



Module 2.2



Quality and safety indicators for fresh and frozen beef, conventional versus organic

Carmen Georgeta NICOLAE

University of Agronomic Sciences and Veterinary Medicine of
Bucharest , Faculty of Animal Products Engineering and
Administration

Bucharest, Romania

carmennicolae19@yahoo.com



Module: Sustainable processing for organic food products



Outline

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Learning Outcomes

In the context of supplying high-quality food for human consumption, the beef, sources of "noble protein", play an important role.

The module "Quality and safety indicators for fresh and frozen beef, conventional versus organic" provide information about cattle, chemical composition and sensorial characteristics of beef, physico-chemical analyzes, specific legislation.

The skills acquired relate to the identification of beef quality, and the recognition of meat suitable for human consumption.

Introduction

Numerous studies and archaeological discoveries have revealed that man has consumed meat for at least 1.5 million years. Moreover, it seems that the survival and evolution of the human species over time have depended on regular consumption of meat.

Meat is an important source of proteins, lipids, minerals and vitamins indispensable to the life and activity of the human body.

One of the meat consumed with pleasure by human is beef. It is important for beef producers and traders to control the quality and sensory characteristics (sensitivity, aroma, juices and color) of the beef to meet consumer preferences.

The sensory quality of meat depends not only on the factors of production - race, genotype, age, diet, growth path or slaughter, but also technological factors - slaughter conditions, aging, cooking.

Representative breeds of domestic cattle for meat



➤ **Aberdeen Angus**



➤ **Hereford**



➤ **Shorthorn**



➤ **Charolaise**



Representative breeds of domestic cattle for meat



➤ **Limousine**

➤ **Blonde d'Aquitaine**

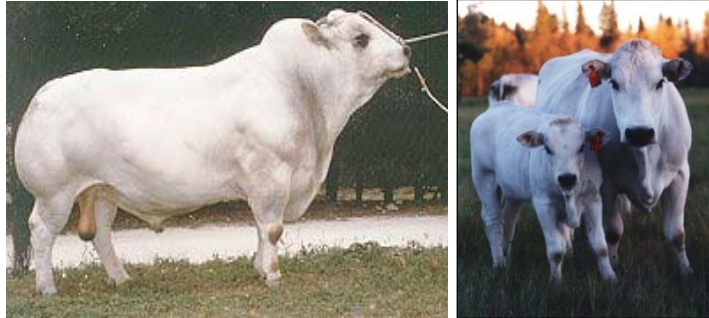


➤ **Blanc-Bleu Belge**

➤ **Chianina**

Representative breeds of domestic cattle for meat

➤ Marchigiana



➤ Romagnola



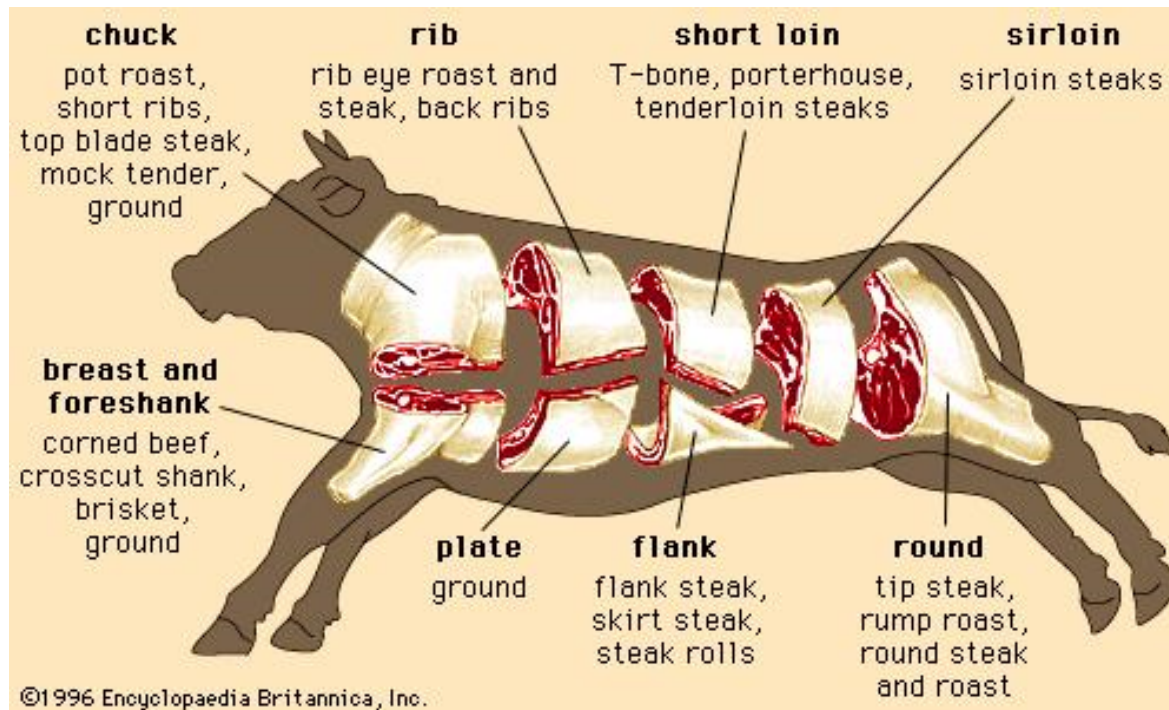
➤ Piedmontese



➤ Podolica



The carcass pieces of the cattle





The quality of beef depends on the ratio between the components: the muscles, the reserve fat and the supporting tissues. The quality is better as the percentage of muscle is higher and supporting tissue is lower.

Chemical composition of muscle tissue

Water	72 – 75 %
Proteins	18 – 22 %
Lipids	0.5 – 3.5 %
Minerals	0.8 – 1%

Muscle tissue proteins

Meat proteins are particularly important, falling into the high biological protein class, for their full content in essential amino acids and for the ratio they are found in.

Depending on the location, the muscle tissue proteins are divided into three main classes:

- Sarcoplasmic proteins are found in sarcoplasm, accounting for 30-35% of all muscle tissue proteins;
- Myofibrillary proteins are 52-56% and are localized in miofibrils. It contributes at least 70% to the nutritional value of the meat and has a high content of essential amino acids;
- The stromal proteins represent 10% and play an important role in determining the texture of the meat.

In order for the human organism to synthesize proteins, it needs 20 amino acids, where 8 are essential amino acids (they can not be synthesized by the human body and must be brought into proteins from animal and plant products).



The amino acid composition of beef (it is reported at 100 g)



Indicator	Beef muscle tissue
Water, %	76,8
Protein, %	26,80
Transformation coefficient	6,25
Total essential amino acids, mg, of which:	8093
• Valine	1148
• Isoleucine	939
• Leucine	1624
• Lisine	1747
• Methionine	588
• Treonine	875
• Tryptophan	373
• Phenilalanine	904
Total non-essential amino acids, mg, of which:	12967
• Alanine	1365
• Argynine	1296
• Asparaginic acid	2326
• Hystidine	769
• Glycine	878
• Glutamic acid	3609
• Oxyproline	58
• Proline	658
• Serine	904
• Tyrosine	800
• Cysteine	310
Total amino acids	21060

Muscle tissue lipids



Fat is the most variable component of meat, the proportion being directly influenced by species, age, race, sex, and animal's condition. Muscle fat ensures the flavor of meat.

Muscle tissue lipids are inside the muscle fibers or accompany connective tissues that form an integral part of muscle tissue. Lipids in muscle fibers have an energetic and plastic role.

The biological value of lipids is closely correlated with their saturated fatty acid content.

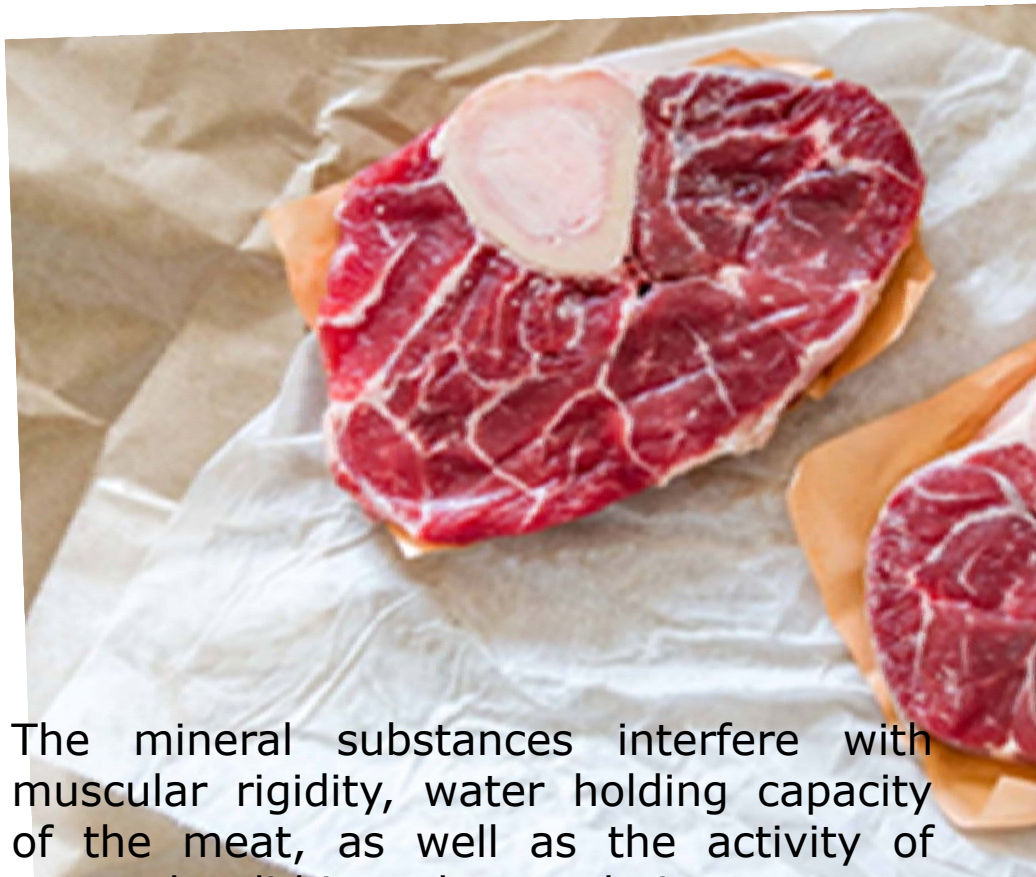


Lipid content of total muscle tissue (dorsal muscle, pulp) g / 100 g

	Indicator	Beef muscle tissue	
	Total lipids	2.50	
	Triglycerides	1.70	
	Phospholipids	0.70	
	Cholesterol	0.06	
	Total fat acids		
	Saturated	2.29	
	C14:0 (myristic)	1.11	
	C15:0 (pentadecanoic)	0.06	
	C16:0 (palmitic)	0.01	
	C17:0 (margaric)	0.65	
	C18:0 (stearic)	0.02	
	Monounsaturated	0.37	
	C14:1 (miristoleic)	1.05	
	C16:1 (palmitoleic)	0.02	
	C18:1 (oleic)	0.08	
	Polyunsaturated	0.30	
	C18:2 (linoleic)	0.13	
	C18:3 (linolenic)	0.09	
	C20:4 (arachidonic)	0.02	

Muscle tissue mineral substances

The mineral content of beef



The mineral substances interfere with muscular rigidity, water holding capacity of the meat, as well as the activity of some glycolithic and proteolytic enzymes.

Indicator	Beef
Ash, %	1.0
Potassium	355.0
Calcium	10.2
Magnesium	22.0
Sodium	73.0
Sulphur	230.0
Phosphor	188.0
Chlorine	59.0
Iron	2900.0
Iodine	7.2
Cobalt	7.0
Manganese	35.0
Copper	182.0
Molibdenum	11.60
Nickel	8.6
Tin	75.7
Fluorine	63.0
Chlorine	8.2
Zinc	3240.0

Muscle tissue vitamins

The meat is an important source of B vitamins. In ruminants, B vitamins can be synthesized by intestinal microflora, even if they are not found in feed.

The beef is one of the most important source of nicotine-amide (4-10 mg%) in food and it provides significant quantities of riboflavin and pyridoxine.



**The vitamin content of beef
(at 100g comestibil part)**

Indicator	Beef
B ₆ , mg	0.42
B ₁₂ , µg	3.00
Biotin, µg	3.50
Niacin, mg	5.40
Pantothenic acid, mg	0.60
Riboflavin, mg	0.20
Thiamin, mg	0.10
Folate, µg	9.60

The beef safety indicators

Quality assessment is done through a series of organoleptic, physicochemical, microbiological examinations on representative samples of the analyzed lot. Laboratory analyzes are performed to assess the product integrity, freshness and sanitation.

The sensory examination of the meat must be carried out in natural light or in artificial light that does not change color, in rooms without foreign smells, at a temperature of about 20° C.



The organoleptic characteristics of beef

Thermal state	Dry and chilled	Frozen	
		as such	after thawing
Appearance	<p>on the surface, dry film;</p> <p>in the section, slightly moist; glossy, elastic and strong tendons, glossy joints;</p> <p>clear liquid;</p> <p>connective tissue white-pearly and elastic; to chilled meat, touching with finger cold feeling without sticking</p>	<p>compact block, sometimes covered with a thin layer of fine crystals, similar to snow crystals</p>	<p>the surface of wet meat; sometimes it may have a dry film;</p> <p>in the section; smooth and damp, pressing with the finger expresses relatively easy opalescent juice;</p> <p>non-glossy connective tissue with reduced elasticity</p>
Color	<p>on the surface pink to red colored film;</p> <p>in section characteristic color</p>	<p>at surface normal color with more vivid shade, sometimes darker;</p> <p>when touching with a hot knife or finger, a red-and-white patch appears</p>	<p>on the surface, color from pink to dark red;</p> <p>connective tissue and flesh interfascicular fat of red color;</p> <p>red, opalescent meat juice</p>



The organoleptic characteristics of beef



Thermal state	Dry and chilled	Frozen	
		as such	after thawing
Consistency	firm and elastic, both on the surface and in the section the marks that are formed by pressing your finger come back quickly; meat juice is obtained hard and is clear	loud; by striking with hard objects, gives clear sound	low elasticity; fingerprint traces return hard and incomplete
Smell	pleasant, characteristic	no smell	pleasant, characteristic
Fat characteristics	white, pink-white fat; soft; at friction, greasy sensation	hard consistency; characteristic color	consistency slightly diminished; the color of interfascicular fat with reddish shade

Characteristics	Chilled and dry meat	Frozen meat	Thawed meat
Appearance	The general appearance of the meat is observed: muscle, connective tissue, tendons, synovial fluid and periosteum. It is examined the section surfaces of the muscles cut in the carcass processing. Humidity is visually appraised by palpation and by means of a filter paper applied to the surface of the meat.	Examine whether the meat block is compact. Examine the ice layer and appreciate surface integrity and superficial dehydration.	The general appearance of the meat is observed. The appearance of muscle masses, subcutaneous connective tissue, tendons, synovial fluid, and periosteum are appreciated. Examine the section surfaces of the muscles cut in the case processing. The appearance of the meat juice is appreciated.
Color	The color is observed on the outside and in the section. It is appreciated if the color is characteristic for the species.	Observe the color on the outside and at the point of contact with the hot knife or finger.	The color of the meat is observed in the outside and in the section, the connective tissue and the meat juice.
Consistency	It is appreciated by pressing your finger on the surface and on a section made at the time of examination and by analyzing the fingerprint.	It is appreciated by palpation and by the sound of the hit with a tough object.	The examination is similar to the dry or chilled meat.



The sensory analysis of beef



Characteristics	Dry and chilled meat	Frozen meat	Thawed meat
Smell	<p>It is appreciated by direct smell at the outer surface and at the surface of a fresh section, paying particular attention to deep layers near the bone.</p> <p>Sample of boiling: The scent is made several times from the moment of heating up to boiling.</p> <p>Sample grilling: the odor is appreciated during the grilling.</p> <p>Both samples can be complemented by research into the taste of meat pieces.</p>	<p>It is appreciated by direct smell at the outer surface.</p> <p>In case of doubt, the boiling test and the grilling sample are carried out as in the case of chilled or frozen meat.</p>	<p>Examination is done in the same way as the dry or chilled meat.</p>
Fat appearance and characteristics	<p>Consistency is appreciated by friction between fingers, color and smell both on the surface and in the deep layers.</p> <p>It is appreciated if the odor is specific to the species.</p>	<p>The color and color uniformity is appreciated on the outside.</p>	<p>Examination is done in the same way as the dry or chilled meat.</p>

The sensory analysis of beef

Characteristics	Dry or chilled meat	Frozen meat	Thawed meat
Characteristics of the bone marrow	The evaluation is made after the longitudinal sectioning of the tubular bones and the removal of the marrow from the medullary canal. The color, the consistency (elasticity), the gloss, the degree of filling of the medullary channel and the adherence to the walls are appreciated.		Examination is done in the same way as the dry or chilled meat.
Characteristics of the broth	Boil for 30 minutes and the broth obtained is appreciated after sedimentation, smell transparency, color, taste and appearance of fat.		Examination is done in the same way as the dry or chilled meat.

The result of the organoleptic meat test indicates how it can be used, namely:

- Fresh meat is good for consumption and can be treated by preservation and processing in meat preparations.
- Relatively fresh meat should be consumed as soon as possible. It can not be treated by preservation or used in meat preparations.
- Altered meat is destroyed or used for technical purposes.



Appreciation of beef sanitation by sensory characteristics



Factors of appreciation	Fresh meat	Relatively fresh meat	Altered meat
Exterior appearance	On the surface, the meat has a dry film. The fat has normal color, consistency and taste typical of the species. The tendons are glossy, elastic and strong. The joints are smooth and glossy. Synovial fluid is clear.	The meat occasionally has a dry film on the surface, sometimes it is covered with a small amount of sticky mucus. Fat has a matt appearance and reduced consistency. The tendons are somewhat softer, matte or even gray. The joints are covered with abundant mucus. Synovial fluid is cloudy.	The surface may be dry or wet and sticky, often covered with mold stains. Grease has a matte appearance and a gray dirty color. Decreased consistency. Odor and taste of rancid. The tendons are soft, gray, damp and covered with mucus. The joints are covered with abundant mucus. Synovial fluid is cloudy.
Color	On the surface the meat is pink to red. The section is glossy, slightly moist without being sticky, of color characteristic of the species and the respective muscle region. Muscle juice is hard to obtain and is clear.	On the surface and in the section the color is matte and darker compared to fresh meat. The section is moist without being sticky. A filter paper applied to the section absorbs much moisture. Muscle juice is cloudy.	On the surface the color is gray or greenish. The section is damp and very sticky. Sometimes it is discolored, sometimes gray or greenish.



Appreciation of beef sanitation by sensory characteristics



Factors of appreciation	Fresh meat	Relatively fresh meat	Altered meat
Consistency	The meat is fine and elastic. In section, it is compact. The fingerprint returns quickly and completely to the original form.	The meat is soft both on the surface and in the section. The traces that are formed by pressing your finger come back quite quickly and completely.	Both on the surface and in the section the traces that are formed at the fingerprint remain persistent.
Smell	Pleasant and characteristic of each species.	Slightly acid or mold. Sometimes a heavy scent of unrestrained meat feels on the surface. The smell of mold is missing in deep layers.	Smell of mold both on the surface and in the deep layers.
Bones marrow	Fully fills the medullary canal, is elastic, pearly white in color and normal consistency. The section is glossy.	Slightly cut off the edge of the bone. Softer and darker than the fresh marrow. The section is matte, sometimes gray.	It does not fill all the medullary channel. Much less consistency. Dark gray color. The periosteum dark color, often black.
Broth after boiling and sedimentation	Transparent, clear and pleasantly aromatic. On the surface, a compact layer or large fat islands separated with pleasant smell and taste.	Cloudy, tasteless, or even slightly rancid. On the surface, the fat separates as small drops, sometimes with a smell of rancid.	Dirty cloudy with flocks. Odor of mold. There are almost no drops of fat on the surface.

The physico-chemical methods for assessing beef quality



Determination of the pH of beef

Determination of pH shows the degree of freshness of the meat only if the slaughter of the animals was done under appropriate conditions.

Measurement of the pH value is done either by means of indicator paper, the error being + 0.5 pH units or with pH meter, the method error being + 0.01 ... + 0.03 pH units.

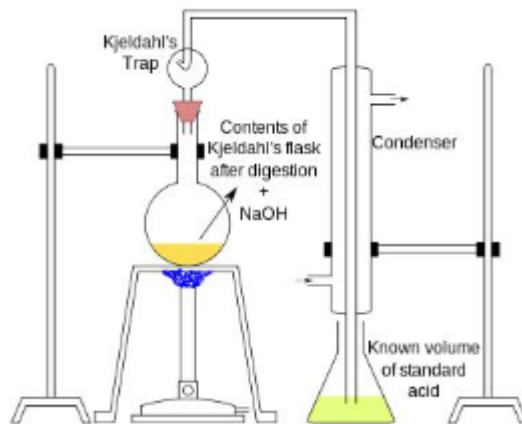
Depending on the freshness pH is:

- for fresh meat: 5,5 - 6,0
- for relatively fresh meat, we have: 6.0 - 6.7
- for altered meat, the values exceed the maximum permitted level for relatively fresh meat.

Depending on the thermal state pH is:

- for chilled meat: 5,8 - 6,2
- for frozen meat: 6,2 - 6,4
- for frozen meat: 6,2 - 6,4

The physico-chemical methods for assessing beef quality



Determination of total protein substances

Determination of peroxidase

Identification of hydrogen sulfide

Determination of ammonia (NH₃)

Determination of amino acid content of meat

Determination of carbohydrate in meat

Determination of water

Determination of fatty substances by extraction with organic solvents

Determination of bacterial activity

The background of the slide is a close-up photograph of fresh vegetables, including green leafy herbs, purple onions, and other produce, creating a vibrant and natural setting.

EU food safety policy targets the entire food chain. Its purpose is to guarantee:

- the safety and nutritional value of food and feed;**
- high standards in animal health and welfare and plant protection;**
- clear information on the origin, content, labeling and use of food.**

Determination of total ash (ISO 936/1998)

Determination of nitrogen content (ISO 937/1978)

Determination of moisture content (ISO 1442/1997)

Determination of total fat content (ISO 1443/1973)

pH value (ISO 2917/1999)

Determination of chloride content (ISO 1841-1/1946)

Determination of total phosphorus content (ISO 2294/1974)

Determination of the sensorial characteristics of frozen beef meat
(ASTM E1871/2010, ASTM E1885-04/2004)

Codex Alimentarius Commission (CODEX);

World Organisation for Animal Health (OIE);

IPPC International Plant Protection Convention

Advantages of using meat in the diet:

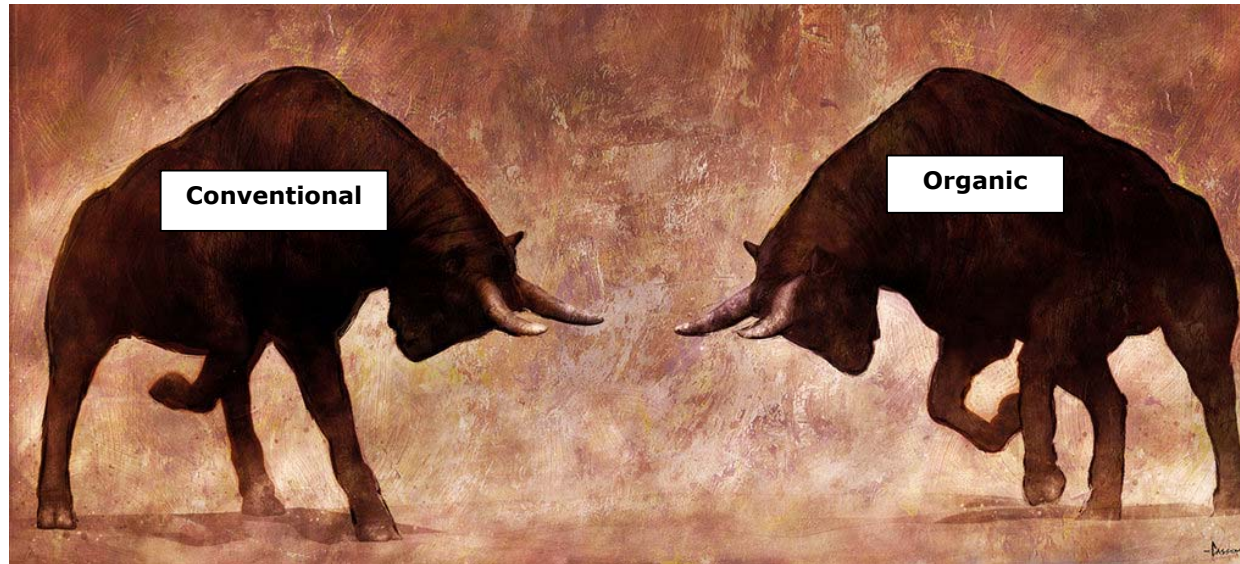
- ✓ Meat has an important erythropoietic action due to its high content of amino acids, iron and hematopoietic vitamin;
- ✓ Meat has a composition similar to human muscles, and due to lysine-rich content, it plays a special role in the development of children;
- ✓ The meat stimulates the activity of the central nervous system and improves the ability to work, intensifying metabolism being recommended in preventing and combating obesity.

Disadvantages of using meat in food:

- ✓ Meat is poor in Ca, so the Ca: P ratio is very low;
- ✓ Meat is acidifiable due to the predominant composition of the anion P-, S-, Cl-, and the viscera is rich in nucleoproteins, whose metabolism results in uric acid. Used in large amounts raises the level of this metabolite in the blood favors its deposition into the tissues;
- ✓ Meat contains cholesterol, its level being 100-300 mg% in the liver, 400 mg in the kidneys, reaching 3-3.5 g% in the brain.



Conventional versus organic



<https://sancient.deviantart.com/art/Bull-fight-404237789>

In the past two decades, the increase of organic beef consumption is in some measure driven by consumer perceptions that organic foods are more nutritious and healthy than non-organic foods.

According Średnicka-Tober et al. (2016), there were no systematic reviews comparing specifically the nutrient content of organic and conventionally meat.



Conventional versus organic



Organic cattle requirements

EU

(European Union)

European organic standards require cattle to be fed whole milk until at least 12 weeks of age and maximize the use of pasture throughout their lives (for cows as well as growing cattle) with a minimum of 60% of their dry matter intake from forage (European Commission, 2008).

<http://eurlex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008R0889>

USDA

(United States Department of Agriculture)

Organic ruminant livestock—such as cattle, sheep, and goats—must have free access to certified organic pasture for the entire grazing season. This period is specific to the farm's geographic climate, but must be at least 120 days. Due to weather, season, or climate, the grazing season may or may not be continuous.

Organic ruminants' diets must contain at least 30 percent dry matter (on average) from certified organic pasture. Dry matter intake (DMI) is the amount of feed an animal consumes per day on a moisture-free basis. The rest of its diet must also be certified organic, including hay, grain, and other agricultural products.

<https://www.ams.usda.gov/sites/default/files/media/Organic%20Livestock%20Requirements.pdf>



Conventional versus organic

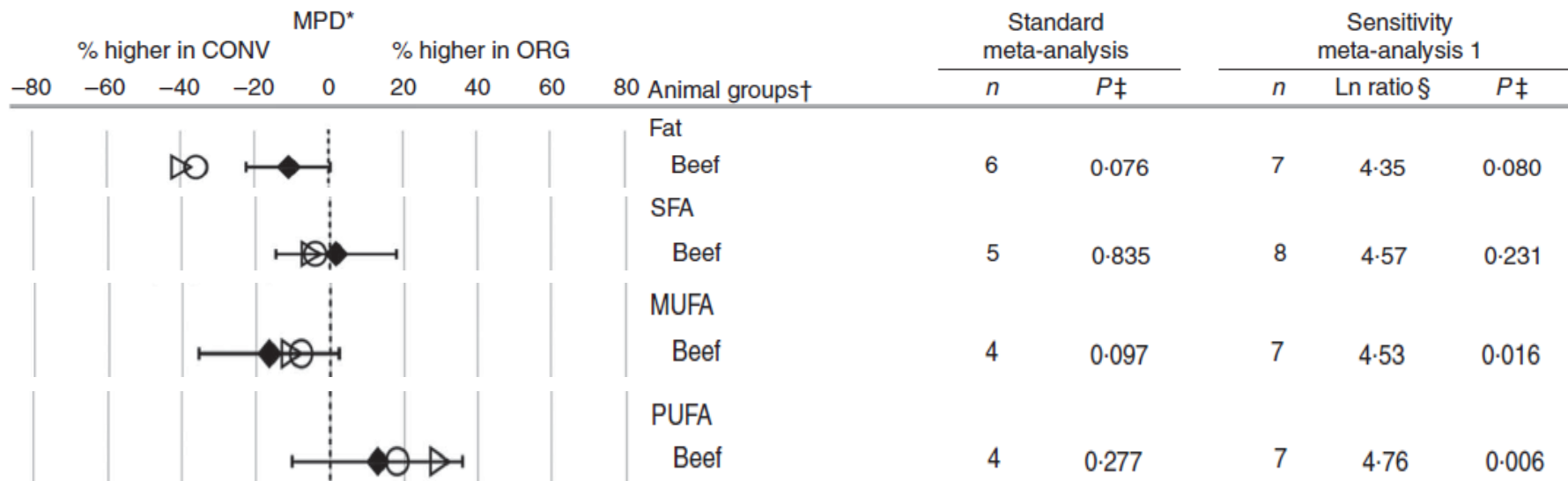


Characterization of conventional and organic beef

Specifications	Conventional	Organic
USDA Definition	None	Must be "Certified"
Hormone implant use	Likely	Prohibited
Therapeutic antibiotics	Likely	Prohibited
Subtherapeutic antibiotics	Likely	Prohibited
Chemical fertilizer use	Likely	Prohibited
Chemical pesticide use	Likely	Prohibited
Grazing life	>70% of life	>80% of life
Confinement	>30% of life	>20% of life
Fed meat-and-bone meal	Prohibited	Prohibited
Fed tallow	Allowed	Prohibited
Manure applied to land	Allowed	Mandated

<http://www.meatscience.org/docs/default-source/publications-resources/rmc/2008/conventional-organic-natural-grass-fed-beef---keith-belk.pdf?sfvrsn=0>

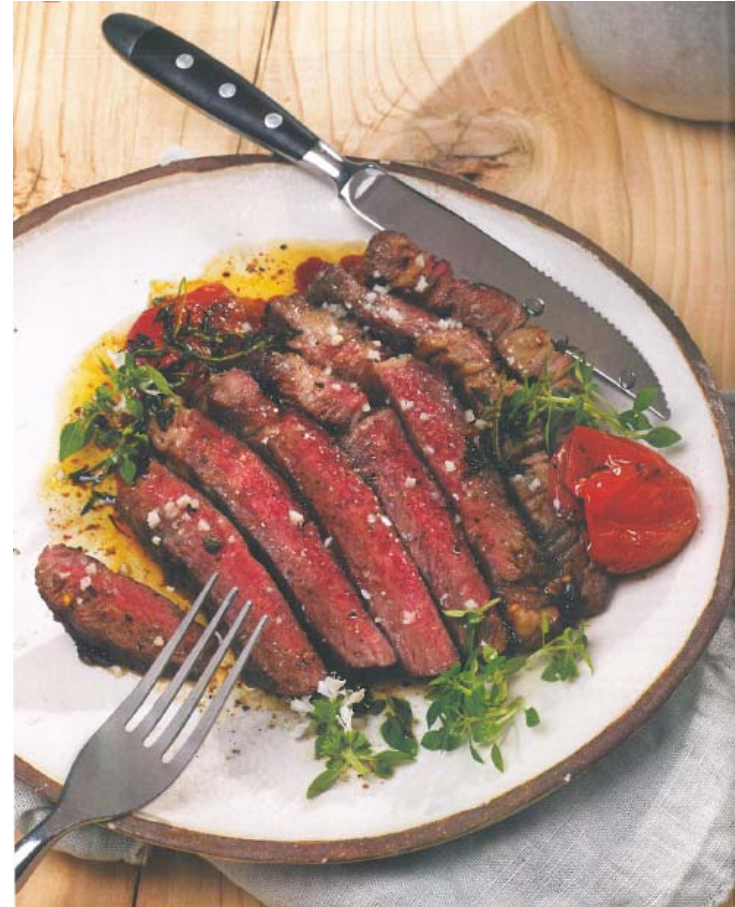
Composition of organic meat products



According to Średnicka-Tober Dominika et al., 2016. Composition differences between organic and conventional meat: a systematic literature review and meta-analysis. *British Journal of Nutrition*, 115: 994–1011.

Overall, the beef is:

- ✓ An excellent source of high biological value protein, vitamins and minerals
- ✓ A source of endogenous antioxidants and other bioactive substances
- ✓ A delicacy if is cooked by a "master chef"



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- All the online link were accessed in January – February, 2018.



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