Authent-Net Commodity Status Report

Commodity: Beef

State of the Art of the commodity:

1. Market Share of Commodity:

In the last years, the world bovine meat production has been modestly increasing: in 2016 it is expected to reach 68.4 million tonnes, while in 2015 it was 67.9 million tonnes. The United States are the major bovine meat producing country in the world, with 11328000 tonnes (10815000 in 2015) that is the highest production in the last three years. The second producer is Brazil, with 9620000 tonnes (9425000 in 2015) which is encouraged in herd expansion thanks to the international trade, despite of a reduction in domestic demand. The European Union is the third beef producer (7876000 tonnes in 2016 and 7719000 in 2015), followed by China, India and Argentina.

In Europe, beef production increased by 3.4% year on year in the first half of 2015, thanks to milk cow slaughtering due to low milk prices and changes in milk producing system. The European countries where this growth was greater were: Hungary, Bulgaria, the Czech Republic, Estonia, Lithuania and Romania, because of the increase in the number of slaughtered heads and in carcass weight. However EU 15 countries (Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom) maintained higher absolute changes in slaughtered beef volume than EU 13 countries (the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia ,Slovakia, Bulgaria, Romania and Croatia), especially thanks to Italy, Spain, Austria, Belgium and Portugal, despite of a smaller increase in slaughtering percentage. On the other hand, Ireland, the Netherlands and the United Kingdom reduced the number of slaughtered animals to increase dairy herds. The growth in EU-13 countries slaughtering is referred to bulls and bullocks and confirms the trend to a rise of importance in beef production in certain EU-13 countries, despite of a shift from beef to dairy in other EU-15 countries. Therefore, the rise of production forecasted in 2016 compared to 2015 (2%) is mainly due to the culling of dairy cows, heavier average slaughter weights and retention of male dairy calves for meat production.

2. Process Specificity of commodity (production/welfare):

It is possible to distinguish between fresh and processed meat. Fresh meat is defined as meat without treatments different from chilling and freezing, while processed meat is a very broad category of many different types of products, all defined by having undergone at least one further processing or preparation step such as, i.e. grinding, adding an ingredient or cooking, which changes the appearance, texture or taste. The main classes of processed meat are described below:

- minced meat – boneless meat reduced in fragments which contains less than 1% salt;

- mechanically separated meat – obtained by removing meat from bones using mechanical devices that bring to the loss or modification of muscle-fibrous meat texture;

- meat preparations – fresh meat (including fragments), containing flavourings, additives or subjected to treatments that do not modify the muscle-fibrous texture;

- meat products – processed products derived from processed meat or further processing of other meat products subjected to treatments that modify the muscle-fibrous texture. There are many meat products produced in different countries, but it is possible to categorize them in six groups, considering the processing technology used:

1. fresh processed meat products – products that are composed of muscle mixed fragments with different amounts of animal fat. They are salted and small quantities of non meat ingredients are added to improve taste and binding. All ingredients are added fresh and some of these products are filled in casings. They are cooked or fried immediately prior to consumption (e.g. hamburgers).

2. cured meat products – products that are submitted to a curing process and they are treated with small amounts of nitrite. These products are divided in two groups:

- *cured raw meat*: products that undergo a process of curing, fermentation and ripening in controlled conditions without any heat treatment (e.g. raw cured beef);

- *cured cooked meat:* products that undergo a curing process and then they are submitted to heat treatment (e.g. cooked beef).

3. raw-cooked meat products – products composed of muscle meat, fat and non meat ingredients which are reduced in fragments, mixed and portioned before being submitted to heat treatment (e.g. meat loaf);

4. precooked – cooked meat products – products made of muscle trimmings, fatty tissues, head meat, animal skin, blood, liver and other edible parts mixed, which undergo two different heating processes: precooking of raw materials and cooking of the finished product mix (e.g. corned beef);

5. raw fermented sausages – uncooked meat products obtained by a mixture of lean and fatty tissues combined with salts, nitrite, sugars, spices and other non meat ingredients filled into casings. They are submitted to a fermentation process (drying and ripening) to obtain the typical flavour and they are consumed raw (e.g. salami).

6. dried meat products – lean meat that undergo a process of drying in natural or artificial conditions to prolong its shelf-life (e.g. dried meat strips or flat pieces).

3. Trade of Commodity:

In 2016 the world trade in bovine meat is expected to rise 1.3% compared to 2015 and to reach 9.3 million tonnes. Brazil is becoming the first exporting country for this commodity (1.8 million tonnes), by superseding India, that was the leader in world beef exports in 2014 and 2015. This trend is due to herd expansion, reduced domestic consumption and currency devaluation. India is forecast to maintain the second place with 1.7 million tonnes of bovine meat exported, despite of the competition from countries of South America. The third exporter is Australia, despite of a fall in output that has reduced exports by 10.5% compared to 2015.

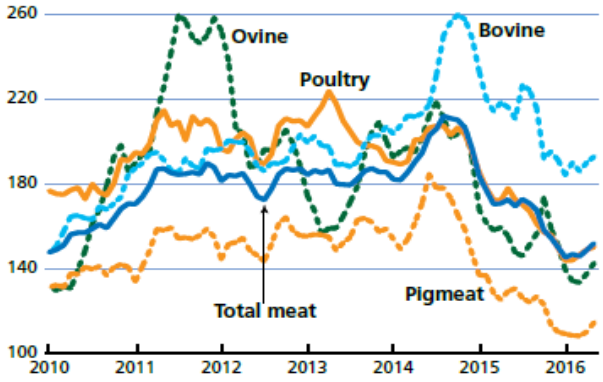
The United States are the forth beef trader with 1.1 million tonnes, rising by 6% from 2015 to 2016, after 3 years without growth in output.

Europe export quotes are expected to little increase compared to 2015, with 292000 tonnes; in 2015 Turkey and Lebanon were the main importers of European live animals.

Considering imports, in 2016 the expansion of demand from Asia (China, Malaysia, Iran, Korea), that would be mainly met by exports from South America, India and the United States accompanied by the recovery in imports from the Russian Federation, are expected to be the main drivers of growth in beef trade. China is becoming the first importer with 1.4 million tonnes. On the other hand, the United States have strongly reduced their purchases but remaining the second world importing country with 1.2 million tonnes. Moreover, imports by Vietnam, Japan and Egypt may modestly decrease, while those from Europe and Canada are remaining steady. In 2015 there was a minor shift in EU suppliers from Brazil and New Zealand to Argentina and the USA.

In 2016 world meat prices are reducing compared to 2014 and 2015, while food consumption is remaining steady.

International prices (FAO meat price index*: 2002-2004 = 100). FAO food outlook, June 2016.



*The FAO price indices are calculated using the Laspeyres formula; the weights used are based on the average export value of each commodity for the 2002-2004 period.

In Europe beef consumption was 10.7 kg/capita in 2015 and it is expected to stay at this level in 2016.

Bovine meat statistics (thousand tonnes, carcass weight equivalent: carcass weight after bleeding, skin, bowel, limbs, head, tail, kidney, fat, breast and external genitalia removal). FAO Food Outlook, June 2016

	Production		Imports		Exports		Utilization	
	2015 *estim.*	2016 *f'cast*	2015 *estim.*	2016 *f'cast*	2015 *estim.*	2016 *f'cast*	2015 *estim.*	2016 *f'cast*
ASIA	**17 990**	**18 118**	**4 592**	**4 780**	**1 945**	**1 966**	**20 681**	**20 928**
China	6 766	6 801	1 207	1 351	38	49	7 954	8 093
India	2 678	2 700	-	-	1 678	1 685	1 000	1 015
Indonesia	601	608	70	65	1	1	670	672
Iran, Islamic Republic of	254	254	98	131	4	4	348	381
Japan	481	475	703	688	2	2	1 164	1 170
Korea, Republic of	323	308	366	390	8	8	720	686
Malaysia	31	31	224	258	15	16	240	273
Pakistan	1 725	1 775	4	4	33	33	1 697	1 747
Philippines	295	300	145	150	4	4	436	446
AFRICA	**6 230**	**6 225**	**742**	**728**	**128**	**88**	**6 844**	**6 865**
Algeria	140	140	82	83	-	-	222	223
Angola	105	104	94	90	-	-	199	194
Egypt	859	870	360	350	9	10	1 210	1 210
South Africa	870	862	25	24	92	50	803	836
CENTRAL AMERICA	**2 555**	**2 571**	**366**	**367**	**325**	**359**	**2 595**	**2 579**
Mexico	1 850	1 865	195	193	151	187	1 894	1 871
SOUTH AMERICA	**15 576**	**15 722**	**329**	**320**	**2 545**	**2 758**	**13 365**	**13 284**
Argentina	2 713	2 653	-	-	201	231	2 512	2 422
Brazil	9 425	9 620	53	50	1 626	1 776	7 853	7 894
Chile	211	200	217	210	11	13	417	397
Colombia	845	820	5	5	13	19	837	806
Uruguay	546	551	4	4	336	369	213	186
Venezuela	557	582	30	30	-	-	592	612
NORTH AMERICA	**11 873**	**12 400**	**1 681**	**1 523**	**1 440**	**1 501**	**12 131**	**12 423**
Canada	1 058	1 072	282	283	356	352	986	1 003
United States of America	10 815	11 328	1 396	1 237	1 084	1 149	11 142	11 417
EUROPE	**10 375**	**10 406**	**928**	**947**	**475**	**515**	**10 828**	**10 837**
European Union	7 719	7 876	322	327	289	292	7 752	7 911
Russian Federation	1 604	1 551	510	524	43	54	2 071	2 022
Ukraine	380	310	2	2	27	28	355	284
OCEANIA	**3 260**	**2 930**	**63**	**63**	**2 273**	**2 067**	**1 052**	**955**
Australia	2 550	2 250	14	14	1 688	1 511	878	782
New Zealand	690	660	16	16	582	553	124	123
WORLD	**67 859**	**68 372**	**8 700**	**8 728**	**9 131**	**9 253**	**67 496**	**67 871**
Developing countries	41 754	42 045	5 263	5 445	4 943	5 170	42 141	42 306
Developed countries	26 105	26 327	3 437	3 283	4 189	4 083	25 355	25 566
LIFDCs	7 981	7 998	128	128	1 804	1 810	6 305	6 315
LDCs	3 519	3 513	166	163	4	4	3 682	3 671

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Key KNOWN Authenticity Issues with this commodity (links):

List of known beef authenticity issues by topic

1. Substitution

Species substitution

In 2013 mislabelled meat products containing horse meat were discovered in many European countries (Ireland, UK, France, Norway, Austria, Switzerland, Sweden and Germany), inducing member states to increase surveillance on these topics. As a matter of fact a common fraud is to mix superior quality meat with cheaper one in ground meat or meat products without declaring it on label or declaring false percentages. Considering analytical tools, species identification is mainly achieved using different methods:

- histological techniques to differentiate species considering muscular parameters (fiber length, diameter, density and pattern of the muscular fibers);

- chemical analysis considering the fact that the amount of certain substances varies among species (glycogen, fat);

- genetic methods using nuclear or mitochondrial DNA:
    - End point PCR;
    - Multiplex PCR;
    - Nested PCR;
    - Real time PCR;
    - RFLP (Restriction Fragment Length polymorphism) PCR;
    - RAPD (Random Amplification of Polymorphic DNA) PCR;
    - AFLP (Amplified Fragment Length Polymorphism);
    - Sequencing Barcoding – FINS (Forensically Informative Nucleotide Sequencing);
    - DNA Hybridization.

- Protein analysis:
    - Poly Acrylamide Gel Electrophoresis (PAGE);
    - Sodium Dodecyl Sulphate PAGE (SDS-PAGE);
    - Counter Immunoelectrophoresis (CIE);
    - Isoelectric Focusing (IEF);
    - Liquid Chromatography.

- Immunological methods:
    - Precipitation Test – Overnight Rapid Beef Identification Test (ORBIT), Multispecies Identification Field Test (MULTI-SIFT);
    - ELISA;
    - Immunoblotting.

NEWS AND CASES RELATED TO SPECIES SUBSTITUTION

- Conspiracy to sell horse meat instead of beef - criminal investigation
http://www.independent.co.uk/news/uk/crime/horsemeat-three-men-charged-conspiring-beef-selling-magistrates-court-police-a7211611.html

- £15,000 fine for lacing lamb mince with cheap beef
http://www.messengernewspapers.co.uk/news/14421045.Skimping_Halal_butchers_slapped_with__15_000_fine_for_lacing_lamb_mince_with_cheap_beef/?ref=twtrec

- Supermarket supplying takeaways and restaurants has been fined £20,000 after environmental health officers discovered lamb mince on sale containing 80% beef
http://www.mirror.co.uk/news/uk-news/supermarket-supplying-takeaways-restaurants-famous-6353818

- US researchers uncover mislabelled meat in two studies
http://www.foodqualitynews.com/R-D/Reasons-behind-mislabelled-meat-findings-vary-researchers

- Adulterated meat products identified in products sold by a large supermarket chain in Russia
https://www.securingindustry.com/food-and-beverage/new-adulterated-meat-scandal-surfaces-in-russia/s104/a2442/#.WMaJEm_hDcs

Protein substitution

Animal proteins could be replaced with vegetable cheaper ones, such as soy, that can be identified thanks to different techniques:

- ELISA;
- Histochemical analysis;
- Immunohistochemical techniques;
- Immunofluorescence;
- HPLC;
- PCR.

Cheaper animal proteins could substitute more expensive animal proteins.

H - caldesmon ELISA can be used to differentiate tissues (it is present in smooth muscles and absent in cardiac and skeletal muscles) and detect this kind of frauds.

Melamine and urea could be also used to add nitrogen to products instead of real meat proteins. Analytical methods normally used to measure total nitrogen content (Kjeldhal and Dumas) are not able to discriminate between nitrogen atoms derived from proteins or chemical compounds, thus chromatographic techniques are employed (liquid or gas chromatography coupled to mass spectrometry).

Fat substitution

The substitution of animal fat with cheaper vegetable one might occur. However, vegetable fat contains phytosterols that are absent in animal fat and can be detected by using different chromatographic methods, such as:

- HPLC;
- GC-MS;
- (APPI) LC-MS/MS

Tissue substitution

The substitution of muscle with collagen or offal may occur. Referring to collagen it is important to consider that it contains hydroxyproline in a larger amount (about 8%) than other proteins. Therefore, it is possible to distinguish between meat parts containing different percentages of hydroxyproline by:

- spectroscopic method;
- chromatographic techniques (LC/MS-MS).

Regarding offal, it can be discriminated from skeletal muscle tissue by:

- mid-infrared spectroscopy;
- ELISA detecting h-caldesmon (it is present only in smooth muscles but absent in cardiac and skeletal ones).

Breed substitution

Different methods can be used to differentiate some cattle breeds:

- genetic analysis.
  - Microsatellite DNA markers, used to identify the Italian cattle breeds Chianina, Marchigiana, Romagnola and Piemontese (Dalvit et al, 2008);
  - SNP, used to detect the cattle breeds Holstein and Japanese Black (Sasazaki et al, 2004).
- NIRS, used to study Friesan and Hereford breeds (Alomar et al, 2003).

Sex substitution

It is possible to determine the sex origin of meat by detecting sex-specific hormones by different analytical tools, such as:

- GC-MS;
- HPLC/MS-MS;
- ELISA;

Moreover, it is possible to employ molecular techniques for sex specific identification of raw meat:

- End point PCR to distinguish the DNA regions that differ between males and females (zinc fingers genes, sex determining region of the y chromosomal gene, tooth enamel amelogenin gene);

- Real time PCR to distinguish the DNA regions that differ between males and females (sex-determining region of y chromosomal gene, X chromosomal proteolipid protein gene, tooth enamel amelogenin gene).

2. Addition of substance X

Additives

Many additives could be fraudulently added to meat. Among these, colouring agents, aromas and preservatives can be detected using HPLC and GC, while fibrinopeptides A and B deriving from trombin addition - are identified using LC-MS/MS.

NEWS AND CASES RELATED TO ADDITIVES

- Ho Chi Minh authorities confiscated a large amount of pork soaked in loads of chemicals to look like beef in a butcher shop in Saigon
http://www.thanhniennews.com/society/yet-another-food-safety-scare-as-fake-beef-discovered-at-saigon-butcher-shop-59006.html

- Chinese firm investigated over food fraud
http://www.globalmeatnews.com/Safety-Legislation/Chinese-firm-investigated-over-meat-doctoring

Water

Water could be added to meat in order to increase its weight; thus extraneous water in meat can be determined by measuring water and protein content, using standardized methods and by determining the water/protein ratio.

3. Process/production/welfare deception

Meat preparation (high temperature cooking process)

It is possible to verify if a product has been treated at high temperatures by detecting chemical compounds produced during its cooking, such as acrylamide, produced above 120°C and that can be identified and quantified, as example, by HPLC (Eerola et al, 2007; Paleologos et Kontominas, 2007) and LC-MS/MS (Granby et Fagt, 2004).

Fresh versus thawed meat

The analytical tools used to distinguish between fresh and thawed meat can be classified in 7 categories:

- sensory methods;
- enzymatic methods (spectrophotometric and colour test methods to measure Beta-hydroxyacyl-CoA-dehydrogenase – HADH);
- optic microscopy (histology);
- electron microscopy;
- Comet Assay;
- Infrared Spectroscopy;
- Nuclear Magnetic Resonance.

Slaughtering methods

Council Regulation (EC)n. 1099/2009 on the "Protection of animals at the time of killing" requires, as a general rule, that "animals shall be spared any avoidable pain, distress or suffering during their killing and related operations". However, it allows slaughter without stunning for particular methods prescribed by Jewish rite (kosher meat) and Muslim rite (halal meat) if it takes place in a slaughterhouse. Therefore, there must be a correct labelling system to avoid that meat obtained through Jewish or Islamic ritual slaughter may be purchased by unwilling consumers who prefer not to eat this meat, while vice versa meat deriving from stunned animals could be sold to Muslim or Jewish consumers.

NEWS AND CASES RELATED TO SLAUGHTERING METHODS

- Beef exporters plead guilty to halal fraud
http://www.omaha.com/news/crime/beef-exporters-plead-guilty-to-halal-fraud/article_f84f81d2-d21b-50f2-a82d-7c42f64ee23c.html

Geographic origin

Different methods can be used to determine the geographic origin of meat and they are divided into two groups:
- chemical analysis, such as inductively coupled plasma mass spectrometry of trace elements and stable isotopes ratios (oxygen, carbon and nitrogen isotopic ratios), based on the principle that the content of these substances in animals depends on feed intake, drinking water, pollution and soil composition, that are typical of the geographic areas in which the animal lives;
- genetic analysis, such as SNP, used to identify breeds that are typical of specific countries.

Organic versus conventional meat

A strategy to differentiate between animals bred using organic or conventional farming systems could be the analysis of isotopic composition, through stable ratio mass spectrometry as it was utilized in Irish beef (Schmidt et al, 2005). The differences detected in carbon, nitrogen and sulphur isotopic composition are partly due to feed intake and to the higher content of 15N contained in fertilizers applied to the soil where conventional animals are fed.

Feed intake

It is possible to determine the feed intake by different chemical methods, which can detect in animal blood and fat the metabolised forms of typical feed constituents. The most common procedures are:

- carotenoids content (higher in pasture than in concentrate and hay) in heifer's fat, detected by HPLC;
- fatty acids composition in meat, detected by GC (higher ratio of polyunsaturated fatty acids than saturated ones and of n-3 polyunsaturated fatty acids than n-6 ones, in grass-fed animals than in concentrate fed animals);
- vitamin and terpen contents in meat.

List of meat authenticity issues by priority

- Prioritisation established according to European Food Fraud Network Reports

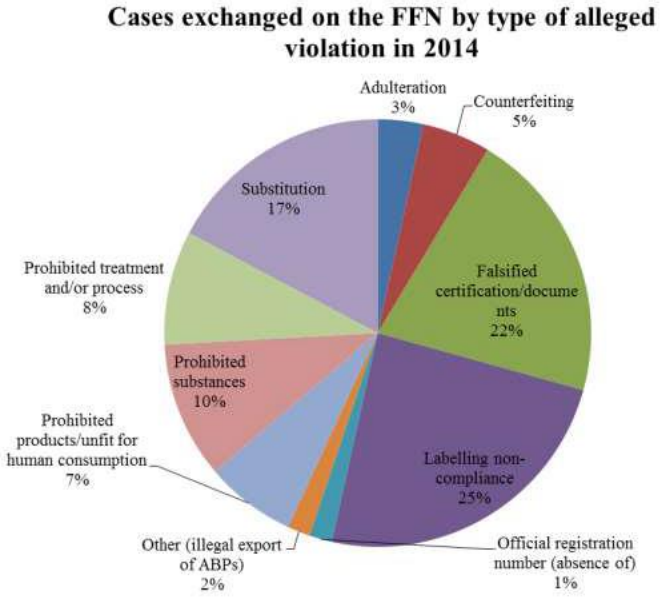
The EU Food Fraud Network (FFN), activated after the horse meat crisis in 2013, is a tool to facilitate the exchange of information on potential food fraud cases. This service is provided by 28 national authorities designed by each Member State for cross-border cooperation.

In 2014, 60 cases were notified by the network, mainly involving meat products and mostly related to:

- Labelling irregularities (durability dates, addition of water, ingredients);

- falsified certification and/ or documents;

- substitution (replacement of higher value species with lower value ones).



https://ec.europa.eu/food/sites/food/files/safety/docs/official-controls_food-fraud_network-activity-report_2014.pdf

- Prioritisation established according to consumer organizations' studies

From April 2014 to August 2015 seven European consumer organizations (Altroconsumo, Consumentenbond, DECO, dTest, OCU, Test-Achats, Which?) analysed a big range of meat- based foods in order to evaluate the presence of frauds. The results showed that the most common irregularities were:

- Mislabelling (for example using similar names to those of legal defined products without respecting the same quality standards; selling products with the same trade name but different characteristics due to confusing definitions by national laws; unclear and misleading food labelling);

- Missing QUID (Quantitative Ingredient Declaration) or discrepancies between what is declared and the actual meat content;

- Undeclared water addition;

- Use of additives (for example the addition of additives in some traditional meat preparations, permitted by EU Regulations, can be unlawfully extended to similar foods that do not meet the same definitions; the utilization of marinades can be unlawfully used to transfer additives to meat by the "carry over principle"; an illegal use of sulphites can take place in fresh meat);

- Undeclared mechanically separated meat;

- Meat species substitution (for example the addition of undeclared species to the declared ones or products only containing other species without the presence of the declared one).

http://www.beuc.eu/publications/Close-up_on_the_meat_we_eat_Consumers_want_honest_labels.pdf

Existing relevant information on methods:

The following standards are approved by the Association of Official Agricultural Chemists (AOAC International) or by the International Organization for Standardization (ISO).

Additives

1. *Nitrite*

- Determination of nitrite in cured meats by colorimetric method – AOAC Official method 973.31
http://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=1556

- Determination of nitrite content in meat and meat products (Reference method) – ISO 2918/1975
https://www.iso.org/obp/ui/#iso:std:iso:2918:ed-1:v1:en

2. *Nitrate*

- Determination of nitrate content in meat and meat products (Reference method) by colorimetric method – ISO 3091/1975
https://www.iso.org/obp/ui/#iso:std:iso:3091:ed-1:v1:en

- Determination of nitrates and nitrites in meat by spectroscopic method – AOAC 935.48
http://www.eoma.aoac.org/methods/info.asp?ID=16587

3. *Ascorbic acid*

- Determination of total vitamin C in food – semiautomatic fluorimetric method – AOAC official method 984.26
http://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=345

4. *Phosphorus and polyphosphates*

- Determination of total phosphorus content in meat and meat products (Reference method) – ISO 2294/1974
https://www.iso.org/obp/ui/#iso:std:iso:2294:ed-1:v1:en

- Determination of total phosphorous content in meat and meat products by spectrometric method – ISO 13730/1996
http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=22789

- Determination of linear condensed phosphates in meat and meat products by thin layer chromatographic separation – ISO 5553:1980
https://www.iso.org/obp/ui/#iso:std:iso:5553:ed-1:v1:en

- Determination of total phosphorus content by titrametric, gravimetric method – AOAC 969.31
http://www.eoma.aoac.org/methods/info.asp?ID=16332

- Determination of phosphorus in meat and meat products by spectroscopic method – AOAC 991.27
http://www.eoma.aoac.org/methods/info.asp?ID=16417

5. *Colouring agents*

- Detection of synthetic, water-soluble colouring agents in meat and meat products by a thin layer chromatographic method – ISO 13496/2000

https://www.iso.org/obp/ui/#iso:std:iso:13496:ed-1:v1:en

6. *Sulphur dioxide*

- Detection of sulphurous acid (free) in meat by titrimetric method – AOAC 892.02
http://www.eoma.aoac.org/methods/info.asp?ID=9328

7. *Preservatives*

- Detection of preservatives (sorbates, ascorbates, benzoates, sulphites) in ground meat by spectroscopic method – AOAC 980.17
http://www.eoma.aoac.org/methods/info.asp?ID=9464

Meat components

1. *Fat*

- Determination of total fat content in meat and meat products – ISO 1443/1973
https://www.iso.org/obp/ui/#iso:std:iso:1443:ed-1:v1:en

- Determination of fat (crude) or ether extract in meat by gravimetric method – AOAC 960.39
http://www.eoma.aoac.org/methods/info.asp?ID=16128

- Determination of fat (crude) in meat and meat products – AOAC 991.36
http://www.eoma.aoac.org/methods/info.asp?ID=16281
2. *Water*

- Determination of moisture content in meat and meat products (Reference method) – ISO 1442/1997
https://www.iso.org/obp/ui/#iso:std:iso:1442:ed-2:v1:en

- Determination of moisture in meat and meat products by air drying – AOAC 950.46
http://www.eoma.aoac.org/methods/info.asp?ID=15720

- Determination of moisture and fat by microwave and Nuclear Magnetic Resonance analysis – AOAC 2008.06
http://www.eoma.aoac.org/methods/info.asp?ID=49193

3. *Protein*

- Determination of nitrogen content (Reference method) – ISO 937/1978
https://www.iso.org/obp/ui/#iso:std:iso:937:ed-1:v1:en

- Determination of nitrogen in meat by Kjeldahl method – AOAC 928.08
http://www.eoma.aoac.org/methods/info.asp?ID=16468

- Determination of crude protein in meat and meat protein by combustion method -AOAC 992.15
http://www.eoma.aoac.org/methods/info.asp?ID=16519

- Determination of crude protein by digestion method – AOAC 981.10
http://www.eoma.aoac.org/methods/info.asp?ID=16570

- Determination of protein in raw and processed meat by authomated dye binding method – AOAC 2011.04
http://www.eoma.aoac.org/methods/info.asp?ID=49499

- Determination of soyben flour in meat/cured meat by microscopy – AOAC 913.01
http://www.eoma.aoac.org/methods/info.asp?ID=16740

- Determination of soy proteins in raw and heat processed meat by Enzyme Linked Immunosorbent Assay – AOAC 988.10
http://www.eoma.aoac.org/methods/info.asp?ID=16859

4. *Hydroxyproline*

- Determination of hydroxyproline content in meat and meat products – ISO 3496/1994
https://www.iso.org/obp/ui/#iso:std:iso:3496:ed-2:v1:en

- Determination of hydroxyproline in meat and meat products by colorimetric method – AOAC 990.26
http://www.eoma.aoac.org/methods/info.asp?ID=16706

Species identification

- Multiplex PCR – ISO/NP 20148 under development
http://www.iso.org/iso/catalogue_detail.htm?csnumber=67154

- Identification of beef and poultry adulteration of meat products by ORBIT (overnight rapid bovine identification test) and PROFIT (poultry rapid overnight field identification test) kits – AOAC 987.06
http://www.eoma.aoac.org/methods/info.asp?ID=16876

Official Bodies/ Countries involved in control funding of this commodity:

International:

- International Meat Secretariat (IMS)
http://www.meat-ims.org/
- Agri benchmark
http://www.agribenchmark.org/beef-and-sheep/beef-and-sheep-network.html
- Liason Centre for the Meat Processing Industry in the European Union (CLITRAVI)
http://www.clitravi.eu/

National European Associations:

- ASSOCARNI (Italy)
http://www.assocarni.it/
- Beef Policy Unit (Ireland)
http://www.meat-ims.org/groups/beef-policy-unit/
- Belgian Meat Office
http://www.meat-ims.org/groups/belgian-meat-office/
- Centre d'Information des Viandes (CIV) (France)
http://www.meat-ims.org/groups/centre-dinformation-des-viandes-civ/
- Confecarne (Spain)
http://www.meat-ims.org/groups/confecarne/
- Dutch Meat Association (COV) (Netherlands)
http://www.cov.nl/
- Fédération des Industries et des Commerçants en gros de la viande (France)
http://www.fnicgv.com/Default.aspx?lid=1&rid=76&rvid=1140
- INTERBEV- Interprofession bétail et viande (France)
http://www.interbev.fr/interbev/missions/
- Meat Industry Ireland (Irerland)
http://www.meat-ims.org/groups/meat-industry-ireland-138591444/
- The Livestock and Meat Commission of Northern Ireland (LMC) (Northern Ireland)
https://www.lmcni.com/
- The Norwegian Egg and Meat Marketing Board (Norway)
http://www.matprat.no/
- UNICEB - unione importatori esportatori industriali commissionari grossisti ingrassatori macellatori spedizionieri carni bestiame prodotti derivati (Italy)
http://www.meat-ims.org/groups/uniceb/
- VDF – German Meat Association (Germany)
http://www.v-d-f.de/

Gaps:

It is necessary to ameliorate analytical tools to detect meat frauds following three strategies:

1. to improve standardization of analytical validated procedures not included in existing standards (determination of additives, use of molecular techniques to determine species substitutions);

2. to revise standardized methods, such as the EU reference method to determine hydroxyproline content in meat (it is a simple spectrophotometric technique, while other more advanced ones (e.g.LC-MS/MS) are available but not recognized as reference techniques);

3. to develop and validate innovative analytical approaches to propose solutions for different issues directly linked to frauds such as:

- distinguishing different meat cuts (a possible solution could be the evaluation of collagen content that varies among different meat cuts, considering that visual inspection is useful only to differentiate primary beef cuts);

- characterizing different animal breeds, using larger data set to build effective models (NIR techniques);

- determining the animal feed intake , since the actual analysis based on carotenoid content in fat and blood are influenced by other factors such as breed, gender, lactation and rumen environment;

- establishing the geographic origin of meat, since the simple identification of breed could not be effective due to the fact that individual breeds can be raised in different countries despite of their origin;

- determining the slaughter age of animals;

- quantifying vegetable fat as adulterant in meat, not only revealing its presence by phytosterols detection;

- detecting animal fat from different not declared species used ;

- developing methods to reveal fresh- thawed products applicable to ground meat and temperatures higher than -12°C (the HADH method is not applicable to ground meat because the grinding process causes alterations similar to those induced by freezing and it is able to detect frozen-thawed meat only if the freezing temperature has been -12°C or below).

References:

- AOAC International
https://www.aoac.org/AOAC_Prod_Imis/AOAC_Member/Default.aspx?WebsiteKey=2e25ab5a-1f6d-4d78-a498-19b9763d11b4&hkey=8fc2171a-6051-4e64-a928-5c47dfa25797

- Analytical methods for authentication of fresh vs thawed meat – a review, Ballin N.Z., Lametsch R. (2008) Meat Science 80 (2008) 151-158

- Authentication of meat and meat products, Ballin N.Z. (2010) Meat Science ,86 ,577-587

- Categories of meat products (FAO)
http://www.fao.org/docrep/010/ai407e/ai407e09.htm

- Close-up on the meat we eat – Consumers want honest labels, BEUC (The European Consumer Organisation), Nov. 2015

- Comparison of new immunofluorescence method for detection of soy protein in meat products with immunohistochemical, histochemical and ELISA methods, Petràsovà M. et al (2014) Acta Vet. Brno, 83:S65-S69.

- European Commission, Short term Outlook for EU arable crops, dairy and meat markets in 2015 and 2016

- European Regulation 853/2004 attachment 1

- FAO Food Outlook June 2016

- Food Fraud Network Activity Report 2014

- Fraudulent Adulteration/substitution of meat: a review, Bhat M.M. Et al (2015) International Journal of Recent Research and Applied Studies, Volume 2, Issue 12 (5) December 2015

- International Organization for Standardization - http://www.iso.org/iso/home.html

- Meat species specifications to ensure the quality of meat – a review, Singh V.P., Neelam S. (2011) International Journal of Meat Science 1 (1):15-26.

- Study on information to consumers on the stunning of animals, European Commission. Directorate General for Health and Food Safety.