

ORIGINAL PAPER

Received: 02.12.2019

Accepted: 24.12.2019

## IMPORTANCE OF BREEDING AND MANAGEMENT OF COLD-BLOODED HORSES IN TERMS OF THEIR MEAT UTILIZATION

Dorota Kołodziejczyk , Magda Socik, Stanisław Socha  

Siedlce University of Natural Sciences and Humanities, Faculty of Agrobiotechnology and Animal Husbandry, B. Prusa 12/14, 08-110 Siedlce

### ABSTRACT

The aim of the study was to analyze the role of breeding and utilization of cold-blooded horses. The analysis was based on both published statistical data and our own survey conducted in order to examine the level of horse meat consumption among Poles and to check their food preferences regarding this type of meat. We found that horse meat is virtually absent on Polish tables. This is due to the emotional attitude the Poles foster towards horses, so half of the respondents were entirely against horse meat consumption. Despite the varied attitude of respondents towards horse meat consumption, the analysis of statistical data shows that since 2013 the number of farms keeping 10 or more cold-blooded horses has been increasing. The current direction of changes, such as the development of agritourism, an increase in the number of organic farms, farmers joining agri-environmental programs or supporting activities for sustainable agriculture, will probably increase the scale of cold-blooded horse farming.

**Key words:** cold-blooded horse, breeding history, meat performance

### INTRODUCTION

Domesticated animals, including horses, have been accompanying the mankind eversince. According to Lasota-Moskalewska [2005], horses have been utilized for riding, loads carrying, and drawing all kinds of carriages. However, before these utility features were first applied, horses were used as a source of food [Clutton-Brock 1999]. The meat of foals was particularly valued.

Both location and time of horse domestication are difficult to approximate, as the history of horse use may only be described basing on iconography or excavations, these sources are scarce though [Lasota-Moskalewska 2005]. Some researchers [Outram et al. 2009, Warmuth et al. 2011] claim that taming and domestication of the horse took place about 3,500 years BC in the Eurasian steppes. Other sources [Lasota-Moskalewska et al. 2009] state that numerous horse bones from the early Neolithic period (about 7,000 years BC) were uncovered in Uzbekistan. First horses arrived in Europe probably about 1500 BC. They were originally used as battle horses, then as a means of transportation as mount, pack or draft horses. However, horses have also been used as a source of protein.

In 2015, the world population of horses was around 58 million, of which 4 million were raised and bred on the European continent. In Poland, the number of horses dropped from 624 thousand in 1995 to 185.5 thousand in 2016 [GUS 2017]. Despite the constantly decreasing number of horses, Poland still remains the main exporter of horses to Japan and Italy. About 25,000 horses (of the total weight 12,000 tons) are slaughtered each year in Poland, of which 95% is exported. Such significant production is possible due to very good conditions for rearing, long-term traditions, large pasture areas and considerable production of cereals or root crops [Fedorski 2003].

Horse meat is a specific foodstuff and has a specific group of consumers. In Europe, Italians are the leaders in terms of quantity eaten, with the annual consumption per capita of 0.88 kg, followed by Belgians, with the annual per capita consumption of about 0.5 kg [Martin-Rosset 2001, Martuzzi et al. 2001].

Horse meat has a high protein content, around 21% (Table 1 [Szkucik and Pysz-Lukasik 2009, Makala 2007]), and the protein has a high biological value. There is an increased content of vitamins such as B1, B2, PP, and minerals, mainly calcium, iron and phosphorus [Zin and

**Table 1.** Chemical composition (%) and energy value of 100 g of meat by species [Szkucik and Pyz-Łukasik 2009, Makała 2007]

**Tabela 1.** Skład chemiczny (w %) i wartość energetyczna 100 g mięsa różnych gatunków zwierząt [Szkucik and Pyz-Łukasik 2009, Makała 2007]

Meat type Rodzaj mięsa	Water – Woda	Protein – Białko	Fat – Tłuszcz	Minerals – Sole min.	Energy content, kJ/100 g of meat Wartość energetyczna, kJ/100 g mięsa
Beef – Wołowina	66–71	18–21	3–15	0.9	473–854
Veal – Cielęcina	70–77	20	1–7	1.0	380–602
Pork – Wieprzowina	60–75	17–19	10–22	0.6	418–1112
Chicken – Kurczęta	67–75	17–22	4–12	0.8	406–808
Rabbit – Królicze	66–75	20–24	1–6	1.4	427–849
Horsemeat – Konina	~74	20.1% (12.8–21.5)	8.5	1.1	~656

Szumlik 1998, Barowicz and Brejta 2012]. Compared to other red meats, horse meat has a lower calorific value. Horse meat also has a delicate structure, which is the result of the presence of fine muscle fibers, which makes it different from beef. The characteristic features of this product are its color, slightly sweet taste and smell [Kwiatkowska 2002, Litwińczuk 2004, Barowicz and Brejta 2012]. This is due to the high content of glycogen in the horse muscle tissue, about 0.9% [Stanisławczyk 2013].

From the processing point of view, horse meat is not inferior to other meats that are commonly appreciated by consumers. Both in its chemical composition and the technological image, horse meat resembles beef. That of young horses, foals, has an even more delicate structure and is much better digestible than beef or pork [Kapusta 2013].

#### Breeding of Polish cold-blooded horses – historical outline

Cold-blooded horses are the most common breed of horses in Poland. They represent about 50% of the total number of horses bred in our country. This is due to the fact that horses of this breed are characteristic for early maturation, good feed conversion, rapid growth and ease of maintenance [Jastrzębska 2006].

Cold-blooded horses, also referred to as draft horses, are versatile in usage. They are still used for field work as a draft force, especially in poorer regions of Poland. They can also be found on agritourism holdings. Irrespective of the usage, a majority of the horses are finally slaughtered.

The beginnings of cold-blooded horses breeding in Poland date back to the 19th century. During this period, landowners began importing initially Percherons and Belgian horses, and later Ardennes horses [Grzechnik 2007]. In the estates of the Krasieński, Zamojski, and

Kronenberg families one could admire stallions of heavy breeds, which were usually used for mating local mares, reared by local peasants. With a setup of stud farms in Vilnius and then in Janów Podlaski, well-organized forms of horse breeding began. At the turn of the 20th century, two of the most significant breeding regions of cold-blooded horses could be distinguished on the Polish soil. One region were the lands surrounding Łowicz and Sochaczew, the other around Dąbrowa Białostocka, Grodno and Sokółka. The interwar period had a negative impact on cold-blooded horses. The authorities at the time did not recognize or support breeders. There was no stud farm at that time that would manage pure-bred cold-blooded horses [Mroczkowski et al. 2010].

The term “cold-blooded horse” (a collective name for the draft horse breeds) in the Polish language was first used in the specialist literature in 1964, when the first stud book entitled *Księga Stadna Koni Zimnokrwistych i Pogrubionych* (“Stud Book of Cold-Blooded Horses and Heavy Warmbloods”) was issued. The name clearly indicates the placid and composed nature of the horses. In Poland this term denotes horses characterized by a stocky build, similar in appearance to the Ardennes horse. They are small- or medium-sized, often graded as “heavy warmbloods” [Fedorski 2003]. Horses imported from Western Europe played a huge role in creating and improving the population of Polish cold-blooded horses. These include Ardennes (Swedish and French), Bretons, Boulonnais and Belgian horses. Initially, horses were crossed casually, depending on the breeder, and only later did these activities acquire the form of an organized system, which was applied in certain regions of Poland. Of course, formation of a particular breed of animals depends on the specific area and its economic and social environment.

Currently, in Polish cold-blooded horse breeds, four varieties are distinguished: Sztum horses, Lidzbark-

Warmian horses, Łowicz horses and Sokólski horses. In Poland, cold-blooded horse breeding is usually associated with Warmia and Mazury, the region where the breeds originally come from. They were spread across the Białystok region and the neighboring areas (such as the Vilnius region, Polesie, or the provinces of Nowogródek and Grodno), and the breeding itself took place in Warmia, part of Gdańsk Powiśle, Western Pomerania and Silesia, and in the area of Sochaczew, Radom and others. Initially, the main application of the horses was to work in the field, in the absence of agricultural machinery. Thanks to their hard-working and tough disposition, extremely placid temperament, and slow movement, the horses were perfect in the field. Although mechanical equipment has finally replaced horses at work [Stojanowska and Wachel 2011], the tradition of breeding Polish cold-blooded horse survives. They are still used in the forestry and tourism, but currently the largest percentage is intended for slaughter. They are also managed in agritourism farms and used in hippotherapy. They fit in the areas where composure, strength and friendly disposition really matter.

Following the end of World War II, cold-blooded horses proved indispensable, as there was no other draft force available in war-devastated Poland. In 1946 and 1947, Poland obtained cold-blooded horses within the post-war humanitarian aid program carried out by the United Nations Relief and Rehabilitation Administration (UNRRA). Horses were also brought from the Netherlands, Belgium and the Scandinavian countries. More than a dozen studs were created, where the herds of horses were improved to produce valuable genetic material through professional selection and breeding. Administratively imposed regional distribution of breeding centers resulted in separate regional types of cold-blooded horses, such as: Sokolski, Sztumski, Łowicki, Koszaliński, Radomski, and Lidzbarski horses. An important step was the assembly of the Cold-Blooded Horse and Heavy Warmbloods Stud Book in 1964, and the Cold-Blooded Horse Stud Book [Mroczkowski et al. 2010].

Systematic breeding work had a result in the improvement and genetic consolidation and phenotypic equalization of the population. Studs with outstanding results included the Stallion Stud Farm in Kętrzyn and, in particular, the Nowe Jankowice Stud Farm, where strictly focused breeding work on cold-blooded horses began as early as in 1950. Nowe Jankowice is still operational and is currently the only state stud farm that breeds cold-blooded horses. Traditional auctions, which are held there twice a year, in spring and autumn, are very popular among breeders from all over Poland [Grzechnik 2007]. The annual “Cold-Blooded Horse Festival” taking place in the Stallion Stud Farm in Kętrzyn, whose tradition dates back to 1997, is also worth mentioning. The festival

is an occasion for cold-blood breeds popularisation and involves auctions, championships, shows or parades, with the presentation of the power and skills of cold-blooded horses, in particular of the draft breeds.

### **General characteristics of the Polish cold-blooded horse**

The Polish cold-blooded horse should be harmonious in lines, have a wide back, deep chest, good muscularity and a definitely strong physique. It is characteristic for excellent feed conversion rates, heavy body weight, rapid development and growth, somewhat lymphatic constitution, and good fertility. All these features predispose these breeds for slaughter. Both early maturation and rapid growth rates are maintained by limiting any genetic contribution from foreign breeds of late-maturing cold-blooded horses. The gait at both the walk and trot should be springy, prominent and correct, a mild and even-tempered disposition are desirable traits as well [PZHK 2018].

Cold-blooded horses are relatively easy to raise compared to other farm animals. They are characterized by rapid growth, reach maturity early, do not cause problems in the paddock, are highly prolific, and – if properly fed – they convert the feed well, even feeds of lower quality, and quickly reach their heavy weight. The proper development of cold-blooded foals largely depends on the mare’s milk yield, and the least expensive rearing cycle involves early spring foals. By the age of three, cold-blooded horses should have reached 96% of the adult body weight and approximately 100% of its height [after Barowicz and Brejta 2012].

The aim of the study was to analyze the importance of breeding and use of cold-blooded horses in the aspect of their use for meat.

### **MATERIAL AND METHODS**

The material for the study comprised the statistical data published by the Polish Central Statistical Office for 2000–2018 [GUS 2018] and the results of a survey that aimed to find the level of horse meat consumption among Poles and check their attitude towards this type of meat.

The survey was conducted online in 2018. The questionnaire was available on the Internet URL for 3 days and consisted of 10 closed, single-choice questions. A respondent was able to fill the form only once. The questionnaire was prepared according to Babbie [2004]. A total of 220 respondents answered the survey questions. The survey included the following questions: (A) “What sex are you?”, (B) “Which age group do you belong to?”, (C) “What is your education level?”, (D) “Where do you live?”, (E) “How often do you eat meat?”, (F) “Have you ever eaten horse meat?”, (G) “Are you more emotional towards horses than to other farm animals?”, (H) “Do you

have knowledge on horse meat consumption in Poland?”, (I) “Do you have knowledge on horse meat nutritional value?”, (J) “Are you against eating horse meat?”.

## RESULTS AND DISCUSSION

The results of the survey are presented in Fig. 1. The data allows concluding that the demand for horse meat among Polish consumers is next to none. Exactly half of the respondents declared they eat meat every day, 17.7% three days a week, 4.5% only eat meat once a week. The results imply that meat is commonplace in the diet of Poles (Fig. 1E). Another question (Fig. 1F) reveals that only 17.7% of the respondents have eaten horse meat at least once in their lifetime, while the vast majority (82.3%) have not eaten this type of meat at all. The results obtained in our survey are very similar to those reported by Krupa and Majka [2000]. The authors, who studied consumer meat preferences, examined the frequency of consumption of various sorts of meat and found that 78% of respondents had never eaten horse meat.

Of the people who took the survey, 46.6% were men and 53.4% were women (Fig. 1A). The largest group of people participating in the study were young people in the age group of 20–30, the least numerous age group was older people over 60 (Fig. 1B). People with higher education constituted the largest percentage of respondents (61.4%), and the lowest number of respondents was with vocational education (Fig. 1C). The structure of education level in the study by Krupa and Majka [2000] was slightly different. People with higher education constituted a much smaller group of respondents, only 16.4%. The largest number of people who took part in the study of the above-mentioned authors were respondents with secondary-school level education, 47.8%. A high percentage of people at a young age and with higher education participating in our survey may indicate that the group we examined should be more interested in healthy nutrition with better awareness in this field.

Fig. 1D shows that the most people (31.4%) who took part in the survey were inhabitants of large cities, over 500 thousand residents, but also a large group (almost 27%) were rural-area residents.

As many as 61.2% of respondents (Fig. 1G) declared their positive emotional attitude towards horses. For many people in this group, this is probably the primary barrier preventing them from eating horse-meat. Therefore, the opinion on the inclusion of horse meat in the diet was divided almost equally. Slightly more (52.3%) of respondents were willing to eat horse meat instead of meat of other species, while 47.7% of people were against it (Fig. 1J). This decision could have been influenced by the fact that a significant proportion of the population did not have any knowledge that horse meat was consumed. Nor did they have any awareness as to

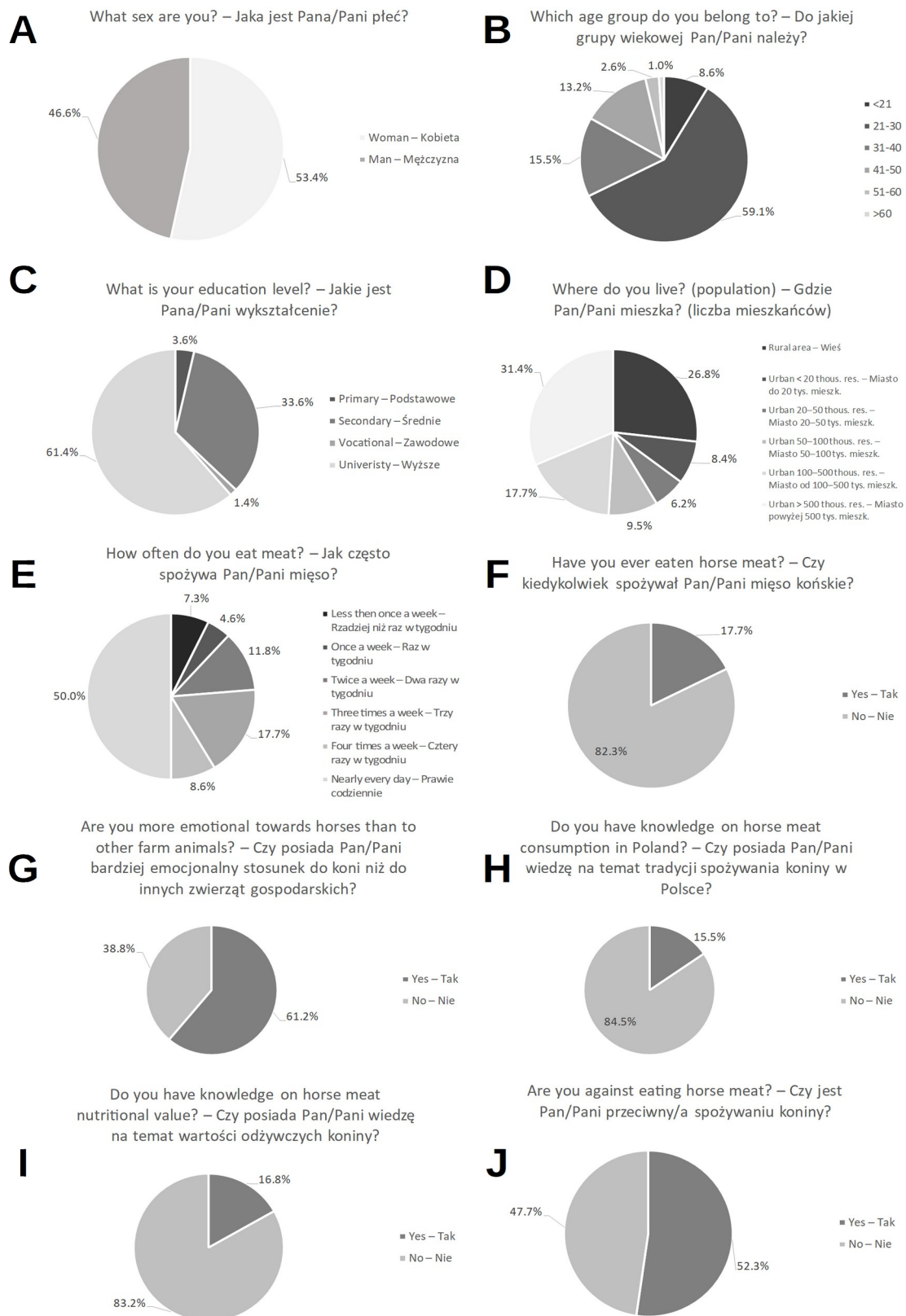
the nutritional value of horse meat. The survey shows that up to 84.5% of respondents declare lack of knowledge about the traditions and ways of consuming horse meat in Poland (Fig. 1H), and 83.2% of respondents do not have knowledge about the nutritional value of horse meat (Fig. 1I).

Tereszkiewicz et al. [2014] are also of the opinion that emotional and psychological factors determine the low levels of horse meat consumption in Poland or its complete absence from the diet. Litwińczuk [2004], in turn, believes that the reason for the low consumption of horse meat in Poland is its color and sweet taste, which differ from the meats of other farm animal species.

On the other hand, horse meat is a very valuable and healthy product, and it should be offered as a healthy food item. It is characterized by a high protein content, and its amino acid composition is at the levels satisfying the total needs of the human body [Korzeniowski et al. 1999]. In addition, horse has a high content of vitamins and minerals, and is safe to eat [Kortz and Gardzielewska 1988]. Thanks to the physicochemical properties, reduced fat content and a rich composition of fatty acids, it can be assigned to the group of dietetic meats, and in its composition it resembles particularly lean beef [Sarnecki 1977]. It is worth mentioning that horse carcasses are characterized by good lean percentage, ranging 65–75% depending on the cut [Janiszewska and Kortz 1988]. That is why horse meat is a product particularly desired by consumers, however those living in countries other than Poland [Urban 2008].

Meat from Polish horses is of very good quality due to the purity of the environment they live and the natural way of feeding. Selling horses abroad for slaughter and meat date back to the 1950s and 1960s. Defective horses were anyway sent to slaughter, so with the lack of interest from Polish consumers, the horses were exported to Western Europe, where horse meat markets existed. In 1967, 16.1 thousand horses were exported on hoof and 13.1 thousand as carcasses. The following years saw an increase in the exports, and in 1970, 42.4 thousand live animals and 40.8 thousand carcasses were sold abroad. The year 1979 was the record-breaking, with 170,000 horses exported for slaughter. In the 1980s, Poland was forced out of the traditional horse markets. The reason was the import from the central and Baltic Soviet republics, as well as Romania, Bulgaria and then Czechoslovakia. Currently, exports of Polish horse meat are on a significant decline. Annually, 25–30 thousand horses are exported, of which 95% goes to Italy, and the remaining 5% to Belgium and France.

Polish horse producers should put greater emphasis on adapting the product to the requirements on the markets of importing countries. Depending on the country, differences exist in the preferences of the horse meat. The Belgian, French and Dutch markets expect



**Fig. 1.** Survey results

**Rys. 1.** Odpowiedzi respondentów

warm-blooded, massive horses, with thin bones, adequate weight and frame, with slight subcutaneous and intramuscular fat, with age ranging from 5 to 15 years. The most valuable raw material most often comes from horses weighing 500 to 700 kg, with a minimum age of 8 years, and graded as quality grade I or II. Good quality horse meat offered in these countries should be firm, lean and dark, which is preferred by consumers. The Italian market, on the other hand, most often imports slaughter foals between half- to one and a half year, and meat from adult cold-blooded horses, slightly marbled, obtained from animals at age 2 to 7 years. Fresh meat has vivid red color and relatively strong texture. However, horse meat contains a considerable amount of water. Using horse meat, a chef may prepare most of the dishes that are made of mutton and beef, because of a similar structure. Thermal treatment makes it quite tough, so it is very important to marinate the meat before cooking [Zin et al. 1999].

In Poland, insufficient tenderness is reported as the main flaw of horse meat that reduces its consumption [Korzeniowski et al. 1998]. This also results from an increased quantity of connective tissue proteins [Korzeniowski et al. 1994]. The coherent and firm texture of raw meat, with visible connective tissue membranes makes horse meat unattractive in appearance. Also horse fat is characteristic for its yellowish to sometimes even orange, repulsive color [Korzeniowski et al. 1993, Litwińczuk 2004].

Age of the horse is a factor affecting the chemical composition of horse meat [Zin et al. 1999]. Meat from foals is characterized by a high protein content (ranging from 21.1% to 22.4%) and low fat levels (from 0.8% to 2%). Rak and Morzyk [2002] report that water content decreases and fat and minerals content increases with age. It has also been shown that meat obtained from older animals is more leathery and tough, even after heat treatment. The main reason for these defects is the increase in the amount of collagen, which results in a decrease in nutritional value and an increase in meat hardness [Zin et al. 1999]. Therefore, horse meat is usually obtained from young or middle-aged individuals that are not exploited. Such meat is in demand on foreign markets. The most numerous part of the export pool are middle-aged horses, and only 10–12% can be considered foals [Brodzińska 2007].

French importers are eager to buy older, warm-blooded horses that are in good condition and have minimal intramuscular and subcutaneous fat. However, it has still not been established to what extent meat obtained from foals is more desirable for consumption and processing than meat obtained from adult horses. It is also unknown at what exact age the quality of meat begins to decline. Research conducted by Rak and Morzyk [2002] shows that the meat of older horses has a more intensive intramuscular fatness, similarly more fat appears on

the surface of the half-carcass. The color of tallow is also a very important aspect for the consumer's decision. Tallow in foals is the lightest in color, pale creamy, while in adult horses the color is yellow. It is also important to analyze the meat obtained from individuals of different age groups. Foals, whose pre-slaughter weight is low, provide relatively little meat, 62.6 kg on average. It is surprising that relative weight of the meat obtained is the highest, up to 60%, while in the group of young horses 59.1% of meat is obtained, and 55.4% from older horses. A quantitative analysis of the meat obtained in individual grades was also carried out. The largest amount of 1st grade horse meat was obtained from foals (53.7% of grade I, 6.3% of grade II). Adult horses provide a relatively less grade I meat, from 43.3% to 46.5%. A similar relationship occurs for grade II (from 12.2% to 13.8%) [Korzeniowski et al. 1998].

The content of good quality meat in the carcass (1st grade) is thought to be related to age, but only at the beginning of rearing. As the animal reaches the age of three years, the significance for this factor decreases, as evidenced by reduced differences between grades I and II [Krupa and Szmulik 1999]. Comparing slaughter performance between foals and adult horses, horses younger than two years have a higher slaughter value, a higher lean percentage and the lowest fat content. Foal meat is characterized by exceptional color, tenderness and lower marbling. Slaughter performance decreases as horses age, and the percentage of body fat increases, which is adverse for the meat. In horses between 3 and 20 years old, age has no significant impact on the physicochemical characteristics of the meat, only the deterioration in the tenderness of meat from those older than 8 years is noted [Stanisławczyk 2013].

The effect of meat tenderness deterioration as animals grow older is associated with changes that occur in muscle collagen structures [Jeremiah and Martin 1981, Nowacka and Janicki 2002]. Collagen located in the intramuscular connective tissue takes on a stiffer and harder form. It also becomes more resistant to thermal denaturation, it is attributed to a role in the progressive toughening of meat [Powell et al. 2000]. Some of the muscles contain a lot of elastin (e.g. m. semitendinosus, m. longissimus dorsi), which is a connective tissue that undergoes thermo-hydrolysis at a minimum temperature of 130°C. Elastin also affects the tenderness in individual parts of the carcass, it also brings changes as the animal ages [Rak and Morzyk 2002]. In addition, as the animal reaches maturity and with age, the color of the meat darkens and the fat takes on a yellowish hue, sometimes even orange. The above-mentioned studies clearly show that the age of the animals affects both the technological and sensory properties of meat.

Polish horse meat has the required microbiological purity. Not a single case of trichinosis has been repor-

ted so far. This is in contrast to horse meat from South America, in which the occurrence of *Trichinella spiralis* is very common. The secret is the use of primitive breeds of horses, which are not fed with typical farm feeds [Ancelle 1999]. On the other hand, in the case of Brazil and Mexico (Poland's toughest competitors), Salmonella is the most common threat present in raw material coming from these countries [Chabela et al. 1999].

### Structure of horse breeding farms in Poland

Data published by the Central Statistical Office [GUS 2017] show that 61.6 thous. farms were involved in breeding and farming of livestock animals in Poland in 2016. Comparing to 2013, when the number of farms was 87.2 thous., there is a sharp drop in the interest in this field of agriculture. Of all farms located in Poland, only 8.6% managed horses. Most farms, 46.3%, were within 5–15 ha of arable land, with a marginal number of smallest farms, not exceeding 1 ha, only 0.7%. On average, in 2016 most Polish farms, 53.2%, had only one horse (53.5% in 2013), 17.0% had two horses (21.4% in 2013), 24.7% from 3 to 9 horses (14.1% in 2013), and in 5.1% of farms there were 10 or more horses (3.6% in 2013, Table 2 [GUS 2014, GUS 2017]). The average horse density on these farms per 100 ha of arable land was 22.3. An average horse farm possessed 3 horses [GUS 2017].

**Table 2.** Number of horse farms by size in 2013 and 2016 [GUS 2014, 2017]

**Tabela 2.** Struktura liczby gospodarstw według skali chowu koni w roku 2013 oraz 2016 [GUS 2014, 2017]

Number of horses Liczba koni	Horse farms, % Gospodarstwa utrzymujące konie, %	
	2013	2016
1	63.9	53.2
2	15.1	17.0
3–9	17.6	24.7
≤ 10	3.3	5.1

The presented data indicate that despite the decrease in the total number of farms involved in horse rearing and breeding, an increase in the density of horses on farms that have decided to breed horses can be seen. Since 2013, the number of farms maintaining 10 and more horses has increased by almost half, while the number of farms managing one horse has decreased.

### Procurement and exports of horses in relation to horse population

Over the last decade, the population of horses has worryingly decreased – by almost 45%. So has horse on-

hoof export volume. Currently, the country's population of cold-blooded horses is about 134,000 (Table 3, [GUS 2018]). In Poland, the use of horses for agricultural work is becoming less and less common, also the Polish State Forests almost completely withdrew from using horses at logging, so draft horse breeding has no economic justification. The cold-blooded breeds are now more popular on agritourism farms, where they are used for carriage or sleigh rides or take part in local driving competitions.

**Table 3.** Quantitative structure of cold-blooded horses

**Tabela 3.** Ilościowa struktura pogłowia koni zimnokrwistych

Year – Rok	Population, thous. heads Pogłowie, w tys. szt.
2009	223.35
2010	202.46
2011	177.24
2012	165.15
2013	154.67
2014	151.86
2015	144.79
2016	137.00
2017	134.02
2018	134.33

The UE horse meat market has no import limits, unlike many other food commodities. In the absence of such restrictions, the prospect of growth is promising. However, there are competitors, such as is China, the USA. Consumer requirements are also increasing; therefore, in order to maintain the market, the decreasing trend in the number of horses should be reversed, and the final product should be constantly improved. Due to the fact that not all countries have sufficient horse herds, some countries are forced to import meat or horses for slaughter. In 2004, a total of 69,000 tons of horse meat was produced in 25 countries that were members of the European Union at that time, of which as much as a third was produced in Poland. For many years, slaughter horses originating in Poland have been sold on the EU market, because the European Union's self-sufficiency is extremely low (it ranges from 40 to 45%) [Brodzińska 2007]. The largest horse meat deficit is recorded in Italy, where native production meets the demand in only 30%. Thanks to this Italy is the most important importer of live horses and meat in the whole European Union. It is this country where Poland exports the vast majority of horses and horse meat. Poland is the fourth largest meat producer in the entire European Union and has as much as 11% of EU market share [Pawlonka 2017]. In general, the horse meat market is insignificant and accounts for only 0.4% of the total meat production in the world. French,

Italian, Belgian, Dutch and Japanese like horse meat and eat the most of it. The supply on the horse-meat markets in the consumer countries are on average in 70% satisfied by imports, in Japan it reaches even 90%. The largest producers of horse meat include China (with 1.7 million horses slaughtered annually), Mexico (0.63 million), Kazakhstan (0.34 million), Mongolia (0.31 million) and Argentina (0.26 million horses). In Poland, in recent years, the production ranged 20–22 thousand slaughtered horses, which places Poland among the leading countries. There is still a high density of horses in Poland, with an average of 1.7 horses per 100 ha of arable land. Most, 56% of the population, are cold-blooded horses and their crossbreds [after Barowicz and Brejta 2012, Polak 2016].

**Table 4.** Horse population and horse livestock procurement in 2000–2018 [GUS 2003–2019]

**Tabela 4.** Pogłowie koni i skup żywca końskiego w latach 2000–2018 [GUS 2003–2019]

Year Lata	Population, thous. heads Pogłowie, w tys. szt.	Livestock procurement, thous. tons Skup żywca, w tys. t
2000	550	31.9
2001	546	27.0
2002	330	17.9
2003	333	22.1
2004	321	24.0
2005	312	20.8
2006	307	18.0
2007	329	16.4
2008	325	14.7
2009	298	18.1
2010	264	17.7
2011	254	16.5
2012	222	14.8
2013	207	13.9
2014	207	13.8
2015	207	16.3
2016	185	14.8
2017	185	13.0
2018	185	13.8

## CONCLUSIONS

An analysis of the consumer survey reveals that although meat is a very common component of the diet of Poles, horse meat is definitely not a popular item. The results of the survey confirm the hypothesis that Poles are mostly reluctant to eating this type of meat. Moreover, they do not know much on its nutritional values, which

indeed are high. Horse carcasses are characterized by good meatiness, and the share of lean in individual parts ranges 65–75%. The respondents declared emotional attitude to horses and as many as over half of the respondents (52.3%) directly oppose horse meat consumption. In addition, there is a perception that the utilization of horses for meat is not economically justified and the product is too expensive. This is not true though. It may seem surprising that rearing horses, including foals, is more profitable compared to raising other animal species. Feed for horses is cheaper, weight gains are better than in the case of cattle and, additionally, slaughter performance is higher.

According to government statistics published in the years 2010–2018 [GUS 2018], since 2013 the number of farms maintaining 10 and more horses has increased by almost half, while the number of farms with one horse has dropped. The current trend in changes, such as the development of agritourism, an increase in the number of organic farms, farmers joining agri-environmental programs or supporting activities for sustainable agriculture, will probably increase the scale of cold-blooded horse breeding.

Considering the fact that horse meat belongs to lean, low-calorie meats with high nutritional value, it is worth promoting as an attractive, healthy and safe food product. To achieve this, potential consumers should be made aware that farming and breeding horses is more profitable compared to other livestock animals. Feed for horses is less costly, better weight gains may be attained than for cattle, and the slaughter performance is higher. To encourage Poles to include it in their diet, tasting events of horse meat products and dishes should be organized.

A growing number of consumers care for the quality and safety of food. This argument may be used in the promotion of horse meat consumption, through dissemination of knowledge on its values, highlighting its high biological and nutritional quality and the taste of horse meat.

## ACKNOWLEDGEMENT

The study was carried out as part of statutory research, grant no. 139/s/00. This research grant includes research work of graduate students and doctoral students.

## REFERENCES

- Ancelle, T. (1999). History of trichinellosis outbreaks linked to horse meat consumption 1975–1998. *Eurosurveillance*, 9–10. DOI: 10.2807/esm.03.08.00120-en.
- Babbie, E. (2004). *Social research in practice [Badania społeczne w praktyce]*. PWN, Warszawa [in Polish].
- Barowicz, T., Brejta, W. (2012). *Horse meat on a Polish table [Konina na polskim stole]*. Kengraf, Warszawa, 2012 [in Polish].



- Brodzińska, K. (2007). Possibilities of animal production development in Poland from the aspect of its sustainability [Perspektywy rozwoju produkcji zwierzęcej w Polsce w aspekcie zrównoważonego rozwoju]. *Problemy Rolnictwa Światowego*, 2(17), 327–334 [in Polish]. DOI: [10.22004/ag.econ.198931](https://doi.org/10.22004/ag.econ.198931).
- Chabela, M.L., Serrano, G.M., Calderon, P.L., Guerrero, I. (1999). Microbial spoilage of meats offered for retail sale in Mexico City. *Meat Sci.*, 51, 4, 279–282. DOI: [10.1016/S0309-1740\(98\)00096-5](https://doi.org/10.1016/S0309-1740(98)00096-5).
- Clutton-Brock, J. (1999). *A natural history of domesticated mammals*. Cambridge.
- Fedorski, J. (2003). *A guide for horse breeders and equine enthusiasts [Poradnik dla hodowców i miłośników koni]*. PWRiL, Warszawa [in Polish].
- GUS (2003). *Concise Statistical Yearbook 2003 [Mały Rocznik Statystyczny 2003]*. Główny Urząd Statystyczny, Warszawa [in Polish].
- GUS (2005). *Concise Statistical Yearbook 2005 [Mały Rocznik Statystyczny 2005]*. Główny Urząd Statystyczny, Warszawa [in Polish].
- GUS (2014). *Characteristics of agricultural holdings in 2013 [Charakterystyka gospodarstw rolnych w 2013]*. Główny Urząd Statystyczny, Warszawa [in Polish].
- GUS (2017). *Characteristics of agricultural holdings in 2016 [Charakterystyka gospodarstw rolnych w 2016]*. Główny Urząd Statystyczny, Warszawa [in Polish].
- GUS (2018). *Statistical Yearbook of Agriculture (all issued 2008-2018) [Rocznik Statystyczny Rolnictwa (wydania 2008-2018)]*. Główny Urząd Statystyczny, Warszawa [in Polish].
- Grzechnik, M. (2007). Let breeding make sense again [Odzyskać sens hodowli]. *Koń Pol.*, 4, 16–18 [in Polish].
- Janiszewska, J., Kortz, J. (1988). Horse utilization for meat, part III [Mięsny kierunek użytkowania koni, część III]. *Koń Pol.*, 4, 23 [in Polish].
- Jastrzębska, E. (2006). The history of cold-blooded horse breeding. Part 1 [Historia hodowli koni zimnokrwistych. Część 1]. *Hodowca Jeździec*, 1(12) [in Polish].
- Jeremiah, L.E., Martin, A.H. (1981). Intramuscular collagen content and solubility: their relationship to tenderness and alternation by postmortem aging. *Can. J. Anim. Sci.*, 61, 53–61. DOI: [10.4141/cjas81-008](https://doi.org/10.4141/cjas81-008).
- Kapusta, F. (2013). Selected problems of meat production and processing in Poland in the first decade of the 21st century [Wybrane zagadnienia produkcji i przetwórstwa mięsa w Polsce w pierwszej dekadzie XXI wieku]. *Nauk. Inż. Techn.* 2(9), 67–84 [in Polish]. DOI: [10.15611/nit.2013.2.05](https://doi.org/10.15611/nit.2013.2.05).
- Kortz, J., Gardzielewska, J. (1988). Nutritional value of horse meat [Wartość użytkowa mięsa końskiego]. *Koń Pol.*, 3, 8–9 [in Polish].
- Korzeniowski, W., Jankowska, B., Kwiatkowska, A. (1994). Quality of horse muscle and adipose tissues [Jakość końskiej tkanki mięśniowej i tłuszczowej]. *Med. Weter.*, 4, 48 [in Polish].
- Korzeniowski, W., Jankowska, B., Kwiatkowska, A. (1998). Nutritional value of lean in selected prime cuts of horse carcass [Wartość odżywcza mięsa wybranych elementów zasadniczych tuszy końskiej]. *Acta Acad. Agricult. Tech. Ol.*, 30, 110–115 [in Polish].
- Korzeniowski, W., Jankowska, B., Kwiatkowska, A. (1993). Content of carotene and vitamin A in horse-meat fat [Zawartość karotenu i witaminy A w tłuszczach końskich]. *Med. Weter.*, 420 [in Polish].
- Korzeniowski, W., Kwiatkowska, A., Jankowska, B. (1999). Horse meat is worth to be liked [Warto polubić koninę]. *Prz. Gastronom.*, 8, 8–9 [in Polish].
- Krupa, J., Szmulik, A. (1999). Effect of constitution type and age on slaughter value of horses [Wpływ typu konstytucyjnego i wieku na wartość rzeźną koni]. *Zesz. Nauk. AR w Krakowie*, 356, 33–42 [in Polish].
- Krupa, J., Majka, A. (2000). A study on consumer preferences for meats and meat products in the south-eastern macro-region of Poland [Badanie preferencji konsumenckich mięsa i jego przetworów w południowo-wschodnim makroregionie Polski]. *Żywność*, 2(23), 91–99 [in Polish].
- Kwiatkowska, A.M. (2002). Glycolysis in skeletal muscles of horse carcasses depending on the temperature of post-slaughter storage and its impact on the quality characteristics of the meat [Glikoliza w mięśniach szkieletowych tusz koni w zależności od temperatury poubojowego przechowywania i jej wpływ na cechy jakościowe mięsa]. Wydawnictwo UWM Olsztyn [in Polish].
- Lasota-Moskalewska, A. (2005). *Animals domesticated in the history of mankind [Zwierzęta udomowione w dziejach ludzkości]*. WUW Warszawa 2005 [in Polish].
- Lasota-Moskalewska, A., Szymczak, K., Khudzhanazarov, M. (2009). A Problem of the Earliest Horse Domestication. Data from the Neolithic Camp Ayakagytma 'The Site', Uzbekistan, Central Asia. *Archaeologia Baltica* 11, 14–21.
- Litwińczuk, Z. (2004). Animal raw materials, evaluation and use [Surowce zwierzęce, ocena i wykorzystanie]. PWRiL [in Polish].
- Makała, H. (2007). The use of horse meat in Poland and in the world [Wykorzystanie mięsa końskiego w Polsce i na świecie]. *Gospodarka Mięsna*, 11, 16–18 [in Polish].
- Martin-Rosset, W. (2001). Horse meat production and characteristics. *Book of Abstracts of the 52nd Annual Meeting of EAAP*, 7, 322.
- Martuzzi, F., Catalano, A.L., Sussi, C. (2001). Characteristics of horse meat consumption and production in Italy. *Annali della Facoltà di Medicina Veterinaria*, 21, 213–233.
- Mroczkowski, S., Frieske, A., Bohaczyk, M. (2010). *Polskie konie zimnokrwiste*. *Prz. Hod.* 12, 20–22 [in Polish].
- Nowacka, A., Janicki, B. (2002). Mięsne użytkowanie koni – temat ciągle aktualny. *Prz. Hod.* 4, 23–24 [in Polish].
- Outram, A. K., Stear, N.A., Bendrey, R., Olsen, S.L., Kasparov, A., Zaibert, V., Thorpe, N., Evershed, R.P. (2009). The Earliest Horse Harnessing and Milking. *Science*, 323, 332–335. DOI: [10.1126/science.1168594](https://doi.org/10.1126/science.1168594).
- Pawlanka, T. (2017). The specificity of the meat processing sector in the European Union – state and outlook [Specyfika sektora przetwórstwa mięsnego w Unii Europejskiej – stan i perspektywy]. *Zag. Ekon. Rol.*, 1(350), 179–197 [in Polish]. DOI: [10.5604/00441600.1233010](https://doi.org/10.5604/00441600.1233010).
- Polak, G. (2016). *Konina – temat tabu*. *Hodowca Jeździec*, 48(1), 20–21 [in Polish].
- PZHk (2018). *Breeding program of the Polish Cold-blooded Horse [Program hodowli koni rasy polski koń zimno-*

- krwisty]. *Polski Związek Hodowców Koni*, Warszawa, 2018 [in Polish].
- Powell, T.H., Dikeman, M.E., Hunt, M.C. (2000). Tenderness and collage composition of beef semitendinosus roasts and cooked by conventional convective cooking and modeled, Multi-stage, convective cooking. *Meat Sci.*, 55, 140–145. DOI: [10.1016/S0309-1740\(99\)00171-0](https://doi.org/10.1016/S0309-1740(99)00171-0).
- Rak, L., Morzyk, K. (2002). Chemical analysis of meat [Chemiczne badanie mięsa]. Wyd. AR Wrocław [in Polish].
- Sarnecki, A. (1977). World slaughter horses and horse meat market [Światowy rynek żywca i mięsa końskiego]. *Gosp. Mięsna* 8, 19–21 [in Polish].
- Stanisławczyk, R. (2013). Effect of horse age at slaughter on the changes in sensory properties of horse meat during freezing storage [Wpływ wieku uboju koni na zmiany właściwości sensorycznych ich mięsa w czasie zamrażalniczego przechowywania]. *Nauka Przyr. Techn.*, 7(4), 71, 1–10 [in Polish].
- Stojanowska, A., Wachel, M. (2011). Horse breeding in Agricultural Property Agency's companies [Hodowla koni w spółkach ANR]. *Prz. Hod.* 8, 13–14 [in Polish].
- Szkucik, K., Pyz-Lukasik, R. (2009). Health quality of rabbit meat [Jakość zdrowotna mięsa królików]. *Med. Weter.*, 65(10), 665–669 [in Polish].
- Tereszkiewicz, K., Molenda, P., Pokrywka, K., Bukata, B. (2014). Slaughter horse transport [Transport koni rzeźnych]. *Logistyka-Nauka*, 3, 6315–6325 [in Polish].
- Urban, S. (2008). Poland's participation in the international horse-meat trade [Udział Polski w międzynarodowym handlu koniną]. *Gosp. Mięsna*, 60 [in Polish].
- Warmuth, V., Eriksson, A., Bower, M.A., Cañon, J., Cothran, G., Distl, O., Glowatzki-Mullis, M-L., Hunt, H., Luis, C., Mar Oom, M., Yupanqui, I.T., Ząbek, T., Manica, A. (2011). European Domestic Horses Originated in Two Holocene Refugia. *PLOS ONE*, 6(3), e18194. Public Library of Science. DOI: [10.1371/annotation/ef679268-70cb-49f8-8e1b-2c9df4ed1930](https://doi.org/10.1371/annotation/ef679268-70cb-49f8-8e1b-2c9df4ed1930).
- Zin, M., Szmulik, A. (1998). Analysis of slaughter value and meat quality of semi-draft type geldings and mares [Analiza wartości rzeźnej i jakości mięsa klaczy i wałachów typu pogrubionego]. *Zesz. Tow. Nauk. Rzeszów*, 6, 60–63 [in Polish].
- Zin, M., Znamirowska, A., Budzyński, M. (1999). Horse slaughter value and meat quality depending on age [Wartość rzeźna koni i jakość mięsa w zależności od wieku]. *Ann. UMCS*, 28, 215–220 [in Polish].

## ZNACZENIE HODOWLI I UŻYTKOWANIA KONI ZIMNOKRWISTYCH W ASPEKCIE ICH WYKORZYSTANIA W UŻYTKOWOŚCI MIĘSNEJ

### STRESZCZENIE

Celem pracy była analiza znaczenia hodowli i użytkowania koni zimnokrwistych. Wyniki analizy zostały opracowane na podstawie danych statystycznych i przeprowadzonej ankiety, której celem było zbadanie poziomu spożycia koniny wśród Polaków oraz sprawdzenie ich preferencji żywieniowych, dotyczących wyboru rodzaju mięsa. Stwierdzono, że konina nie jest popularnym mięsem na polskich stołach. Wynika to z emocjonalnego stosunku do koni, w związku z czym połowa respondentów była przeciwna spożywaniu mięsa końskiego. Mimo zróżnicowanego nastawienia konsumentów do spożywania koniny, analiza danych statystycznych pozwala stwierdzić, że od roku 2013 wzrasta liczba gospodarstw, utrzymujących 10 i więcej koni zimnokrwistych. Obecny kierunek zmian, takich jak rozwój agroturystyki, wzrost ilości gospodarstw ekologicznych, dołączanie przez rolników do programów rolnośrodowiskowych czy też wspieranie działań dla zrównoważonego rolnictwa, prawdopodobnie jeszcze zwiększy hodowlę koni zimnokrwistych.

**Słowa kluczowe:** koń zimnokrwisty, historia hodowli, użytkowość mięsna.