Chapter 7
Impact of Animal Feeding on the Nutritional Value and Safety of Food of Animal Origin

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Abstract The quality, traceability and safety of food of animal origin are affected by several factors, but animal feeding plays one of the most important roles. The basis of the relationship between animal feeding and food quality is the carry-over of some nutrients, tracers and/or contaminants from feed to tissues and, consequently, to food (meat, milk and eggs). As regard the nutrients, an increasing number of papers report the possibility of improving the proportion of some beneficial components in products of animal origin through different dietary strategies. An enrichment of food with omega 3 fatty acids, conjugated linoleic acids, vitamin A and E and selenium could be obtained including feeds with a high concentration of these nutrients in the animal diet. In addition, some specific tracers (i.e. terpenes or volatile compounds) can be identified and quantified in products of animal origin to establish their geographic origin. Finally, as the demand for safer products is growing not only in EU, but worldwide, all actions to prevent and control the contaminants along the food chain must be implemented. The mycotoxin contamination of seeds and forages represents an emergent problem that can be worsened by the globalisation of trades and global warming. The carry-over of mycotoxins from feed to food of animal origin must be monitored to maintain the content of mycotoxins under the maximum levels established by regulation. In conclusion, animal feeding can exert a great impact on the quality, traceability and safety of food products, in order to satisfy the growing requirements of consumers.

Keywords Food safety • Food quality • Traceability • Animal feeding • Carry-over

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Abbreviations

AFB1	B1 aflatoxin
AFM1	M1 aflatoxin
CLA	Conjugated linoleic acid
CVD	Cardiovascular disease
DHA	Docosahexaenoic acid
EPA	Eicosapentaenoic acid
LA	Linoleic acid
MUFA	Monounsaturated fatty acids
PUFA	Polyunsaturated fatty acids
Se	Selenium
SFA	Saturated fatty acids
SPME	Solid phase micro extraction

7.1 Animal Feeding and Quality of Food of Animal Origin

The "Quality of food of animal origin" is a highly complex concept because it involves the whole food chain, starting from the field (i.e. knowledge of pasture, forages, cereal production, etc.) to animal breeding (feeding, genetics and management), and to food processing (treatments, packaging, etc.). All production phases and operators are involved in the improvement of the food quality.

The concept of "quality" in food of animal origin can assume different meanings in relation to the stakeholders and countries, and it has been subjected to significant changes over time (Hocquette and Gigli 2005). Usually, all characteristics of food products evaluable by the consumers (i.e. nutritional traits, sensorial properties, social considerations) can be considered within the holistic and wide concept of "food quality". This chapter discusses the improvement of nutritional value of foods and, in particular, the increase in certain nutrients with beneficial effects on human health will be investigated.

7.1.1 Fatty Acids Profile in Food of Animal Origin

Animal fat contained in food is the chemical component that is more involved in human health due to its high content of saturated fatty acid (SFA). The World Health Organisation (WHO) and Food and Agriculture Organization (FAO) emphasise the need to decrease the intake of fat from food of animal origin, in order to reduce the incidence of more common pathologies in the developed countries such as obesity and cardiovascular diseases. The WHO and FAO (2003) provide data which suggest that by 2020 chronic diseases will account for almost 75 % of all

Table 7.1 Fatty acid profile (g/100 g of total fatty acids) of different food of animal origin

	Recomm.[a]	Milk	Trout	Chicken	Pork	Beef	Eggs
SFA[b]	25	63–71	28–29	33–36	36–40	41–48	45
MUFA[b]	15	23–33	41–43	32–47	43–47	43–45	37
PUFA[b]	60	4–6	29–30	20–32	13–21	7–16	18

[a] Recommended nutritional supply for human health

[b] The range of variation is due to different cuts

deaths worldwide with the vast majority being related to cardiovascular disease (CVD).

The recommended fatty acids ratio in human diets is 25:15:60 (SFA:MUFA:PUFA), but fat of milk is very high in SFA (>60 % of fatty acids).

Among meats of different species, the fatty acid profile of chicken is preferable to pork and beef. Fish products are the richest food in PUFA, and in particular in omega 3 fatty acids (about 24–25 % of fatty acids) (Table 7.1).

Some industrial processes can reduce the fat content of animal origin (i.e. milk skimming, ham trimming) but the partial or total removal of fat is not realisable for some products (e.g. cheese or egg). In addition, the lipid component of food of animal origin has a large number of substances with a bioactive role such as n-3 fatty acids (EPA and DHA acids), conjugated linoleic acid (CLA) and fat-soluble vitamins (A and E vitamins) (Givens 2010). In recent years, several attempts have been made to improve the fatty acid profile of animal origin foods by decreasing the proportion of harmful components (mostly SFA) in favour of PUFA such as omega 3 and various isomers of conjugated linoleic acids that have a beneficial effect on human health.

7.1.1.1 Omega 3 Fatty Acids

Several experiments have shown that supplementation of dairy cow diets with oilseeds rich in omega-3 fatty acids (i.e. flaxseed, rapeseed or soybean) is an effective strategy for improving the nutritional value of milk fat (reviewed by Glasser et al. 2008). However, literature reports that the effects of flaxseed on the milk fatty acid profile tend to be minimal (Kennelly 1996; Glasser et al. 2008). In this regard, Kennelly (1996) reported that the PUFA content of milk produced by cows fed flaxseed does not exceed 3–4 % of total fatty acids. Glasser et al. (2008) indicated that flaxseed promotes only slight increments of omega 3 in the content of milk (<1 % of total fatty acids). From a meta-analysis of published data, the same authors concluded that the beneficial effects exerted by flaxseed on the milk fatty acid profile are dose-dependent, as the magnitude of these effects was negligible at inclusion levels exceeding 600 g/head/day. Accordingly, a recent experiment (Cattani et al. 2013) observed that supplementation of 500 or 1,000 g extruded flaxseed/head/day led to comparable increments in the omega-3 content of milk and ripened cheese (Table 7.2). However, despite these shortcomings, flaxseed was found to be an effective source for improving the nutritional value of milk fat.

Table 7.2 Fatty acid profile (g/100 g of fatty acids) of milk and cheese obtained by cows fed different levels of extruded linseed (Cattani et al. 2013)

	Dietary treatment[a]			*P* values[b]	
	CTR	EF500	EF1000	CTR vs. EF	EF500 vs. EF1000
Milk					
SFA	72.5	72.9	71.7	0.83	0.34
MUFA	22.7	22.1	22.8	0.70	0.50
PUFA	3.59	3.93	4.29	0.09	0.20
n-6	2.74	2.80	2.98	0.31	0.31
n-3	0.30	0.52	0.61	0.03	<0.05
n-6:n-3	9.68	5.54	5.16	0.38	<0.05
Cheese					
SFA	71.4	70.4	69.6	0.32	0.53
MUFA	25.0	25.5	26.1	0.50	0.64
PUFA	3.65	4.07	4.35	0.12	0.38
n-6	2.79	2.88	2.98	0.26	0.47
n-3	0.31	0.53	0.63	0.06	0.30
n-6:n-3	9.38	5.53	4.94	<0.05	0.60

[a] CTR, control diet without extruded flaxseed; EF500, diet with 500 g/head/day of extruded flaxseed; EF1000, diet with 1,000 g/head/day of extruded flaxseed

[b] Orthogonal contrasts: CTR vs. EF500 + EF1000; EF500 vs. EF1000

Consequently, the milk of dairy cows fed with flaxseed displayed low atherogenic and thrombogenic indexes, thereby indicating low ratios between some SFA deleterious for human health (myristic, palmitic and stearic acids) and PUFA exerting health benefits as omega-3 and omega-6 fatty acids (Caroprese et al. 2010; Hurtaud et al. 2010).

Similar results were reported for sheep milk (Branciari et al. 2012). Even if flaxseed represents the most used source to improve the fatty acid profile of dairy products and meat, other oilseeds have been employed with the same scope. By supplementing cottonseed and soybean to dairy cows, some authors (Dhiman et al. 1999, 2000; Solomon et al. 2000) found positive responses on the CLA content of milk and cheese. Bailoni et al. (2004) observed that feeding dairy cows with extruded and toasted full-fat soybeans reduced the total proportion of SFA in milk and increased the total PUFA (in particular linoleic and α-linolenic acids) compared to soybean meal. More specifically, full fat soybeans reduced the proportion of palmitic acid (C16:0), which was found to be responsible for increasing cholesterol concentration in blood. Other studies reported that oilseed supplementation was also effective in improving the fatty acid profile of butter or cheese produced using milk of different species (Dhiman et al. 1999; Luna et al. 2005; Nudda et al. 2005; Gómez-Cortés et al. 2009; Hurtaud et al. 2010; Mele et al. 2011). Cattani et al. (2013) found that omega-3 and omega-6 fatty acids were efficiently recovered (>90 %) in curd during the cheese-making process, providing evidence that the supplementation of extruded flaxseed to dairy cows could represent a valid strategy for improving the nutritional quality of cheese fat.

In recent years, several studies have been conducted on beef cattle to manipulate the fatty acid composition of meat by the dietary inclusion of oilseeds. Recently, Mach et al. (2006) investigated the effects of three increasing levels (50, 80 and 110 g/kg of dry matter) of whole canola seeds and whole flaxseed on the fatty acid profile of 54 Holstein bulls and observed that the concentration of omega-3 fatty acids in the *Longissimus dorsi* muscle increased linearly with the supplementation level. Several studies investigated the effects of physical form of seeds on the fatty acid profile of milk and meat. Gonthier et al. (2005) did not observe differences when raw, micronised and extruded flaxseed were offered to dairy cows. Similarly, Raes et al. (2004), in a study conducted on Belgian Blue bulls, found that whole soybean and flaxseed (extruded or crushed) exerted comparable effects on the fatty acid profile of meat.

Regarding non-ruminant species, some recent studies showed that supplementation of extruded flaxseed could represent a promising strategy to enrich eggs (Shapira et al. 2008) and rabbit meat (Kouba et al. 2008) with omega-3 fatty acids.

7.1.1.2 Conjugated Linoleic Acids

The term “conjugated linoleic acid” (CLA) refers to a mixture of positional and geometric isomers of omega-6 essential fatty acids (cis-9, cis-12, C18:2, LA) (Kelly 2001). In ruminants, these isomers are mostly synthesised by some bacteria in the rumen as intermediate compounds of the bio-hydrogenation process, and, partly, in the mammary gland from the endogenous conversion of transvaccenic acid by Δ9-desaturase. In recent years, CLA aroused great interest in the scientific community because several in vivo and in vitro studies highlighted not only its anti-carcinogenic activity but also its anti-atherogenic, anti-obesity, anti-diabetic and immune-stimulating properties (McGuire and McGuire 1999). Cis 9, trans 11 CLA is the biologically more active isomer and accounts for 80–90 % of the total CLA present in milk or meat.

Even if food products derived from ruminant animals, milk in particular, are commonly rich in CLA (Bailoni et al. 2005), attempts are being made at further enriching their contents by means of nutritional strategies (Antongiovanni et al. 2003). The CLA content in milk or meat varies greatly from 0.1 to 2 % of fatty acids (Khanal and Olson 2004). The content of CLA in milk is mainly influenced by the amount and quality of forages. Cows fed with pasture, better if high hill pasture, produced milk with a higher content of CLA than those fed hay or silage (Bortolozzo et al. 2003) (Fig. 7.1). If pasture or fresh forages are not available, fats or fatty feeds can be added to the diet but, in order to avoid the process of bio-hydrogenation in the rumen, these supplements must be ruminally protected. The best protection is their saponification to calcium salts. As an alternative, full-fat oilseeds can be used, provided that they are adequately treated (i.e. extrusion) in order to protect lipids from rumen degradation (Bailoni et al. 2004) (Fig. 7.2).

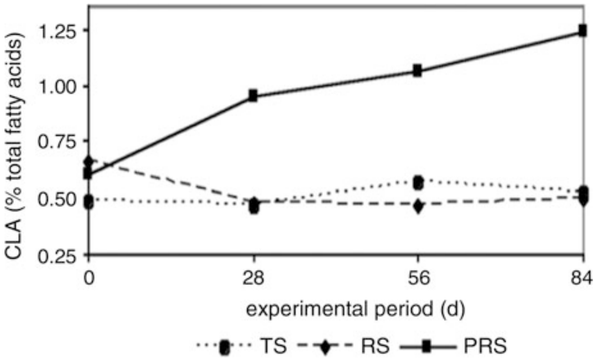

Fig. 7.1 CLA content of milk obtained by cows at pasture (PSR) and with total mixed ration with the addition of toasted (TS) or raw (RS) soybean (Bortolozzo et al. 2003)

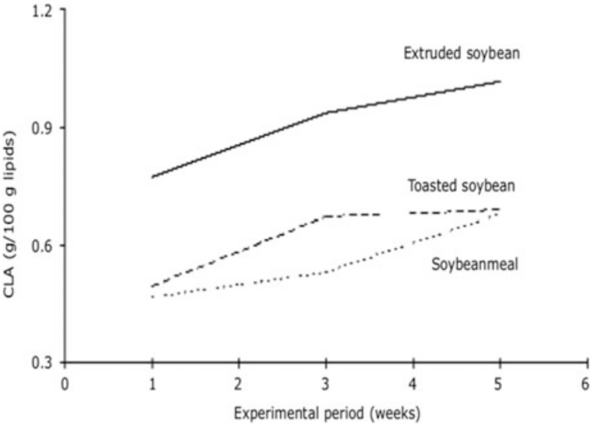

Fig. 7.2 CLA content of milk obtained by cows fed extruded or toasted soybean seeds and soybean meal (Bailoni et al. 2004)

In order to increase the CLA content of cattle meat, rumen-protected CLA can be administered directly to fattening animals. Schiavon et al. (2011) carried out an experiment on double-muscled Piemontese bulls to evaluate the effects of two rations differing in crude protein density (HP = 14.5 % DM and LP = 10.8 % DM) and top dressed or not with 80 g/day of rumen protected CLA for a long period (336 days). The authors observed that the concentrations of both cis9, trans11 CLA and trans10, cis12 CLA strongly increased in all tissues ($P < 0.01$) of bull-fed rumen-protected CLA (dosage of 80 g/day) compared to the control group (Fig. 7.3).

7.1.2 Selenium

Selenium (Se) is an essential trace element for both animals and humans. As a component of selenoamino acids (i.e. selenomethionine and selenocysteine), Se plays important roles in the maintenance of the thyroid function (WHO 2004)

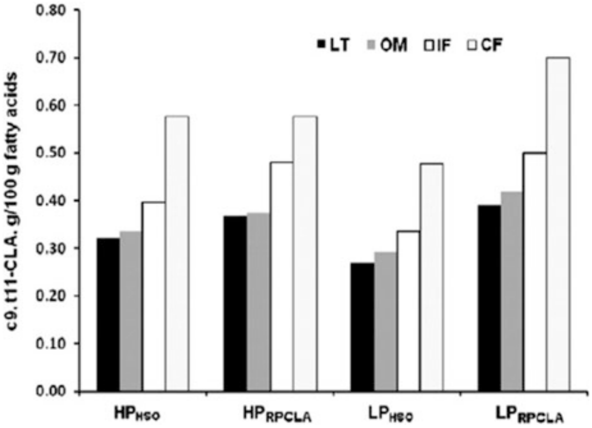

Fig. 7.3 Cis9, trans11 CLA concentration in the lipids of different tissues (LT, *Longissimus thoracis*; OM, other muscle; IF, intermuscular fat; CF, cover fat) in bulls fed two diets (HP = 14.5 % of dietary crude protein; LP = 10.8 % of dietary crude protein) and two top-dressings (HSO = 65 g/day of top dressed hydrogenated soybean oil, RPCLA = 80 g/day of top dressed rumen protected conjugated linoleic acid)

and the prevention of infertility (Ursini et al. 1999) and cancer (Corcoran et al. 2004; Whanger 2004).

Differently from fish and other seafood that are usually rich in Se, milk and dairy products are the poorest sources of Se (Matek et al. 2000). Usually, selenium concentration in milk ranges between 5 and 56 mg/l, depending on the selenium content of vegetable sources fed to animals and of soil where plants were cultivated (Underwood 1971). Recently, several studies have examined the validity of increasing the selenium content of milk by supplementing dairy cow diets with different levels and forms (inorganic or organic) of Se. Supplementation levels investigated by the literature ranged from a minimum of 0.10 mg Se/kg DM (Ortman and Pehrson 1999; Muñiz-Naveiro et al. 2006) to a maximum of 8 mg Se/kg DM (Moschini et al. 2010). Results showed that the transfer of Se from the ration to milk was nonlinear and decreased at increasing supplementation levels (Knowles et al. 1999; Moschini et al. 2010). In this regard, NRC (2001) indicates that selenium should be added to diets of lactating cows at a level of 0.30 mg/kg DM. Regarding the supplemented form, the use of organic Se (selenised yeast from *Saccharomyces cerevisiae*) for animal feeding has been recently introduced by the European Union (Commission Regulation: 2006/1750/EC). Selenised yeast was found to be rapidly effective, as a concentration of Se in milk reached the plateau only 1 week following the beginning of the supplementation period (Ortman and Pehrson 1997). Furthermore, several contributions (Conrad and Moxon 1979; Aspila 1991; Malbe et al. 1995; Ortman and Pehrson 1997; Givens et al. 2004) highlighted that organic Se is more effective than inorganic (sodium selenite or selenate) in increasing the selenium content of milk. A recent meta-analysis (Ceballos et al. 2009), considering the results of 42 different trials, reported that, on average, supplementation with Se promoted an increment of Se concentration in milk of 13 μg/l; however, when organic selenium was used, the magnitude of this response increased up to 29 μg/l. Wu et al. (2011) outlined that the greater effectiveness of organic Se compared to the inorganic form is due to a higher availability of selenomethionine that is better absorbed by the tissues than inorganic forms. However, Weiss (2005) specified that inorganic forms should be preferred when the dietary content of sulphur, an antagonist of organic Se, exceeds 2 %.

Regarding dairy products, the literature showed the possibility of improving the selenium content of cheese, as there was a high recovery of Se in the curd during the cheese-making procedure (Knowles et al. 1999; Moschini et al. 2010).

Other studies conducted on poultry showed that egg and egg products can also be enriched with Se by adding this microelement to the diets of laying hens; as observed for milk, even in this case greater responses were achieved using organic Se (Payne et al. 2005; Skrivan et al. 2006; Invernizzi et al. 2013).

Fewer attempts have been directed at improving the selenium content of meat, especially as this food is, generally, a good source of selenium (Matek et al. 2000). Recently, Juniper et al. (2008), in a study conducted on beef cattle, found that the deposition of organic selenium was greater in the kidney (4.5–6.4 mg/kg DM) and lower in the liver, heart and skeletal muscle. Accordingly to what was described in the case of dairy and egg products, the effectiveness was higher for organic Se compared to inorganic.

7.2 Animal Feeding and Traceability of Food of Animal Origin

Traceability means the *ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution* (Reg. EC 178/2002). This concept of traceability is considered as a pre-condition for a successful food policy. For consumers traceability of food is a credence characteristic (Dolushitz and Engler 2005; Van Rijswijk and Frewer 2008) and is mainly associated with "food identity" in terms of its geographical origin and with animal rearing systems, with particular attention to animal welfare and the environmental impact (Kelly et al. 2005).

In this regard, several analytical tools have been recently developed to quantify specific compounds (tracers) in food and to evaluate the origin of the products or the feeding regimen of animals. These procedures are based on plant biomarkers (i.e. carotenoids, terpenes, flavonoids), metabolic markers (i.e. fatty acid profile, volatile compounds) or physical markers (i.e. isotopes of hydrogen or oxygen to assess the geographical origin and isotopes of carbon and nitrogen to evaluate the feeding regimen of animals). Multi-element and isotopic analyses have been applied to a range of foods to develop methods able to establish their geographical origin, as summarised by Kelly et al. (2005). Other methods are being implemented to evaluate the traceability of food of animal origin using a genomic approach. In the following paragraph the use of terpenes and other volatile substances as tracers of milk and cheese origin will be discussed.

7.2.1 Terpenes

Several researches have been published on the possibility of identifying the provenance of animal origin foods, in particular cheese, through the analysis of specific chemical components. Some papers have turned their attention towards differentiating cheeses of mountain or lowland origin by examining a particular class of substances, namely the terpenes (Mariaca et al. 1997; Viallon et al. 1999). Terpenes are lipophilic aliphatic compounds present in particular herbaceous species and typical of highland pastures. Mariaca et al. (1997) identified terpenes as markers of cheese origin, in terms of altitude, by the sequence plant–animal–milk–cheese. Favaro et al. (2005) established the traceability of Asiago mountain cheese by analysing samples of herbaceous species, milk and cheese of mountain origin using the head-space solid-phase micro extraction (SPME) sampling procedure coupled with gas chromatography–mass spectrometry. Several sesquiterpenes, in particular beta-caryophyllene and beta-humulene, were found in mountain herbage, milk and cheese produced in the mountains, confirming the possibility of using these chemical compounds as suitable markers to discriminate cheese produced from animals grazing on mountain pastures. Figure 7.4 shows the presence of sesquiterpenes in milk samples obtained by grazing cows (from 49 to 54 min of retention time in the chromatograms called Laste Manazzo and Mandrielle); on the other hand, these compounds were absent in milk samples collected at plain in the same range of the retention time of the chromatogram designed at Agripolis.

7.2.2 Volatile Compounds of Milk and Cheese

In addition, Bugaud et al. (2001) found a relationship between the flavour and chemical composition of Abondance cheese and its production from animals grazing on mountain pastures. Therefore, also volatile compounds, which are responsible for the flavour of milk and cheese, can be used as markers to discriminate the origin of a food product. Bailoni et al. (2000) reported the effect of alpine pasture grazing on the flavour of milk produced by a local breed of cows (Rendena). The flavour components were determined by purge and trap techniques coupled with gas chromatography. Milk was collected in 15 farms before and after the grazing period (at plain) and during the alpine pasture (at mountain). The levels of some flavour components (exanal and dimethylsulfide) were over the perception threshold in samples collected at pasture and under this threshold in samples

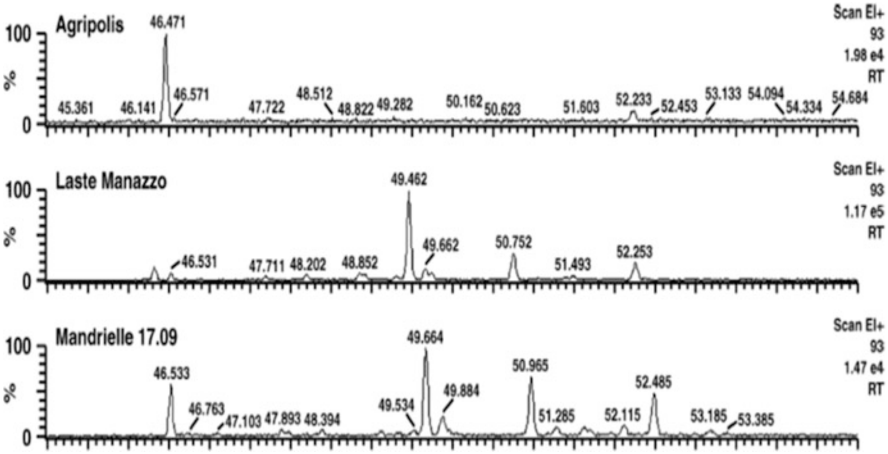

Fig. 7.4 Chromatograms of three milk samples obtained with solid-phase microextraction–gas chromatography–mass spectrometry [Agripolis = lowland sample; Laste Manazzo and Mandrielle = mountain samples (Favaro et al. 2005)]

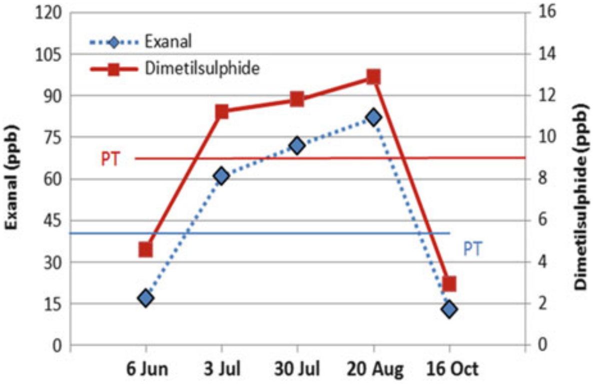

Fig. 7.5 Level of exanal and dimethyl sulphide in milk collected at mountain farms (intermediate samplings) and before and after grazing (6 June and 16 October). *PT* = perception thresholds

obtained by non-grazing cows (Fig. 7.5). These results suggest that a discrimination between milk produced on the alpine pasture and milk produced in the plain is possible using flavour components.

On the basis of previous works conducted on wine, Versini et al. (2000) proposed a new tool to characterise the volatile profile of typical alpine cheeses, using a headspace solid phase micro extraction (SPME) enrichment and gas chromatography coupled by a mass spectrometry (HRGC-MS) procedure. Figure 7.6 reports the chromatograms obtained for the “Puzzone di Moena” and “Nostrano” cheeses. Different amounts of ramified acids are present in two cheeses. This chemical profile can be used to characterise the fermentative pattern of each product and, consequently, their traceability.

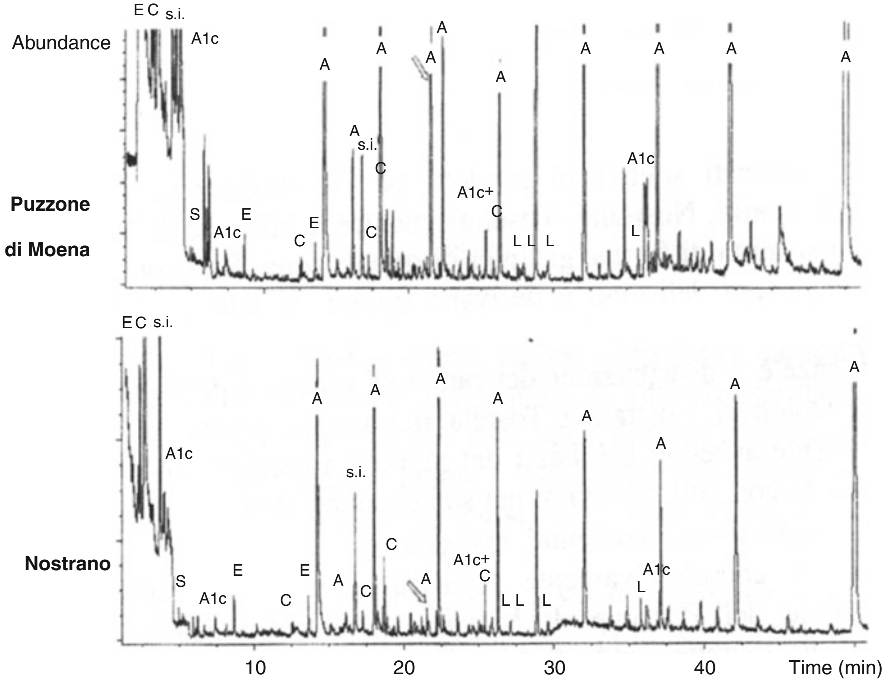

Fig. 7.6 Fatty acid profile of two cheeses (Puzzone di Moena and Nostrano)

7.3 Animal Feeding and Safety of Food of Animal Origin

Food safety refers to the absence of adverse health effects due to the presence of biological and chemical contaminants in food products. As reported in the White Paper on Food Safety (Commission of the European Community 1999), "*assuring that the EU has the highest standards of food safety is a key policy priority for the Commission*". The White Paper proposed a comprehensive and integrated approach to food safety, involving the whole food chain (from farm to fork), all food sectors (production, transport, processing, storage, etc.) and all Member States. Fourteen out of 84 specific actions involve animal feeding, indicating its relevance to guaranteeing safe products for consumers.

Contaminants can have a direct adverse effect on animal health and performance and, because of the carry-over from animal feeds to foods, they may represent a risk also for humans. In the following paragraphs the example of aflatoxin carry-over from feed to food is described.

7.3.1 Aflatoxins in Milk

Among all the food risks, the presence of natural toxic compounds (i.e. mycotoxins) in animal products represents an actual risk, even if their perception by the consumers is very low. The introduction of mycotoxins in the food chain is greatly determined by the ingestion of contaminated feeds by livestock and the subsequent carry-over into animal products for human consumption, particularly into milk and dairy products. At the present time, milk is the only product of animal origin subjected to a EU regulation in terms of mycotoxins and, in particular, aflatoxin M1 (AFM1).

Due to their genotoxic and carcinogenic effects, aflatoxins are considered to be the most dangerous mycotoxins for human health. Aflatoxins are produced principally by *Aspergillus flavus* and *A. parasiticus* mainly in tropical and subtropical regions where the temperature and humidity conditions are optimal for the growth of the moulds. These fungi can produce aflatoxin B1 (AFB1), B2 (AFB2), G1 (AFG1) and G2 (AFG2) on many feed products such as corn, cotton and peanuts. The AFB1 is considered to be one of most potently known natural hepatic-carcinogens for mammals. The exposure to AFB1 occurs mainly with the ingestion of contaminated feeds. Although ruminants are globally more resistant to mycotoxins than most of monogastric animals, as rumen microbes are capable of partially detoxifying mycotoxins, aflatoxin degradation in the rumen is less than 10 % for the contamination level which falls between 1 and 10 μg/ml. When absorbed by lactating animals, the AFB1 is hydroxylated and its main metabolite, the aflatoxin M1 (AFM1), is excreted in the urine, faeces and milk. The International Agency for Research on Cancer (IARC 2002) classified AFB1, AFB2, AFG1 and AFG2 (class 1) and AFM1 (class 2B) as human and possible human carcinogens, respectively. Therefore, the presence of AFM1 in milk and milk products is considered undesirable (Reg. CE n. 165/2010) and the monitoring of contamination of feeds is needed to avoid the carry-over from feed to food. For this reason, the European Commission established both maximum levels of AFM1 in milk and maximum levels of AFB1 in feeds (animal materials, complementary and complete feeds) (Table 7.3).

In European countries the environmental conditions (temperature and humidity) were not favourable to the development of *Aspergillus* (Bailoni et al. 2003; Piva et al. 2006), but some problems could originate from the use of feeds (corn, peanut meal and cottonseed meal) imported from tropical and subtropical areas. However, during the years 2003 and, more recently, 2012, a prolonged drought in the field and summer temperatures over 30 °C caused a production of AFB1 contaminated corn and, consequently, critical levels of AFM1 in milk and derivates.

The carry-over of aflatoxins from feed to milk can vary from 0.1 to 6 %, depending on several factors (milk yield, days in milk, udder infections, etc.), and it is not always predictable or measurable with a high degree of precision. Using the Veldman et al. (1992) equation, it is possible to estimate the AFM1 concentration in milk from AFB1 intake: on this basis cows ingesting an amount of AFB1 higher

Table 7.3 Maximum levels of aflatoxins in animal feed (mg/kg relative to a feed with a moisture content of 12 %; Reg. CE n. 574/2011) and in milk (μg/kg; Reg. CE n. 165/2010)

	AFB1 (mg/kg)	AFM1 (μg/kg)
Complementary and complete feed with the exception of:	0.01	
– Compound feed for dairy cattle and calves, dairy sheep and lambs, dairy goats and kids, piglets and young poultry animals	0.005	
– Compound feed for cattle (except dairy cattle and calves), sheep (except dairy sheep and lambs), goats (except dairy goats and kids), pigs (except piglets) and poultry (except young animals)	0.02	
Raw milk, heat-treated milk and milk for the manufacture of milk-based products		0.050

than 40 μg/head/day produce milk with an AFM1 content higher than legal limits of 0.050 μg/kg. In order to minimise the aflatoxin contamination of feeds, a number of strategies in the field (pre-harvest) or in storage (post-harvest) may be suggested. Aflatoxin detoxification refers only to post-harvest treatments designed to remove, destroy and ultimately reduce the toxic effects of aflatoxins (Ryley and Norred 1999). Aflatoxins are quite stable, although some physical, chemical and microbiological methods have been developed for the detoxification of feeds. Another way to reduce the effect of contaminated feed in animals is the use of mycotoxin binders. These are added to the feed with the aim of "adsorbing" aflatoxin in the gastrointestinal tract and reducing the uptake and subsequent distribution to target organs. A variety of adsorbent materials have high affinity for mycotoxins by the formation of stable linkages (activated carbon, hydrated sodium calcium aluminosilicate and some polymers).

7.4 Conclusion and Perspectives

In conclusion, animal feeding can exert a great impact on the quality, traceability and safety of products of animal origin. Regarding the quality, future perspectives could envisage the production of "functional foods" obtained by improving the transfer of some nutrients with beneficial effects from feed to food and finalised towards satisfying specific needs e.g. omega 3 fatty acids for patients with cardio-vascular diseases, antioxidants for athletes, etc. Regarding traceability, the development of sophisticated analytical techniques to quantify new markers in feeds and foods will make possible to identify the origin of animal products and to provide consumers with information on rearing methods (particularly with regard to the environment and animal welfare). Finally, the increasing demand for food safety requires a greater attention to all contaminants (natural or artificial) that can be moved from feeds to animal products.

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