional products.

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