

Production Technology and Nutritive Value of Iberian Ham (jamón ibérico)

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According to some sources, the tradition of producing Iberian hams (jamón ibérico) dates back to the times before the Roman republic. Recognised as a gourmet product (according to the definition of the Cambridge Dictionary, it is a "product of top quality") Iberian ham is a rarity of Spanish tables and shops where there is always a specific, salty smell. Sold in whole or in slices, it enjoys an unimpeachable reputation and almost constant interest of consumers. This exceptional quality is a result of the effort of breeders and producers, the selection of animals, their feeding and the course of the production process. In Spanish restaurants a plate of evenly cut slices of ham, whose intense taste stimulates the taste buds but does not mask the aromas of subsequent dishes is an almost necessary appetiser (photo 1).



Phot. 1. Iberian ham appetizer

(<https://theyumlist.net/wp-content/uploads/2017/01/Jamon-Iberico-KL-640x400.jpg>; 7.11.2018)

Obtaining such a product requires a series of procedures performed consistently and invariably for many years, starting from the slaughter of an animal to the presentation of ready-to-eat ham and its provision to the consumer. After slaughter, the limbs cut off from the carcass are suspended for natural bleeding. Then, after the removal of the skin and the top layer of fat, they are weighed to be divided into weight groups (each with a separate label).

After the previous marking (burnt out digits - the week and the year of the beginning of the process) and squeezing the remaining blood out of the limbs, the meat is cooled for 24h at the temperature of 0-1°C. During cooling, short-term deep freezing of hams is carried out (the inside temperature reaches -81°C at that moment). After this process, the pH of the meat varies between 5.5 and 6. Hence, it is so important to remove the remaining blood beforehand. Otherwise, its presence with such pH values of meat could form conditions favourable for the growth of microorganisms. Next, the hams are cut in the shape of a "V" letter, coated with sea salt (salado) and stacked one on another (the heaviest at the bottom, photo 2) in a room with a specific microclimate (1-5°C, humidity 80-90%). Salado lasts from 7 to 10 days depending on the weight of the ham - it is assumed that one kilogram means one day of salado.



Phot. 2. Stack of salt-coated hams

(<http://www.hispanskismak.pl/blog-jak-powstaje-szynka-iberyjska-23>; 7.11.2018)

After the time the salt is removed with warm water under pressure, and the hams are suspended in another room, where the temperature is slightly higher (starting from 3°C at the beginning, reaching 12-16°C at the end of the process) and the humidity is 75-80%. This is the so-called "rest" (*asentamiento*) lasting for 2-3 months (in the winter period), during which the salt is absorbed by the meat, and thus it becomes drained. The next stage is drying (*secado*), which lasts from 6 to 9 months, followed by maturation (*maduración*), which must last for at least 18 months to qualify the hams with one of four indications (Council Regulation (EC) No. 510/2006). The whole process, i.e. drying and maturing, is referred to as "sweating" (*sudado*), which determines the later aroma of meat, takes place in spring and summer. As a result, the initial weight of the ham is reduced by 35-40%. The room where "sweating" is carried out has to meet very specific requirements. Both temperature and humidity should be as close as possible to those outside the building (the temperature increases from 15°C at the beginning to 30°C - without rapid changes, only by 1-2°C per week). In order to speed up the process, sometimes the temperature is increased in shorter intervals while reducing the humidity to 60-65%, with efficient ventilation that limits or even prevents the development of pathogens in the meat. One of them is, e.g., *Thyrophagus putrescentiae*, which is the main vermin found in cellars used for the storage of the maturing hams. It can also be found in products sold in stores, however, its presence does not disqualify meat - it is enough to wash or clean it thoroughly by applying general methods but without the use of acaricide formulations.

The final stage of production is a so-called "aging of ham" (*envejecimiento*), which can last from 6 to even 30 months and usually takes place in the autumn period. Before placing the hams in the room where the process takes place, they are thoroughly brushed to remove residues from the previous stages. This is e.g. a slightly green shade on the surface of the meat, which can act as a deterrent to consumers. In this room, the temperature is 10-20°C, and the relative humidity is between 60 and 80%.

The bacterial flora responsible for mould growth (*Penicillium roqueforti*) arising on the outer layer of hams plays an extremely important role during this process. In total, the entire process, from *salado* to shipping to store warehouses, can last from two to even four years depending on the weight or the feeding system.

The whole process is supervised by *maestro jamonero*, or the "master of hams". His most important attribute, and at the same time, an attribute necessary for the correct performance of the work is a tool called *cala* (read: „kala”). It is a tool made of cow's or a horse's femur (sometimes made of wood) which after inserting into specific points on the ham is used to carry out an olfactory test. It allows de-

termining the state of the meat, i.e. the content of blood, mould, bacteria, and whether the salt is evenly distributed in the meat.

An important requirement that applies to food from the RTE ("ready to eat") category, which is applied to Iberian ham, is to meet the quality standards related to microbiological safety, which in Spain is regulated by the Commission Regulation (EC) No. 2073/2005. The above-mentioned document particularly highlights the nature of prophylaxis associated with listeriosis (caused by *Listeria monocytogenes*). The content of the above bacteria may not exceed 100 CFU/g (colony forming units/g) during the product shelf life. Unfortunately, listeriosis is still diagnosed in consumers in Europe. According to EFSA data, in 2013, 9.4% more listeriosis cases were diagnosed than in 2012. Therefore, it became necessary to develop methods that would prevent or eliminate the problem, whether at the production level or after maturing. This increased the number of quality controls and resulted in stricter adherence to the principles of not breaking the chilling chain (Rubio Hernando, 2015). The presence of *Toxoplasma gondii* could also be a potential microbiological problem, however, repeated studies on various types of long-maturing hams (parma, serrano or ibérico) seem to deny the thesis that long salting and maturing of hams are not sufficient to protect food. Research confirming the effectiveness of cooling, freezing and salting was carried out, among others, by deliberately infecting the material and then carrying out a regular production process (Genchi et al., 2017). In the case of naturally infected pigs, the results were similar, both at the 9-month and 12-month of maturing. A certain interdependence was also observed between the lower fat content of hams and the proportionally reduced population of parasites (Herrero et al., 2017). In the case of serrano hams, whose production process does not differ from that used in the production of Iberian hams, four possible methods of salt preservation and cooling were checked - in each case freezing completely eliminated the presence of *Toxoplasma gondii* (Gomez-Samblas et al., 2016).

Classification and Labelling (fig. 1 and 2). Apart from the requirements for the system of animal maintenance, nutrition and slaughter age, the composition of fatty acids in meat is also subject to standards (Tab. 1). In addition, according to the Act, even if the standards are met but the total unsaturated fatty acid content are higher than 67.5% (max. 58.5% oleic acid), the meat will be classified to a lower quality category (Orden APA / 3653, 2007; source: <https://www.boe.es/boe/dias/2007/12/15/pdfs/A51655-51655.pdf>) (7.11.2018).

Table 1. Quality parameters and content of fatty acids (%)

| Fatty acid | Quality | |
|------------------|---------|--------|
| | Bellota | Recebo |
| Palmitic (C16:0) | ≤22,0 | ≤24,0 |
| Stearic (C18:0) | ≤10,5 | ≤11,5 |
| Oleic (C18:1) | ≥53,0 | ≥51,0 |
| Linoleic (C16:2) | ≤10,5 | ≤11,5 |

Źródło: Orden APA/3653, 2007; <https://www.boe.es/boe/dias/2007/12/15/pdfs/A51655-51655.pdf> (7.11.2018).

Designation of the Geographical Origin of the Product. Denominación de Origen (D.O.) guarantees that a given product comes from a specific area, and specific properties (pro-health, technological) and characteristics (flavours, culinary features) are ensured by its region of origin. Typically, the D.O. label contains the name of the province or village from which the product originates although there are exceptions to the rule. Denominación de Origen concerns, among others, many agricultural products, wines, meat and even craft products. The World Intellectual Property Organisation deals with the guidelines and implementation of the program. This designation is to be primarily a guarantee for the consumer that the product will be characterised by high and repeatable quality in the case of further purchased products.

Among the Iberian hams, four have D.O. labels and they are: D.O. Los Pedroches, D.O. Jamón de Huelva, D.O. Dehesa de Extremadura oraz D.O. Jamón de Guijuelo (jamón = ham). It is worth noti-

cing that Iberian ham, even referred to as Pata Negra (100% Iberian breed, 100% nutrition with acorns) does not mean that it has a D.O. These are two separate categories of quality, each awarded on the basis of separate standards. All four Iberian hams that can be found in Spain with the D.O. label are considered to be real connoisseur products with an exceptionally long tradition.

D.O. Jamón de Guijuelo are delicate and tender hams. The quality is influenced by breeding and maintenance conducted in relatively cold regions of the occurrence of the Iberian breed. The producer of this ham has the longest experience in this field, and such products currently account for more than 60% of the ham market in Spain. According to tradition, the process of the selection of hams, their processing and maturing require at least two years. Jamón de Guijuelo has been marked with the D.O. symbol since 1984. The production includes three types of hams - bellota, cebo de campo (formerly: recebo, used interchangeably until today) and cebo - named so for the pigs feeding system. D.O. Jamón de Huelva are produced in the west of Andalusia in the area of the Sierra de Huelva. The products are of high quality and are, alike, divided into: bellota (SUMMUM for the best ones, EXCELLENS for the other), cebo de campo (determined as GRAN RESERVA) and cebo (RESERVA). One of the most recognisable on the global scale are Jabugo hams (Jamón de Jabugo), whose limbs have a characteristic oblong shape. D.O. Dehesa de Extremadura (D.O. since 1990) are high-quality products that come from the Extremadura region and, more specifically, from the extremely numerous dehesa areas near Cáceres and Badajoz. D.O. Los Pedroches is the newest label for D.O. (2006). Their hams, like D.O. Jamón de Huelva have interesting, oblong shapes. The labelling covers 32 municipalities in the Valle de los Pedroches area (north of Cordoba).

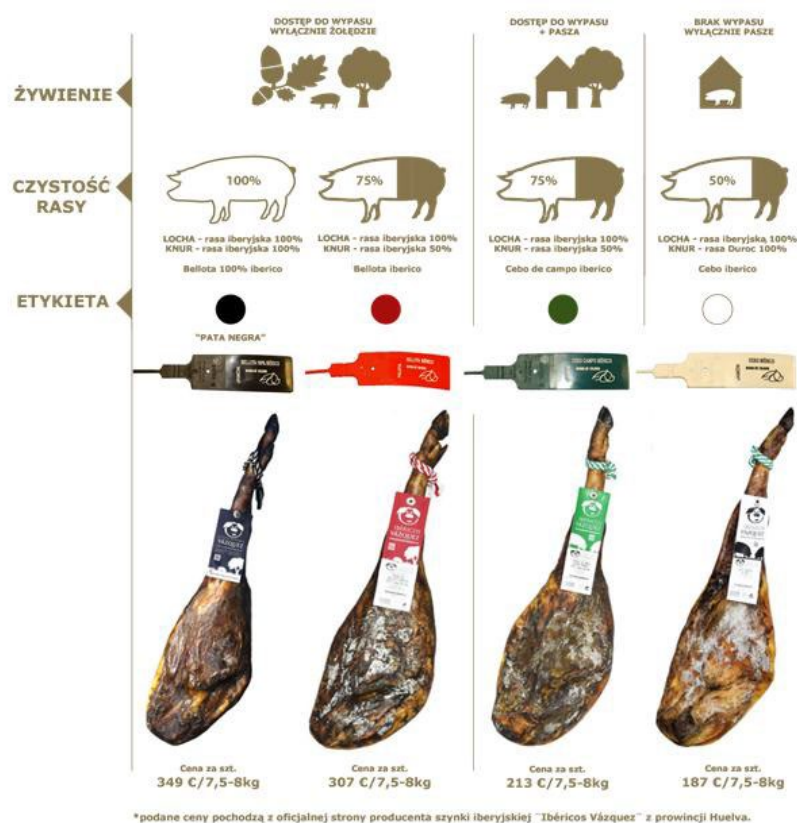


Fig. 1. Illustration showing simplified classification of Iberian ham depending on pig feeding system and breed purity (source: „Josep Llorens i Fills”; <https://www.josepllorens.com/animal/> (7.11.2018) and “Ibéricos Vázquez” <https://www.ibericosvazquez.es/jamones-ibericos-bellota.php>, amended) (7.11.2018)



Fig. 2. Labelling of D.O. Jamón de Huelva hams
(source: <http://masquejamon.com/jamon-de-jabugo/> (7.11.2018))

Nutritive Value. Definitely, the most important component of Iberian ham is fat and fatty acids contained in it. In the times of growing consumer awareness of the products, their origin and nutritional value, Iberian pig meat has been gaining popularity for about three decades. The idea of consuming healthy fats is popularised, and the awareness of their health-promoting properties is growing. The fat content in the entire Iberian pig carcass is high, with the average of 55.4% with a 71 mm of lard thickness as compared to white breeds with the fat content ranging from 25 to 28% with lard thickness of 15-20 mm (Mayoral et al. 1999). Fat has an impact on the juiciness of meat and its taste, which in the case of Iberian hams is often associated with the taste of olive oil, which results from a high content of oleic acid (Tab. 2 and 3).

Table 2. Average content of fatty acids in the fat of hams originating from different pig feeding systems (Garrito-Varo, 2001)

| Management/feeding system | Fatty acid (% in fat) | | | |
|---------------------------|-----------------------|-----------------|---------------|------------------|
| | palmitic (C16:0) | stearic (C18:0) | oleic (C18:1) | linoleic (C18:2) |
| Bellota | 19,3 | 9,5 | 58,3 | 7,8 |
| Recebo | 22,1 | 10,7 | 51,2 | 9,7 |
| Cebo | 22,9 | 11,7 | 49,9 | 9,4 |

Tabela 3. Porównanie zawartości poszczególnych kwasów tłuszczowych w tłuszczu zawartym w szynce od świń rasy białych oraz iberyjskiej (bellota) (García Rebollo, 1999)

Table 3. Comparison of fatty acids content in the fat of ham from White and Iberian (bellota) pigs (García Rebollo, 1999)

| Ham | Fatty acid (% in fat) | | | | | |
|------------------------|-----------------------|-----------------|---------------------|---------------|------------------|-------------------|
| | palmitic (C16:0) | stearic (C18:0) | palmitoleic (C16:1) | oleic (C18:1) | linoleic (C18:2) | linolenic (C18:3) |
| White pigs | 22 | 12,2 | 2,8 | 44,2 | 8,7 | 0,08 |
| Iberian pigs (bellota) | 21,04 | 9,08 | 4,50 | 59,13 | 5,11 | 0,08 |

The cholesterol content in the ready to eat ham ranges from 30 to 34 mg in 100 g meat and is definitely lower than in the case of raw meat (40-58 mg in 100 g muscle), which is caused by changes in fat during the maturing of hams (Ruíz Carrascal and in. 2006). Attention should be paid to the high content of B vitamins, especially vitamin B12 (15.68 µm in 100 g of ham) and B1 (0.84 mg in 100 g of ham). It is also worth noticing the content of sodium in mature ham reaching the average value of 1935 mg per 100 g of ham (Ruíz Carrascal et al., 2006, Torres Torres et al., 2017).

Serving Iberian Ham. Ham which is sold in stores in full, hangs on stands packed with a strong but airy material that prevents the deterioration of meat. In addition, several pieces are always prepared for the so-called lonchado, i.e. a method of slicing. A long, profiled, flexible knife with a special shaft, so-called cuchillo jamonero ("Ham knife") has been created just for this specific activity. Cutting hams, though it seems to be a prosaic activity, is a skill so appreciated that many times a year - to emphasise this tradition - there are organised championships for the professionals cutting meat (cortadores) from all over Spain. Championships and local contests are organised in search of masters of the art of cutting.

An example of the championship is Campeonato de España de Cortadores/as de Jamón, whose 10th edition took place on 27-28 January 2018 in Vejer de la Frontera. The skills, the style and the creativity of the cutting masters are assessed there. The judging panel awards points for how the ham is profiled as well as evaluates the cleanliness and order of the workplace, the simplicity of the cutting line, the size and thickness of the slices, the effectiveness and efficiency of the cutting movements, and creativity in serving the plates. One of the competitions is, for example, cutting and placing exactly 100 g slices of ham on the plate, with an acceptable fluctuation of ± 2 g, and for exceeding this limit points are deducted from the final result (ANCJamón, 2018).



Fig. 3. Announcement of the 10th Ham Cutting Championship in Vejer

Więcej informacji na stronie – *More information at:* www.ancj.org/final-2017.html (7.11.2018)

In addition to the way the ham is handled, its presentation is also important. Jamonera (or portajamones) is a rack which steadily supports the ham so that its most valuable parts are available for cutting, and the rest, like the hoop, are a feast to the eye with a dark, characteristic colour. Therefore, Jamonera has to meet both utility and decorative requirements, and therefore, we can meet various types depending on the type of material (e.g. wood, stainless steel) or shape (photos 3 and 4). A sample price for a stainless steel stand is € 299, and the right knife: from € 70 to € 90. In combination with the price of the ham itself, the final amount can be as much as 700 €, which, however, does not discourage consumers. According to statistics from the Spanish Ministry of Agriculture, an average Spanish citizen consumes about 3.2 kg of ham per year, and in the case of Iberian ham it is 0.04 kg per month (with the value rising to 0.14 kg in December), which gives the result of 0.58 kg of Iberian ham/person/year. Due to the price of the product, this amount is definitely satisfactory for the ham dealers (Cerdeño, 2010).

The cultural background, which has been created over decades around the customs associated with the production of Iberian ham, has made it a connoisseur product present in the homes of almost every citizen of Spain. Its quality and popularity is a result of a specific way of feeding pigs based on grazing and acorns or distinction of professions closely related to the production process - such as a

vareador, taking care of the grazing animals, the master of hams - watching over their maturing or the cutting master - serving the hams to the table. According to the Spanish Ministry of Agriculture, although the knowledge of this product is widely available in the country and almost everyone has met it directly as a consumer, it is negligible outside of Spain (excluding some countries of South America or Mexico). However, there are many business entities involved in the import of this exquisite delicacy, which is an indispensable element of real Spanish cuisine.



Phot. 3. 4. Sample design of a ham holder (left) and correct presentation of ham prior to cutting (right)
(source: <https://tienda.casarex.net/jamoneros/1263-soporte-jamon-arcos-8421002691102.html> (7.11.2018) and <http://www.montesierra.es/blog/que-diferencias-hay-entre-paleta-iberica-y-jamon-iberico/> (7.11.2018))

Another regional product, apart from Iberian hams, also produced in Spain, and which is worth mentioning, is serrano ham. It differs from Iberian ham only by the pig breed - most often it is a pure Duroc breed whose hams are larger (heavier), but with significantly less flavour and tenderness of meat resulting from genetic differences (different distribution of fat in the muscle). It has a more affordable price, which makes it a popular product both in the country and abroad (it is often found in Polish stores). Two of them also have a D.O (Denominación de Origen) labels, so it is a highly valued product, although less fancy.

Currently, the market for Iberian hams is growing, both in terms of production costs and prices. There were, however, periods when prices were fluctuating from € 500 to even € 1000 within a few seasons. This is particularly true for "cebo" quality hams, whose prices in 2017 increased, month to month, and this was an increase of 15%, and in the case of "de bellota" 5% as compared to 2016, which has been to some extent caused by lower supply - due to the long production process, and, at the same time, increased demand for hams (García, 2017). Unfortunately, after a major crisis that was significant for the Spanish economy, the effects of which affected the producers even by 2014, from the number of slaughters amounting to almost 4 million in 2007, this value dropped to just over 2 million in 2014. Since then, these numbers have been increasing again and in 2017 have exceeded 3.3 million slaughters (Lara and De Pedro, 2015; Celestino, 2017).

Summary

Iberian ham is awaiting another international success if the tendency of Iberian pig breeding along with a high demand is maintained. It is highly dependent on the stamina of breeders and producers and their belief in optimistic forecasts announced by experts as well as business entities dealing in the food trade (Vilches, 2014). And, finally, this applies not only to the production of high quality meat products, but it is also a key element of cultivating many years of tradition, which would be a huge loss on the scale of the entire culinary and gastronomic connoisseurs world.

Bibliography

- ANCJamón (2018). Objetivo y bases de participación. Final X Campeonato de España de cortadores/as de jamón (Cel i podstawy uczestnictwa, Finał X Mistrzostw Hiszpanii krojczych szynek). La Asociación Nacional de Cortadores de Jamón.
- Celestino J.V. (2017). El número de cerdos ibéricos sacrificados vuelve a subir y recupera valores precrisis (Liczba ubitych świń iberyjskich ponownie wzrasta i osiąga wartości sprzed kryzysu). Hoy.
- Cerdeño V.J.M. (2010). Consumo de Jamón en España (Spożycie szynki w Hiszpanii). Distribución y consumo, MAPAMA.
- García B. (2017). La razón por la que ha subido el precio de jamón ibérico (Przyczyna wzrostu cen szynki iberyjskiej). Libre Mercado.
- García Rebollo A.J., Ortíz Cansado A., Maciá Botejara E., Morales Blanco P. (1999). Influencia del consumo de jamón ibérico de bellota sobre el perfil lipídico aterogénico (Wpływ spożywania szynki iberyjskiej na aterogenny profil lipidowy). Sólo Cerdo Ibérico, pp. 107–122.
- Genchi M., Vismarra Al., Mangia C., Faccini S., Vicari N., Rigamonti S., Prati P., Mariano A.M., Kramer L., Fabbi M. (2017). Lack of viable parasites in cured ‘Parma Ham’ (PDO), following experimental *Toxoplasma gondii* infection of pigs, Food Microbiol., 66: 157–164.
- Gomez-Samblas M., Vilchez S., Racero J.C., Fuentes M.V., Osuna A. (2016). *Toxoplasma gondii* detection and viability assays in ham legs and shoulders from experimentally infected pigs, Food Microbiol., 58: 112–120.
- Herrero L., Gracia M.J., Pérez-Arquillué M., Lázaro R., Herrera A., Bayarri S. (2017). *Toxoplasma gondii* in raw and dry-cured ham: The influence of the curing process. Food Microbiol., 65: 213–220.
- Lara P., De Pedro E. (2015). Balance sectorial porcino Ibérico (Balans sektoru wieprzowiny iberyjskiej). Cerdo Ibérico 33, AECERIBER, Universidad de Córdoba.
- Mayoral A.I., Dorado M., Guillén M.T., Robina A., Vivo J.M., Vázquez C., Ruiz J. (1999). Development of meat and carcass quality characteristics in iberian pigs reared outdoors. Meat Sci., 52: 315–324.
- Orden APA/3653/2007 (2007). Por la que se publican los valores de ácidos grasos aplicables a las designaciones de alimentación ‘Bellota’ y ‘Recebo’ (Na podstawie którego opublikowane zostają wartości kwasów tłuszczowych stosowane do określania żywności ‘Bellota’ i ‘Recebo’). BOE, 300: 51655.
- Rozporządzenie Komisji (WE) nr 2073/2005 w sprawie kryteriów mikrobiologicznych dotyczących środków spożywczych (2005).
- Rozporządzenie Rady (WE) Nr 510/2006, „Los Pedroches”, w sprawie ochrony oznaczeń geograficznych i nazw pochodzenia produktów rolnych i środków spożywczych (2006).
- Rubio Hernando B. (2015). Barreras sanitarias a la exportación de productos de cerdo ibérico. Aplicación de tecnologías emergentes para eliminar *Listeria monocytogenes* en embutidos crudos curados y sus fuentes de contaminación (Bariery sanitarne eksportu produktów ze świni iberyjskiej. Stosowanie nowo powstałych technologii w celu wyeliminowania *Listeria monocytogenes* z surowych, dojrzewających produktów mięsnych, a także źródła ich zakażenia). Cerdo Ibérico, VIII Jornadas, pp. 173–176.
- Ruíz Carrascal J., Muriel E., Antequera T. (2006). Calidad de la carne de cerdo Ibérico (Jakość mięsa świni iberyjskiej). Carnes de Extremadura, El cerdo Ibérico, Servicio de Publicaciones de la Junta de Extremadura, pp. 75–90.
- Torres Torres B., Izaola Jáuregui O., Luis Román D. A. de. (2017). Abordaje nutricional del paciente con diabetes mellitus e insuficiencia renal crónica: a propósito de un caso (Żywieniowe podejście do pacjenta z cukrzycą oraz chroniczną niewydolnością nerek: na przykładzie jednego przypadku). Nutrición Hospitalaria, 34, 1: 18–37.
- Vilches J.M. (2014). El jamón ibérico, economía y tradición (Szynka iberyjska, ekonomia i tradycja). Trébol, 70: 19-27.

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(JAMÓN IBÉRICO)**

Summary

Iberian ham is a product that has attracted unabated interest in Spain for more than three decades. Its value lies in tradition and production customs that have been kept alive until today. Treatment with coarse-grained sea salt along with long maturation make the ham's taste unique, mainly thanks to the high content of oleic acid in the fat. In addition, the ham is rich in vitamins, in particular those of the B group, which makes it a culinary product with valuable health-promoting properties. This process ensures that the ham is not only tasty but also microbially safe. Apart from the measurable characteristics of Iberian hams, they owe their value to standardized labels, packagings and even the art of processing and serving. The latter is the responsibility of ham cutters, the qualifications of whom are regularly verified in Spanish championships. However, by far the most important factor behind the popularity and recognition of Iberian hams is their invariably high quality associated with the production process.

Key words: Iberian ham, production technology, health benefits