Canned meat products – 200 years in the services of mankind

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Abstract

The technology of production of canned products, namely a hermetically sealed container and the intensity of the thermal process, guarantee a high level of food safety for these meat products. Expansion of the production of canned meat products dates back to the first half of the last century. The period between the 1950s and 1980s can be considered the "golden age" of canned meat products in the Czech Republic. Canned meat products, however, declined in importance after 1990, largely due to the development of the production technology for meat products in that period. At present, canned meat products made not only by industrial manufacturers but also by artisan producers can be found on the market. A temperature of 121.1 °C is the reference value in the production of canned goods. The bacterium *Clostridium botulinum* represents the main biological hazard in canned meat products. Reliable elimination of this microbe is achieved by the attainment of an $F_{121.1}$ value = 2.52 (min). Thermophilic spore-forming bacteria are not considered pathogenic to humans, though their presence can affect the shelf life of products stored at high temperatures.

Canned food production, F value, thermal treatment, thermophilic spore-forming bacteria

Introduction

The Frenchman Nicolas-François Appert, personal chef to one of the German sovereigns, performed the first successful attempt at food preservation based on thermal sterilisation in 1809 (Teuteberg 2008). A year later, his process was radically improved by the Englishman Peter Durand, who replaced Appert's glass bottles with containers made of tinplate, thereby making the direct precursor to modern tin cans. At first, tin cans were luxury goods used for preserving fruit, vegetables and cream. An enormous wave of commercial production of canned foods was later seen in many European countries after Louis Pasteur discovered that microorganisms could be destroyed by heat. True mass production was, however, not to be developed until the 1930s when the cold rolling of tinplate, electrolytic tinplating and an automatic machine for sealing tin cans were invented. A production method for plating vessels with tin was, however, known in Bavaria since the 14th century, where it had spread from Bohemia (Steinhauser 2010). Tinplate combines the strength and malleability of steel with the resistance to corrosion and attractive appearance of tin. Almost a third of global production of tin goes on the production of tinplate. Of the various applications for tinplate, the largest proportion is used in the production of tin cans for the preservation of foodstuffs. Tinplate has served this purpose for more than 100 years, and to this day provides a robust form of packing with a minimal oxygen content and makes it possible to sterilise food in a hermetically sealed container. This treatment provides a long shelf life without the need to use other preservatives or with only the application of merely a small quantity of preservatives being needed (Blunden and Wallace 2003).

At the end of the 19th century, the United States managed to make canned food production so cheap that canned beef and pork meat in brine could be offered to the masses. The German law on meat inspection passed in July 1890, however, banned its import from Chicago for hygiene reasons on the basis of a study by food industry experts. The first success achieved by the German meat industry, established in the 1860s, was not in

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imitation of American canned foods, but in preserved frankfurters. In 1895, master butcher Friedrich Heine from Halberstadt canned some of his frankfurters in airtight cans, and is said to have sold 1 500 a day in 1900 (Teuteberg 2008). The airtight cans enabled the use of lightly flavoured brine that highlighted the taste of the frankfurters.

Global production of canned foods was estimated at 80 billion cans at the beginning of the 21st century (Blunden and Wallace 2003). From the viewpoint of meat processing, this paper will focus primarily on canned meat products.

Production of canned meat products in the Czech Republic

Klíma and Blanka (1984) define canned meat products as meat or meat products hermetically sealed in a tin, glass or other suitable container and heat-treated to ensure a long shelf life and eliminate any health risk during consumption.

The current Czech food legislation defines canned foods as products hermetically sealed in a container and sterilised. Semi-preserved foods are described as products hermetically sealed in a container and pasteurised (Decree 2001). Canned foods must be heat-treated in all parts of the product to a temperature whose effect corresponds to the effect of a temperature of 121 °C acting for a period of at least 10 minutes. Semi-preserved foods must be heat-treated in all parts of the product to a temperature whose effect corresponds to the effect of a temperature of 100 °C, also acting for a period of at least 10 minutes.

The expansion of production of canned meat products dates back to the first half of the twentieth century, and the period between the 1950s and 1980s can be considered the "golden age" of canned meat products in this country, particularly for strategic reasons associated with ideas related to the potential threat to peace. There was a large number of meat packing plants at that time where canned meat products accounted for a significant part of their product assortment (Vamberk, Krahulčí, Studená, Kroměříž, etc.). Industrial production of canned food had, however, already become widely established in Bohemia during the First Republic (Steinhauser 2010). Jan Satrapa's company in Studená became particularly famous for the production of canned meat products. Satrapa also built a plant for the production of tin cans in nearby Rozkoš. Vysočina became the heart of Czech canned food production with the development of processing facilities in Krahulčí and Kostelec.

Canned meat products became less important after 1990, the principal reason being the development of meat product production technology that occurred at that time. New food additives, new technological packaging, improved machinery and the thorough observation of the cold chain have all made significant contributions to extending the shelf life of meat and meat products. The range of meat products on offer also expanded. These developments pushed canned foods to the fringes of interest of consumers who required them only where fridges were unavailable, i.e. on holiday.

The Czech legislation includes canned meat products among meat products. This definition differentiates them from ordinary whole- muscle products and comminuted products in two areas. The first is the use of technological packaging that allows the hermetic sealing of the content, while the second is more pronounced heat treatment (the action of a temperature ≥ 100 °C) than is usual for other heat-treated meat products (70 °C). For this reason, containers made of tinplate, glass, aluminium foil (in the form of pots with a maximum volume of around 150 g) or other materials with sufficient barrier and mechanical properties and resistant to high temperatures are used.

Canned meat products from industrial producers and small artisan producers can currently be found on the market. The mass production of canned foods results in products whose utility properties appeal to the consumer, i.e. storage at room temperature (or ambient temperature), a long shelf life and consumption convenience (no further preparation is generally necessary), while their relatively low price as compared to fresh meat or ordinary meat products is also not insignificant. Brown et al. (2015) conducted research among students (n = 585) at Brigham Young University in Utah, USA. More than a third of respondents (37.4%) stated that they had consumed canned meat products at least once or twice in the last seven days, while consumption of canned vegetables and canned legumes was even higher (51.5% and 58.1%, respectively). The reasons why respondents consumed canned foods were their suitability for immediate consumption, their sensory properties and their favourable price (Brown et al. 2015).

The largest meat processor in the Czech Republic is the Agrofert group. Some of its plants also produce canned meat products, specifically Kostelecké Uzeniny make products in glass and aluminium foil (pots), while Krahulík – Masozávod Krahulčí produces traditional canned products in tin cans at its plant in Studená.

Aluminium pots in five sizes (23, 50, 75, 100 and 120 g) are used in Kostelec. A Dosomat filler from the German manufacturer Waldner serves for dosing and for sealing containers. Glass containers are also used in the production of "pâtés", for the popular pickled sausages "Utopenci" (Plate IV, Fig. 1) and, in recent times, for meat in its own juices. "Pâtés" are filled in glass with contents of 170 and 380 g. Pickled sausages are filled in larger glass jars of 380 g and 700 g. Pork meat in its own juices and beef meat in its own juices are filled in smaller 170 g containers. The last of these products is successfully exported to Great Britain and Germany. The thermal processing of the filled products takes place in rotating autoclaves to a value of F_0 15. Around 80% of production of preserved meat products at Kostelecké Uzeniny is packed in glass and 20% in aluminium pots. Only a single type of product – Prague Ham (Plate IV, Fig. 2) – is currently made in traditional one-pound cans in Studená. This is without doubt the most famous Czech canned meat product around the world.

Thermal treatment of preserved and semi-preserved meat products

The canning industry, or industrial production of canned foods, has stipulated processes of thermal treatment designed to ensure commercial sterility and the microbiological safety of canned foods (André et al. 2013). The Czech Technical Standard ČSN 56 9609 (Rules of correct hygiene and production practice – Microbiological criteria for foods. Principles of determination and application) defines commercial sterility as the absence of viable microorganisms that could grow under distribution conditions, and the absence of microorganisms causing foodborne illness (ČSN 2008). The first condition of commercial sterility, i.e. the absence of viable microorganisms capable of multiplication, means that during a test in closed containers, no increase in the number of microorganisms greater than 10^2 occurs after 7 to 10 days of incubation at 35 – 37 °C. Other limits apply to semi-preserved products which are not exposed to such intense thermal processing and which must subsequently be stored at refrigeration temperatures (Table 1). Anderson et al. (2011) state that commercial sterility does not mean that all microorganisms in the product

Table 1. Limit values for semi-preserved meat products in 1 g (ČSN 2008)

	n	c	m	M
Total number of microorganisms	5	2	5.10^3	5.10^4
Sulphite-reducing clostridia	5	2	0_b	10^2
Salmonella spp.	5	0	0/25	-
Coagulase-positive staphylococci	5	1	0_d	2.10^2

A number of samples lower than *n* may be taken for tests whose purpose is not the assessment of a batch. In such case, the tested samples are assessed as satisfactory if the determined number of microorganisms does not exceed a value of 3*m*. A value < 30/g applies for 0_b and a value < 150/g for 0_d.

must be destroyed. It means that the preserved food must be free of microorganisms that are capable of multiplication at normal temperatures (i.e. outside of the cold chain) during storage and distribution. To all intents and purposes, the Codex Alimentarius also defines commercial sterility in the same way.

The intensity of the thermal treatment process for filled and sealed cans (the "retorting process") is guided by the required shelf life (in the case of canned foods, this is the minimum storage life). Temperatures higher than 118 °C are usually not used abroad, thereby minimising the effect of excessive heat on the quality of the final product (Feiner 2006). Temperatures higher than 118 °C cause a significantly greater degree of fat separation in the contents which may give the product a crumbly texture. Thermal processing takes place in autoclaves, in which a counter pressure acts on the cans, in view of the temperature used (Plate V, Fig. 3). This is necessary at the moment the temperature exceeds 100 °C and must continue during the cooling phase until the temperature falls beneath 100 °C. If there was no counter pressure during the thermal process, the lid of the can would bulge and deformation of the product would occur or, in the worst-case scenario, the can would explode. The difference between the pressure inside the can and the pressure inside the autoclave should be no greater than 0.5 – 0.6 bars. According to Feiner (2006), the counter pressure applied depends on the temperature at 110 °C it is around 1.6 – 1.8 bar, at 118 °C around 1.9 – 2.2 bars, and at 121 °C around 2.2 – 2.4 bars.

The pressure inside the can during thermal processing depends primarily on four factors – the temperature of the product filled into the can before sealing, the intensity of sterilisation, the volume of the headspace inside the can, and the amount of air contained in that space. If hot material is filled into containers, its volume increases less during sterilisation than that of a product filled at a lower temperature. Higher temperatures during thermal processing logically cause a higher internal pressure than lower temperatures. An increased headspace volume also leads to a greater internal pressure, as more air causes greater expansion. The internal pressure inside will fall if air can be removed from the headspace before the can is sealed. The volume of the headspace in cans of meat products is generally between 5 and 10%. The water content also plays a role here. If the temperature of the contents of the can is increased from 20 to 120 °C, the volume of water will increase by 6% (Feiner 2006). An increase in temperature of 10 °C will lead to a 0.6% increase in the volume of water.

Spores of *Bacillus* spp. are devitalised at an $F_{121.1}$ value > 0.7, while spores of *Clostridium botulinum* require a minimum $F_{121.1}$ value of 2.52 for safe elimination. This value is known as the "botulinum cook" (Feiner 2006). Thermophilic spores need $F_{121.1}$ values of more than 6.0 for elimination. For "tropical preserves", expected to be stored at temperatures above 30 °C, an $F_{121.1}$ value between 10 and 14 must be applied during sterilisation to ensure a minimum storage life of 1 year at 35 °C. Czech industrial processors generally perform the thermal processing of filled cans in rotating autoclaves to an $F_{121.1}$ value of 15. Membré et al. (2015) conducted an assessment of risk in French "foie gras" preserves with a view to *Clostridium botulinum*. Products of this type in France are subjected to thermal treatment corresponding to an $F_{121.1}$ (sometimes also F_0) value of 0.5 or more. An extremely low probability of illness per head of population per year (8.0×10^{-10}) has been estimated.

Calculating the F value

The *F* value (or thermal death time) is the length of time in minutes for which a product must be exposed to a given temperature in order for a certain number of microorganisms present to be destroyed. In the production of canned foods, the reference temperature is a value of 121.1 °C. This value, unusual at first glance, has origins in studies in the USA. The temperature of 250 °F chosen there corresponds to 121.1 °C.

It must be realised that the F value represents a combination of the temperature and the time for which this temperature acts during the thermal processing of food (and not merely canned food). The general equation for the calculation of the F value is:

$F = D$ x $(\log N_0 - \log N)$,

where D (decimal reduction time) is the period of time necessary for the applied (constant) temperature to reduce the number of living microorganisms contained in the heated food by 1 logarithmic order (i.e. by 90% or to one tenth) (Kyzlink 1980). The N_0 is the number of microorganisms in 1 g of raw product (semi-product) and N is the maximum quantity of microorganisms that may survive in the heat-treated product.

In the case of canned food, the usual reference bacterium is *Clostridium sporogenes*, since the far more dangerous microbe *Clostridium botulinum* has a lower $D_{121.1}$ value, i.e. the value of D at 121.1 °C (Feiner 2006). Specifically, for *Clostridium sporogenes* the value of $D_{121.1}$ is 1 minute, while for *Clostridium botulinum* it is 0.21 – 0.25 minute (Anderson et al. 2011). This means that the action of a temperature of 121.1 °C for 0.21 minute reduces the frequency of *Clostridium botulinum* cells by one logarithmic order, i.e. by 90% (e.g. from 10^3 to 10^2 in 1 g).

The length of time of the thermal process, i.e. the time for which the sterilised product is exposed to the applied temperature for the purpose of the desired destruction of the microorganisms present, must also be calculated. This is done by calculating the L value (lethal rate), for which the following equation applies:

$L = 10^{(T1 - T2)/z}$

This equation may also be expressed as: $\log L = (T_1 - T_2)$ x z^{-1}

T_1 is the core temperature of the product recorded during the product thermal processing, T_2 is the reference temperature (for canned foods 121.1 °C), z is the temperature difference (in °C) to which the shortening or lengthening of period D by 1 logarithmic order, i.e. by 90%, corresponds under the given conditions (Kyzlink 1980 and Feiner 2006). In most cases, the value of z is 10. This means that increasing the temperature by 10 °C results in a 10 times greater sterilisation effect (Table 2).

Table 2. Different values of L in canned foods for a value of z = 10 (Feiner 2006)

Temperature [°C]	*L* value
101.1	0.01
111.1	0.10
121.1	1.00
131.1	10.00

If the temperature of 121.1 °C is the reference temperature and *Clostridium sporogenes* the reference bacterium for canned goods with a value of $D_{121.1} = 1$ min., the value of L can be calculated using the equation given above. The values of D are, of course, different at different temperatures. Assuming a z value of 10, then at a temperature of 111.1 °C a time of 10 minutes is required for the same lethal effect. At 131.1 °C just 0.1 minute is required (Table 2).

The principal biological risk in canned meat products is the bacterium *Clostridium botulinum*. The reliable elimination of this microbe is achieved by reaching an $F_{121.1}$ value = 2.52 (minutes). This value is based on the 12D concept, meaning that the effect of the temperature during sterilisation must be strong enough to reduce the number of *Clostridium botulinum* cells by 12 orders of magnitude (Feiner 2006).

This minimal 12 log reduction of *Clostridium botulinum* bacteria is the basis for assuring safe commercial canned products, and this requirement has existed for more than 90 years (Anderson et al. 2011) and is a purely theoretical safety formula. If the D value for *Clostridium botulinum* at 121.1 °C is 0.21 min., then:

$F = D (\log N_0 - \log N) / 0.21 (\log 1 - \log 10^{-12}) = 0.21 \times 12 = 2.52$

In other words, the action of a temperature of 121.1 °C for 2.52 minutes ($F_0 = 2.52$) in all parts of the preserved product guarantees that only a single spore of *Clostridium botulinum* will survive in 1 out of 10^{12} cans, i.e. 1 billion cans. As has been stated in the introduction to this paper, annual global production of canned products is less than this figure. If we count on a $D_{121.1}$ value of 0.25 min., then by using the equation we obtain the result F = 3.0 min. (Anderson et al. 2011).

There are, of course, spore-forming bacteria with a higher $D_{121.1}$ value than *Clostridium botulinum.* If cans are to be stored at higher temperatures, then $F_{121.1}$ values of 12 – 16 minutes are used (F_0 = 12 – 16). Steinhauser (1995) states an F_0 value of 16 – 20 for "tropical preserves" with a minimum storage life of 1 year at 40 °C.

Thermophilic spore-forming bacteria in canned food

The stability test for preserved foods after thermal treatment consists of their incubation to detect the possible development of surviving spores. The Codex Alimentarius recommends that preserved foods are incubated for 10 – 14 days at 37 °C. The French standards demand incubation at 37 °C for 7 days or at 32 °C for 21 days (André et al. 2013). These conditions have been shown to suffice for the germination and subsequent growth of mesophilic spores that have survived sterilisation. Spoilage resulting from microbial growth manifests itself in the formation of gas (bombage), off-flavour, discolouration, or deviations in pH values. If test results are positive, the batch of cans is destroyed to prevent problems relating to food safety.

Different test characteristics are used in the simulation of excessive temperatures during the storage of canned foods, generally a temperature of 55 °C, and the length of incubation then depends on the requirements of the country to which the consignment of canned food is to be sent. In this case, this means purchasers from countries with high air temperatures (André et al. 2013). Thermophilic spore-forming bacteria are not considered pathogenic to man, though their presence may affect the shelf life of products stored at high temperatures. If analyses show unstable cans following extended incubation at 55 °C, this indicates shortcomings during the production process, specifically:

- inadequate thermal processing;
- the presence (even in small numbers) of thermo-resistant spores on production lines or in raw materials used.

For these reasons, data on the origin of thermophilic spore-forming bacteria and their survival during sterilisation is particularly valuable to manufacturers of canned foods. André et al. (2013), cited above, performed an extensive analysis of 455 samples of low-acid canned foods (LACF) from 122 different production plants incubated at 55 °C for 7 days in France in 2001 – 2010. Kyzlink (1980) states that an acidic environment (a border pH value of 4.0, usually 3.5, though also perhaps 2.7 to 2.9; the content of organic acids is usually 0.5 – 1.2% or more) is differentiated in canning technology from a mildly acidic or entirely non-acidic environment (mildly acidic foods have a pH value of 4.0 – 6.5; entirely non-acidic foods a pH value > 6.5). The U.S. Food and Drug Administration considers mildly acidic foods those with a pH value > 4.6 and an $a_w > 0.85$ (Anderson et al. 2011).

In the case of the above analyses by French authors, the canned foods were divided into three groups according to the recipes used: vegetable (21 different recipes), ready foods containing meat (15 recipes), fishery products (6 recipes) or other constituents (7 recipes), while the third group was comprised of products containing duck meat (2 different recipes). The thermal processing used for sterilisation was also divided into three groups: an F_0 value < 5 min.; an F_0 value of 5 – 20 min.; and an F_0 value > 20 min.

Of the tested samples, 99 products showed signs of spoilage. From these, 462 isolates of spore-forming bacteria were obtained. Only a single bacterial species was identified in 93%. Two bacterial species were found in 7 samples. In the category of ready dishes containing meat and in the samples of canned vegetables, 27% and 55% of the tested samples, respectively, were spoiled. An overview of bacterial species isolated and identified in the ready dishes category is given in Table 3.

Table 3. Species of bacteria isolated from canned food in the ready dishes category showing signs of spoilage (André et al. 2013)

Bacterial species	Number of isolates	Species in category of canned food [%]
Moorella thermoacetica / thermoautotrophica	60	34.7
Geobacillus stearothermophilus	61	35.3
Geobacillus debilis	1	< 0.6
Geobacillus sp.	1	< 0.6
Thermoanaerobacterium thermosaccharolyticum	8	4.6
Thermoanaerobacterium sp.	6	3.5
Thermoanaerobacterium acidotolerans	1	< 0.6
Thermoanaerobacterium aotearoense	1	< 0.6
Bacillus coagulans	3	3.5
Bacillus licheniformis	3	1.7
Bacillus thermoamylovorans	3	1.7
Bacillus smithii	2	1.2
Bacillus amyloliquefaciens	1	< 0.6
Bacillus sp.	1	< 0.6
Thermoanaerobacter thermohydrosulfuricus	4	2.3
Thermoanaerobacter mathranii / thermocopriae	3	1.7
Thermoanaerobacter sp.	4	2.3
Caldaanaerobius zeae/fijiensis / polysaccharolyticus	2	1.2
Anoxybacillus flavothermus	3	1.7
Paenibacillus macerans	1	< 0.6
Paenibacillus sp.	1	< 0.6

Developments in the taxonomy of bacteria in recent years have led to the discovery of a large number of new bacterial genera, into which many known species have been reclassified. Bacterial classification should reflect the most profound natural relationship between bacteria, which is traditional considered the phylogenetic relationship coded by macromolecules such as the 16S or 23S rRNA genes (Vandamme et al. 2014). The genus diversity is evident at first glance when we compare the agents of spoilage of canned foods in the group thermophilic spore-forming bacteria known more than 30 years ago with the current situation. Kyzlink (1980) lists merely representatives of the genera *Bacillus*, *Clostridium* and *Desulfutomaculum* in his book. André et al. (2013) isolated strains from cans showing signs of spoilage, which they classified into 10 different genera. Of the isolates identified, 71% belonged to just two genera – *Moorella* and *Geobacillus*.

The species *Moorella thermoacetica / thermoautotrophica* and *Geobacillus stearothermophilus* were identified in cans containing vegetables or ready dishes that showed signs of spoilage. Raw vegetables and spices were evidently sources of these spore-forming bacteria. These species were not evident in cans containing duck meat. Representatives of the genus *Thermoanaerobacterium* and the species *Clostridium thermopalmarium / thermobutyricum* were determined in these products.

The greatest thermal resistance was demonstrated by the species *M. thermoacetica / thermoautotrophica*, whose three tested strains showed a D_{121} value of as much as 30 min. (André et al. 2013). A D_{121} value of just a few minutes was shown by *G. stearothermophilus* which corresponds to data described previously. The genus *Moorella* was described for the classification of two thermophilic isolates that had previously been determined as *Clostridium*, specifically *Clostridium thermoaceticum* and *Clostridium thermoautotrophicum* (Carlier and Bedora-Faure 2006). *M. thermoacetica* and *M. thermoautotrophica* are extremely closely related species. Carlier and Bedora-Faure (2006) even consider them identical, for which reason isolates from French canned foods in Table 3 are given together. Nevertheless, analyses have demonstrated and confirmed the existence of two species.

Thanks to the high degree of thermal treatment, industrially produced canned foods are not vehicles that would cause illnesses of food origin in the member states of the EU. The situation may, however, be different for preserved foods prepared in the home, where autoclaves for thorough thermal treatment are not generally available and where the F_0 values used are not capable of inhibiting the development of undesirable spore-forming bacteria. The EFSA report from the year 2014 on alimentary diseases and zoonoses described a total of 9 mass of foodborne disease outbreaks caused by *Clostridium botulinum* toxins in the EU member states, of which five mass outbreaks accompanied by strong evidence of the agents involved were reported in four member states. With the exception of one case, they were household outbreaks, and in two of them the vehicle was preserved foods (EFSA 2015). The report, however, did not give further specification. In 2012, six cases of mass outbreaks caused by botulinum toxin were reported in three member states (France, Portugal and Spain). In one case in France, preserved foods were reported as the vehicle of illness (EFSA 2014). Czerwiński et al. (2012) also state preserved foods as a source of botulinum toxin illness in Poland in 2010. The majority again related to products made in the home.

Conclusions

Canned meat products still represent a large group of meat products, although they are no longer as important as they were in the years 1920 – 1990. The advantage of canned meat products to the consumer lies, first and foremost, in their long shelf life and the fact that they can be stored at room temperature. Industrially produced products are also of a lower cost (per kg of net weight) than ordinary meat products. On the other hand, selected canned meat products prepared by small artisan producers may be considered delicacies with a pronounced taste in view of the ingredients used. The production technology for preserved foods, namely a hermetically sealed container and the intensity of the thermal process, is the basis for a high degree of safety for these meat products. Thorough checks of production processes are absolutely essential, since an anaerobic environment inside the cans and the suppression of competitive microflora by a high temperature during heating create conditions for the growth of spore-forming bacteria. Some of these, e.g. *Clostridium botulinum*, may cause serious illness, while thermophilic spore-forming microorganisms also cause the spoilage of preserved food products stored at high temperatures. Observation of HACCP principles is an essential part of the entire production process in the production of preserved and semi-preserved meat products.

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Fig. 1. “Utopenci” (pickled sausages) are currently the biggest selling preserved meat product in glass from the Kostelecké uzeniny plant in Kostelec (made in sizes of 380 g and 700 g)

Fig. 2. The most famous Czech preserved meat product abroad is probably the one-pound Prague Ham. It is supplied with an “easy-open” lid for easier opening.

Plate V

Fig. 3. The thermal processing of cans generally takes place in rotating autoclaves. The German company LUBECA, part of the SCHOLZ group since 1993, is a leading manufacturer of rotating autoclaves.