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KEYNOTE

Reproductive Capacity of Mangalica pigs – What is the Reality?

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SUMMARY

History of Mangalica pig is dated back to the first half of 19th century, however some former information is available of Mangalica ancestors in the 18th century. This fatty pig breed attained its' typical characteristics till the last quarter of 19th century and these features are still existing. Since Mangalica pigs were nearly extinguished after 1950's the relevant scientific and practical knowledge also stepwise reduced. In the present overview we compare in detail the ancient and modern information on Mangalica reproduction. First estrous of Mangalica gilts was described at around age of 10 to 11 month. Actually, Mangalica gilts can come in heat as early as 7 to 8 months of age and, therefore can have their first farrowing at 11 to 12 months of age. It was reported that several dam lines had quite high litter-size (8-9 piglets) at the beginning of 20th century, however due to different selection scheme these lines disappeared. Fortunately, nowadays we can identify again such more prolific sows. Throughout comparison of old and modern knowledge of Mangalica reproductive biology we should conclude that respectful incorporation of valuable ancient knowledge has same importance as the newest data collected by the most sophisticated instrumentation and methods. Synthesis of them is necessary for the preservation of original genetic value and the market oriented production.

Palabras clave adicionales

Porco autóctone.
Reprodução.
Prolificidade.

Capacidade reprodutiva dos suínos Mangalica – Qual a realidade?

RESUMO

A história do porco Mangalica remonta à primeira metade do século XIX, no entanto, há informação sobre os seus ascendentes no século XVIII. Este porco tipo "gordura" chegou às suas características típicas no último quarto do século XIX sendo que estas ainda se mantêm até hoje. Dado que os porcos Mangalica estavam praticamente extintos após os anos 50's do século passado também foi reduzida a informação científica e conhecimento prático sobre a raça. Nesta revisão comparamos em detalhe informação antiga e moderna sobre a reprodução dos suínos Mangalica. Descrições antigas relatavam o primeiro cio das marrãs Mangalica aos 10-11 meses de idade. Efetivamente, as fêmeas Mangalica podem ter cios aos 7-8 meses de idade e, portanto, podem ter o seu primeiro parto com 11-12 meses. Há relatos que várias linhas "mãe" tinham ninhadas grandes (8-9 leitões) no início do século XX, no entanto, por causa de diferentes esquemas de seleção essas linhas desapareceram. Afortunadamente, hoje podemos identificar novamente essas porcas mais prolíficas. Através da comparação do conhecimento antigo e atual da biologia reprodutiva da Mangalica devemos concluir que a incorporação do conhecimento antigo válido tem a mesma importância que os novos dados obtidos com metodologias e instrumentos mais sofisticados. A sua síntese é necessária para a preservação do valor genético original e para a produção orientada para o mercado.

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INTRODUCTION. BRIEF HISTORY OF THE BREED

It is supposed that the Hungarian Mangalica was created crossing Alföldi, Szalonta and Bakony breeds with the Serbian Sumadia pig arrived at first in Hungary in 1833, however Mangalica's progenitor was referred earlier at the end of XIXth century (Enesei-Dorner & Kovácsy, 1926; Tálasi, 1939). The earliest detailed breed description had mentioned two types, namely the White and Black Mangalica (Czilert, 1859). Later five colour types were reviewed: Blond or White, Black, Swallow-Belly and Brown (Baris) one, like wild boar, and at last the Red Mangalica (Kovácsy & Monostory, 1890; Dorner, 1908). Nowadays three breeds of Mangalica are bred - Blond, Swallow-Belly and Red, which was verified by genetic analysis (Zsolnai et al. 2006, 2013). Furthermore, a new project has been started for reconstruction and propagation of ancient Black Mangalica by a consortium of Debrecen University and National Association of Mangalica Breeders (NAMB) (http 1).

In the past, two housing methods were practiced. In estates pigs were kept in large herds grouped by age and sex, and raised by swineherd. In villages farmers kept their animals in night time at home in pigsty and inday time all pigs were grazing on communal pastures (Enesei Dorner & Kovácsy, 1926; Rácz, 1932). The fatteners wereraised on the pasture till one year of age followed by subsequent 6 months fattening period in forest or in pens. They were slaughtered at the weight of 150-200 kg. With the increasing request of the market fattening was performed in industrial size (15-20,000 pigs). The Hungarian lard and salami were much sought after products on the market (Enesei Dorner & Kovácsy, 1926). In the 1920's the breeders established an organization, which represent their interest. NAMB was founded in 1927, and breeding standards and the registration of breeding animals in herd book were established (Rácz, 1930a, Blantz, 1938). The breeding stock increased till the 2nd World War, then decreased considerably and the race nearly disappeared. Only 34 breeding sows were registered in 1975. The breed was rescued from extinction by state intervention and bred on state farms in gene-reserve (Baltay, 1983). After a long intermittence, in 1994 the NAMB resumed its activity and re-organized the registration of animals. The inspection and introduced a certification of origin for every Mangalica products on the market (Zengő, 1998). The beginning of 1990's was a milestone in the history of the breed and several programmes and research projects have been commenced to preserve and exploit Mangalica. Nowadays, its features like adaptive plasticity to extreme and extensive housing conditions, stress and disease resistance, motherliness and excellent meat quality (taste) are requested.

Authors would like to summarize up to date basic and applied research results on Mangalica breeding and reproductive management.

Breeding and propagation of Mangalica in the past

Generally, in the past, Mangalica pigs were kept in herds in extensive conditions. The animals were fed throughout the year on pastures and in oak-beech forests. Pregnant sows were housed only for farrowing. Breeding gilts were kept also in large groups on pasture and wasteland till the first mating (at 15 -18 months and 80 – 100 kg body weight) (Enesei Dorner & Kovácsy, 1926; Rácz, 1932). Usually, the farrowing season was in February and sows gave birth to 4-6 piglets. At the beginning of 1900's for more intensive breeding, farrowing was proposed twice a year or in larger stocks three times in two years (Janish, 1908). Kovácsy (1903) advised to obtain piglets in February and August if practicing farrowing twice a year. Breeding animals were selected only from litter born in February. He described that simultaneously weaned sows come in heat together and could farrow in the same batch. Juhos (1912) advised to improve housing and nutrition conditions in case of intensive breeding. Without these conditions litter-size and litter homogenity decreased at farrowing in February. Kovácsy (1908) drew attention to improve feeding of sows bred intensively and use the culling sows earlier after 6-7 farrowing in advanced ages and better meat quality. Several breeders had been achieved good results with tendentious selection for prolificacy and adequate nutrition **(Table I)** (Téglássy, 1917; Kiss, 1926; Gábos, 1935; Kertész & Kovács, 1953). Rákos (1917) advised to select replacement gilts from large litter and with higher teat numbers. Average teat number was 10 at that time however numerous gilts had 12 teats. It was suggested to indicate sows with an ear mark according to their fecundity (Kovácsy, 1918b). In 1927 NAMB was established and an improved professional breeding work was started (Rácz, 1930a). General director of NAMB called attention to different blood lines, which had higher prolificacy (Ötömösy, 1931). Rácz (1930b) investigated relationship between teats number and reproductive performance in five breeding stocks. Ten percentage of sows had more than 10 teats and their prolificacy was 30% higher compared to sows with 10 teats.The larger litters require more milk for suckling. Rácz (1932) estimated the milk yield of Mangalica sows between 119.3 - 190.6 kg during the 8 – 10 weeks lactation. Others reported 170.6-235.0 kg and198 – 327 kg milk during 70 days-long period, which was sufficient to rear 8 - 9 piglets (Kovács, 1954, J.Horváth, 1957). It was stated also that the number of offspring increased with parity until the third farrowing and slowly decreased thereafter (Rácz, 1932, Mentler, 1958). Analyzing herd book data, Csukás (1942) showed that Mangalica sow was the most prolific at the age of 5.5 - 6 years. Schalbert (1969) reached a mean litter size of 8-9 piglets after using prolific lines and the offsprings were less fatty and higher meat yields. Unfortunately, these positive efforts had no more benefit in breeding by 1970's, the Mangalica breed nearly extincted (Baltay, 1983).

Recent advances in Mangalica breeding with special regards on reproductive research

After a period of twenty years long interval Mangalica became again popular, however the most unwanted characteristic of them remained the low prolificacy **(Table II)**. Several authors described that a contra selection could be the main reason of the low reproductive performance of Mangalica. The animals were selected for breeding according to its phenotype and maturity and it was enhanced with monodietic maize based nutrition (Kertész & Kovács, 1953; Tóth, 1962).

Concomitant with the commercial renaissance of Mangalica basic and applied research programs started to collect new data on reproductive physiology of this old breed and to assist the activity of breeders and producers. The programs were broadened to international level including researchers of Spain, Germany, Austria, The Netherlands, Japan. The programs later attracted experts dealing with other fatty pig breeds in European and non-European countries i.e. South Africa, China, Japan, Thailand etc.

Background of lower reproductive capacity of Mangalica is not fully elucidated, yet. From slaughter house observation it was indicated that modest ovulation rate (Mangalica– 9.9) is the main reason compared to other breeds (12.4 – Berkshire and 12.8 – Yorkshire) (Bulatovici, 1932).

Our studies from the end of 1990s were focusing on the possible reasons of diminished fecundity in

Table I. References on mean litter size in Hungarian Mangalica (Referências sobre o tamanho médio da ninhada em Mangalica Húngaro entre 1914-1980).

Year	Number of sows (farrowing frequency)	Litter size		Source
		Day 1 p.p.	Day 21 p.p.	
1914	400 (1.5)	n.a.	5.5*	EneseiDorner, 1914
1915	89	6.16	n.a.	EneseiDorner, 1915
1917	n.a.	6.44	n.a.	Téglássy, 1917
1918	n.a. (2.0) n.a. (1.0)	3.3 4.5	n.a. n.a.	Kovácsy, 1918a
1926	n.a.	7	n.a.	Kiss, 1926
1932	3133	6.87	n.a.	Rácz, 1932
1935	n.a.	6.7	n.a.	Gábos, 1935
1938	7000	6.3	n.a	Blantz, 1938
1942	885	6.81	n.a.	Csukás, 1942
1953	21	7.8	n.a.	Kertész&Kovács, 1953
1955	1474	6.5	5.7	
1960	492	6.6	5.9	
1965	861	6.9	5.9	Baltay, 1983
1970	155	6.2	5.7	
1975	34	4.5	3.1	
1980	111	5.2	4.2	

*Weaned piglets.

Mangalica comparison to commercial breeds as control group. We analyzed ovarian features, ovulation, oocyte quality and fertilization process as well as different steroid hormone levels.

Low ovulation rate was described at first presented in **Table III** (Rátky & Brüssow, 1998; Egerszegi et al. 2001, Brüssow et al. 2004). In untreated Mangalica the number of ovarian features varied between 6.8 and 11.7 and was rather different to those of modern breeds. Nevertheless the Mangalica ovaries have the biological potential to grow to a higher number of Graafian follicles. Using various doses of PMSG as an additional gonadotropic source to stimulate follicular growth, number of ovulated follicles similar to commercial breeds was achieved (Rátky et al. 2001; Egerszegi et al. 2007).

Besides lower ovulation rate oocyte quality could also explain the lower fecundity in Mangalica. Differences were found concerning the morphology and maturation of cumulus-oocyte-complexes recovered from preovulatory follicles (Egerszegi et al. 2001). The percentage of oocytes with compact cumulus was higher in Mangalica compared to Landrace gilts (31 vs. 16 %) and less oocytes had expanded cumulus (62 vs. 78 %). The chromatin structures of oocytes was also distinct between Mangalica and Landrace gilts. The rate of mature oocytes (telophase I/metaphase II) was higher in Landrace sows (27 vs. 62 %). However, follicular steroid hormone milieu differed between Mangalica and Landrace gilts as well (Egerszegi et al. 2007). Nearly twice higher oestradiol concentration (29.6 ± 6.8 vs. 16.9 ± 9.7 ng/ml) and a 5-fold higher progesterone level (2020.4 ± 1056.8 vs. 386.2 ± 113.7 ng/ml) was detected in Mangalica follicular fluid.

We examined LH, estradiol and progesterone concentrations of Mangalica in comparison to Landrace gilts to clarify if there are any differences in reproductive hormone secretion during the oestrous cycle (Egerszegi et al. 2003). Mangalica had demonstrated the same time interval of reproductive hormone secretion as Landrace gilts. However, estradiol peak maximum (46.5 ± 5.7 vs. 26.0 ± 6.8 pg/ml) and progesterone secretion during the luteal phase (12.9 ± 2.6 vs. 9.3 ± 2.2 ng/ml) were higher in Mangalica, although their number of corpora lutea was lower. This was confirmed in our recent study where blood samples were collected from the *V. cava cranialis* providing a more precise evaluation of ovarian progesterone secretion. Higher progesterone concentrations despite lower number of CL and increased leptin secretion (11.3 ± 0.6 *vs*. 3.0 ± 0.1, $P<0.05$), and as a consequence altered LH secretion pattern in Mangalica could trigger lower reproductive capacity of this breed (Brüssow et al. 2008).

Since morphometric data of the genital tract were missing, we analysed the reproductive organs of cycling and early pregnant Mangalica gilts (Brüssow et al. 2004). Mean length of Fallopian tube (23.6 ± 1.4 to 24.4 ± 1.4 cm) and weight (3.2 ± 0.2 to 4.2 ± 0.4 g), and uterine horn length (143 ± 9 cm) and weight (247 ± 12 to 372 ± 32 g) were always in the range of commercial breeds. In pregnant Mangalica the length of each uterine horn was significantly shorter (124 ± 5 vs. 188 ± 6 cm). Furthermore, the uterus did not grow in length during early pregnancy (days 1 to 24), whereas in pregnant Landrace gilts uterus grew continuously. Moreover, in our study uterine weight increased significantly later in Mangalica (day 12 to day 24) compared to Landrace (day 1 to day 12). Results of this study support the concept that in Mangalica besides diminished

Table II. Mean litter size in Blonde, Red and Swallow-belly Mangalica between 1990-2014 (Tamanho médio da ninhada Mangalica na loura, vermelha e barriga engolida entre 1990-2014).

Year	Number of sows (farrowing frequency)	Litter size		Source
		Day 1 p.p.	Day 21 p.p.	
1990	224 (1.59)[B]	5.4	5.1	Szabó, 2003
	62 (1.68)[R]	5.0	4.5	
	62 (1.37)[Sw]	5.0	4.3	
1995	170 (1.85)[B]	5.0	4.3	
	20(1.28)[R]	4.0	3.5	
	18 (1.48)[Sw]	5.8	5.0	
2000	616 (1.5)[B]	5.7	5.0	
	75 (1.58)[R]	6.3	5.5	
	74 (1.49)[Sw]	5.7	5.5	
2006	2913 (1.64)[B]	6.0	5.6*	Novozánszky, 2012
	708 (1.43)[R]	6.4	5.8*	
	480 (1.47)[Sw]	6.3	6.1*	
2010	1151 (1.18)[B]	5.4	5.2*	
	627 (0.94)[R]	5.7	5.4*	
	412 (0.92)[Sw]	5.9	5.6*	
2014	2150 (1.40)[B]	5.9	5.7*	Novozánszky, 2015
	474 (1.24)[R]	5.9	5.5*	
	375 (0.98)[Sw]	5.6	5.2*	

[B]Blond, [R]Red and [Sw]Swallow-belly Mangalica; *Weaned piglets

ovarian and oocyte development, uterine conditions, especially growth restricted uterine development, may influence the initial process of early pregnancy and can be another reason of lower fecundity (Brüssow et al. 2004).

Mangalica sows could be kept in different housing conditions. Szabó (2002) referred pregnancy rate of 74%; 78% and 84% and litter size of 5.95; 6.25 és 6.9 in indoor, semi-intensive and outdoor keeping respectively. Hoha et al. (2012) indicated that gilts reared in intensive condition could be bred earlier atthe age of 280 days compared to gilts reared extensively (345 days), furthermore they farrow 1 extra piglet per litter. Vidović et al. (2012) reported 7.2 offspring/farrowing, however the number of weaned piglets decreased to 5.2 in Serbian Mangalica. Pocsai et al. (2013) analized the reproductive performance of Mangalica sows between 2000-2011. It was ascertaining that besides decreasing breeding stock, the farrowing frequency (1.5 to 1) also dropped and the age of gilts at first breeding increased dramatically.

Some of our results support the initial use of modern zootechnical methods in breeding of Mangalica. Nowadays, semen collection and artificial insemina-

Table III. Mean number (± SD) of follicles/corpora lutea in untreated and PMSG treated Mangalica gilts (Número médio (± SD) de folículos/corporais lutea em douradas Mangalica não tratadas e tratadas com pMsg).

Untreated (n)	750 IU PMSG (n)	1000 IU PMSG (n)	1250 IU PMSG (n)	Reference
11.5 ± 2.1 (7)	13.7 ± 3.1 (7)	24.2 ± 2.5 (7)	21.0 ± 2.9 (7)	Rátky & Brüssow, 1998
		22.2 ± 3.4 (10)		Rátky et al., 2001
6.8 ± 1.4 (18)				Egerszegi et al., 2001
		10.3 ± 1.5 (6)		Egerszegi et al., 2003
10.6 ± 3.1 (58)*		17.1 ± 1.2 (22)		Brüssow et al., 2004
11.7 ± 3.5 (8)**				Brüssow et al., 2004
		25.3 ± 2.9[h] (9)		Egerszegi et al., 2007
		28.8 ± 7.3[l] (8)		Egerszegi et al., 2007
		9.7 ± 2.3 (3)		Brüssow et al., 2008

Data in parentheses: number of animals; *Cycling gilts; **First oestrous gilts; [h] High energy level feed; [l] Low energy level feed

tion are performed in few intensive farms, and pregnancy is controlled by ultrasound check. Both the farrowing frequency of sows (from 1.55 to 1.77) and the mean number of total born (>7piglets) and weaned piglets increased after using early pregnancy diagnosis by ultrasound (Egerszegi et al. 2008, 2010).

CONCLUSION

Concerning on puberty attainment our findings showed that under proper housing and feeding conditions gilts might show heat already at age of 7 to 8 months. Breeders should keep in mind that Mangalica gilts can be mated or inseminated at age of 9 to 10 month instead of 11 to 12 month. In accordance with the aforementioned old reports sows should be mated twice a year or three times biannually. Modern zootechnical methods could be useful in propagation of Mangalica.

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