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Chinchillas reproduction results in relation to the age of the first mating time

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Abstract: *Chinchillas reproduction results in relation to the age of the first mating time.* The aim of the study was an attempt to define the age of chinchillas females first time mating in relation to reproduction results. The reproduction indices as: average litter size (born and weaned), number of litters and kits per year, average inter-birth interval (days), in relation to the age of the first mating time were estimated. The research material consisted of 73 females, from which 491 litters were obtained. The females were used at least 3 years as a breeding staff. The females were divided into 4 groups, depending of first mating age: 6 months or earlier (group 1), 7–10 months (group 2), 11–15 months (group 3), 16 months and more (group 4). The reproduction results of 3 years period did not show statistically significant differences between groups, even the reproduction results of first litter into youngest group were significantly higher compare to the results from other groups. The reproduction results of females mated first time at age of 16 months or later were worse than others were. It was verified that chinchilla females should be mated first time at age of 7–10 months.

Key words: chinchilla, age of first mating time, reproduction results.

INTRODUCTION

The aim of the study was an attempt to define the age of chinchillas females first time mating in relation to reproduction results.

Pluses of early mating are:

– reproduction results in breeding staff increase,
– females breeding value estimation can be done earlier.

Minuses of early mating are:

– stopping of growth and development too early mated females,
– probability of weak litters.

The age of first mating time in chinchillas is discussed by scientists, from as young as 4 months of age (Nordholm, 1997) to at least 8 months (Konrad, 1995). 60% of females at Polish farms are first time mated at age 7.5 to 9.5 months (Barabasz, 2002).

MATERIAL AND METHODS

The research material consisted of 73 females, from which 491 litters were obtained. The females were used at least 3 years as a breeding staff. Reproduction results were calculated in relation to the first time mating age. The females were divided into 4 groups, depending of first mating age. The schedule of groups is presented in Table 1.

The reproduction indices as: average litter size (born and weaned), number of litters and number of kits (per year), average inter-birth interval (days), in relation to the age of the first mating time were estimated.

TABLE 1. Number of chinchilla females belonging to each group

Group number	The age of the first mating time (in months)	Number of animals
1	6 and less	8
2	7–10	42
3	11–15	15
4	16 and more	8
	Total	73

The statistical analyze was done by Microsoft Excel Program. The mean, ($\overline{X}$), standard deviation (Sd), variation coefficient (V, in %) were calculated. Statistical differences between groups were estimated by using t-Student test.

RESULTS AND DISCUSSION

The first kindling results are presented in tables 2 and 3. The biggest litters (2.25 kits born) were observed among the youngest females (group 1), the worse one (1.50 kits) into group 3 (Tab. 2). The results from group 1 were statistically better (at level 0.05) compare to group 3 (Tab. 2).

The weaning results were also the best into group 1 (100% kits weaned, Tab. 3). The statistically significant differences on level 0.05 were observed between group 1 compare to the others (Tab. 3).

According to the literature (Maciejowski and Jeżewska, 1993; Socha and Wrona, 2000), over 2.00 kits born and 1.74 kits weaned per litter are estimated as a satisfactory.

The high variation coefficient in number of born and weaned kits' (V) – over 30%, (Tabs. 2, 3), shows genetic differences between females and potential in increasing this trait: by applying proper breeding program at farm it should be possible to increase the reproduction results.

The data concerning litter size results from 3 years period of chinchilla' females breeding are presented in Table 4. There were no observed statistical significant differences in results between compared groups, even such differences should be expected according to first litters' results (Tabs. 2 and 3). In generally, worse results were obtained into older groups (3 and 4).

TABLE 2. The first litter size in relation to first mating time age

The age of the first mating time (in months)	Kits born in first litter		
	number of kits ($\overline{X}$)	standard deviation (S)	variation coefficient (V, %)
6 and less	2.25 [a]	0.71	31.55
7–10	1.93	0.75	38.86
11–15	1.73 [a]	0.71	40.46
16 and more	1.88	0.64	34.04

a – differences on level 0.05.

TABLE 3. The first litter weaning results in relation to first mating time age

The age of the first mating time (in months)	Kits weaned in first litter		
	number of kits ($\overline{X}$)	standard deviation (S)	variation coefficient (V, %)
6 and less	2.25 [a, b, c]	0.71	31.55
7–10	1.55 [a]	0.71	45.80
11–15	1.40 [b]	0.63	45.00
16 and more	1.50 [c]	0.76	50.67

a, b, c – differences on level 0.05

TABLE 4. Litter size in chinchillas in relation to the age of first mating time (average results from 3 years observations)

The age of the first mating time (in months)	Average litter size (at birth)		
	number of kits ($\overline{X}$)	standard deviation (S)	variation coefficient (V, %)
6 and less	2.19	0.46	21.00
7–10	2.05	0.52	25.37
11–15	1.89	0.49	25.93
16 and more	1.89	0.17	8.99

No statistical differences at level 0.05 between groups were observed.

Kindling intervals and yearly number of litters are presented in Table 5. Gestation period in chinchillas is very long as for rodents (102–115 days, average 111 days, Jarosz and Rżewska, 1996). Females can be mated during first estrus, which occur 36–62 hours after kindling. Kindling interval in chinchillas can be as short as 112–120 days (Gromadzka-Ostrowska, 1998). Theoretically, we can receive even 3 litters from female per year. In practice, 2 litters yearly are estimated as a good result (Barabasz et al., 2000). The results less than 1.50 litters per year are estimated as no profitable for farm (Sulik et al., 2001). At our studies the satisfactory results (over 2.00 litters per year) were observe into groups 1, 2, and 3 (Tab. 5). The results in group 4 (1.58 in average per year) is much lower, even statistical differences were not observed (Tab. 5).

TABLE 5. Kindling intervals and yearly litters weaning results in chinchillas according to the age of first mating time

The age of the first mating time (in months)	Average kindling interval (days)	Average number of litters per year	Average number of weaned kits per year
6 and less	165	2.21	3.72
7–10	178	2.05	3.19
11–15	180	2.02	2.65
16 and more	231	1.58	2.54

No statistical differences at level 0.05 between groups were observed.

The number of yearly-weaned kits is strongly correlated to number of litters and litter's size (Sulik and al., 2001, Felska-Błaszczyk and Brzozowski 2005). There were no observed statistical differences between groups, even the results into group 1 (3.72 kits) are higher than into others groups (Tab. 5). The results into group 4 looks be worse compare to others (2.54 weaned kits). The number of yearly-weaning kits is similar to cite in literature (Felska-Błaszczyk and Brzozowski, 2005; Szeleszczuk and Olesińska, 1997).

CONCLUSIONS

1. It is not statistically well-founded to mate chinchillas younger than 7 months old.
2. The reproduction results of females mated first time at age 16 months or later are worse than others are.
3. It was verified, that chinchilla females should be mated first time at age of 7–10 months.

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Streszczenie *Wyniki rozrodu szynszyli w zależności od wieku pierwszego krycia*. Celem pracy było określenie wieku pierwszego krycia szynszyli w powiązaniu z ich późniejszymi wynikami użytkowania rozpłodowego. Określono następujące wskaźniki: średnia wielkość miotu (przy urodzeniu, przy odsadzeniu), liczbę miotów i liczbę młodych uzyskanych rocznie, średnią długość okresu międzywykotowego. Dane te odnoszono do wieku samic przy pierwszym kryciu. W doświadczeniu wykorzystano dane dotyczące 73 samic i ich 491 miotów. Samice były użytkowane rozpłodowo przez okres 3 lat. Samice podzielono na 4 grupy ze względu na wiek pierwszego krycia: kryte do 6 miesiąca (grupa 1), w wieku 7–10 miesięcy (grupa 2), 11–15 miesięcy (grupa 3), 16 miesięcy i później (grupa 4). Oceniając 3-letni okres użytkowania rozpłodowego nie wykazano statystycznie istotnych różnic między grupami, mimo że wyniki pierwszych miotów uzyskanych od najmłodszych samic były

statystycznie lepsze niż pozostałych. Najsłabsze były wyniki uzyskiwane od samic krytych po raz pierwszy w wieku 16 miesięcy i później. Wyniki doświadczenia potwierdziły dotychczasową wiedzę, że najkorzystniejsze jest pierwsze krycie samic szynszyli w wieku 7–10 miesięcy.

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Studies on protein – fat ratio in bulk raw milk in Poland

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Abstract: *Studies on protein – fat ratio in bulk raw milk in Poland*. The results of laboratory tests of milk, as obtained in 2004 and 2005, were analysed. On the basis of these results, the mean level of fat and protein in milk during the successive years, feeding seasons and months of observations was estimated and protein – fat index was calculated. The change of the conditions of raw milk and modernization of dairy cattle feeding technology, being caused by the accession of Poland to the European Union have exerted an influence on the changes in chemical composition of the milk. The obtained results indicate indirectly the achievement of breeding progress during the studied period. The correct value of protein – fat ratio in milk indicates the application of properly balanced feeding rations, employed in feeding of dairy cows by the breeders. Seasonal variation of chemical composition of the raw milk and of protein – fat ratio causes, however, that the raw milk, being purchased during the whole calendar year represents different technological suitability. The effect of the successive years of observations on protein content in milk occurred to be statistically significant.

Key words: chemical composition of bulk raw milk, protein – fat ratio.

INTRODUCTION

Membership of Poland in the European Union resulted in adaptation of standards and structures of dairy production to the changing national demand and export possibilities. The change in the consumption profile of dairy products caused that raw milk with higher protein content and even its particular fractions, has acquired higher and higher technological meaning. Many dairy plants are changing their production profile; they start producing cheese and other dairy products and consequently, more and more attention is paid to the content of protein in milk. During the recent years, more and more attention has been paid to the increase of the role of milk protein content in shaping of basic price for raw milk in relation to fat, in proportion even 75–25%; it should cause higher interest of the breeders in rising the level of the discussed component in the manufactured milk, especially in the light of the fact that national over-production of milk fat has become a problem recently (Jurczak, 2003; Jurczak, 2005; Jurczak and Zdziarski, 2001). Further increase of both or one of the discussed components in milk cannot be, however, considered separately from the problem of their mutual proportions in the raw milk. Protein – fat ratio in milk (P/F) is an important index of evaluating the correctness of balancing the feeding rations for dairy cattle; it may also supply information on dysfunction of rumen as well as on metabolic diseases.

MATERIALS AND METHODS

The research material comprised the results of chemical composition of the raw milk (fat and protein), being purchased during 2 years (2004–2005) in 4 milk processing plants at the territory of the central Poland. On the ground of the obtained data, the level of protein – fat ratio was calculated. As the preliminary analysis did not reveal any significant differences in chemical composition of milk between the examined dairies, the effect of processing plant was omitted in the statistical model. The collection of data, including the analyses of chemical composition of 110.680 deliveries of bulk milk, has been presented according to the years: 2004 and 2005, feeding seasons: summer (V–X) and winter (XI–IV) and the successive calendar months for the both mentioned years in total. Protein – fat ratio was calculated from the data concerning chemical composition of the bulk milk. The results of laboratory tests were statistically estimated, using multi-factor analysis of variance (Statistical Product and Service Solutions base version 8.0 for Windows, User's Guide, 1998, by SPSS Inc., USA) according to constant linear model.

$$Y_{ijkl} = \mu + A_i + B_j + C_k + (AB)_{ij} + + (AC)_{ik} + e_{ijkl}$$

where:

Y_{ijkl} – level of examined trait (content of fat, protein and level of protein – fat ratio),

μ – general mean,

A_i – effect of the year (2004 and 2005),

B_j – effect of season (summer = V – X and winter = XI – IV),

C_k – effect of calendar month (I, II, III……..XII),

e_{ijkl} – random error.

Also, value of coefficients of correlation and determination between fat and protein content in the milk, purchased by the dairy plants during the examined period, was calculated.

RESULTS AND DISCUSSION

Annual, seasonal and monthly mean contents of fat and protein in milk are given in Table 1. All the mentioned factors had a significant effect on the level of protein in milk and the level of protein – fat ratio; in case of fat, statistically significant differences in its content were revealed between the feeding seasons and the successive months. The increase of protein content in the milk, being purchased in 2005, as compared to the previous year, caused (with almost the same level of fat in milk) the rise of value of protein – fat ratio. It may be noticed that the differences, although being statistically significant, were small in figures. The occurrence of interactions between the year and feeding season and between the year and month – at significance level ≤ 0.01 – for all analysed parameters of the purchased raw milk was found. During the summer period, the decrease of the content of usable milk components was recorded, as compared to winter

TABLE 1. The lowest square means and standard errors of fat and protein content and protein – fat ratio in bulk milk during the successive years of observation. feeding seasons and months

Year/ /Season/ /Month	N	Fat %		Protein %		Protein – Fat Ratio	
		LSM	SE	LSM	SE	LSM	SE
Totally	110680	3.965	0.0006	3.302	0.0003	0.8351	0.0001
Year							
2004	56808	3.965^{A}	0.0009	3.299	0.0004	0.8346	0.0002
2005	53872	3.964^{A}	0.0009	3.306	0.0004	0.8356	0.0002
Probability		NS		$p \leq 0.01$		$p \leq 0.01$	
Feeding season							
V–X	56444	3.892	0.0009	3.274	0.0004	0.8434	0.0002
XI–IV	54236	4.038	0.0009	3.330	0.0004	0.8267	0.0002
Probability		$p \leq 0.01$		$p \leq 0.01$		$p \leq 0.01$	
month							
I	8937	4.064	0.002	3.332^{A}	0.001	0.8214	0.0005
II	8994	4.012	0.002	3.330^{A}	0.001	0.8316^{A}	0.0005
III	8981	4.025	0.002	3.343^{B}	0.001	0.8323^{A}	0.0005
IV	8994	3.990	0.002	3.313	0.001	0.8328^{A}	0.0005
V	9203	3.930^{A}	0.002	3.295	0.001	0.8408^{B}	0.0005
VI	9429	3.888	0.002	3.282^{C}	0.001	0.8463	0.0005
VII	9300	3.876^{B}	0.002	3.275	0.001	0.8480^{C}	0.0005
VIII	9327	3.858	0.002	3.265	0.001	0.8478^{C}	0.0005
IX	9636	3.871^{B}	0.002	3.246	0.001	0.8404^{B}	0.0004
X	9549	3.928^{A}	0.002	3.284^{C}	0.001	0.8371	0.0004
XI	9313	4.047	0.002	3.342^{B}	0.001	0.8277	0.0005
XII	9017	4.088	0.002	3.322	0.001	0.8146	0.0005
Probability		$p \leq 0.01$		$p \leq 0.01$		$p \leq 0.01$	

Means within the factor and traits marked with the same letter **do not differ** statistically each other.

season; the protein – fat ratio was, however, higher during the discussed period in comparison to winter months. The level of the mentioned ratio reflects the supply of cows with metabolic energy and is an important index of correct balancing the feeding ration. Deviations from the standard may indicate disturbances in metabolism of the system e.g. acidosis of rumen, acetonemia, Negative Energy Balance and in consequence, deteriorate technological quality of the raw milk.

Optimum range of the discussed index is established individually for the particular breeds; in general, for dairy breeds it is contained within the range of 0.73–0.85 (Cejna and Chladek, 2005; Looper et al., 2001; Murphy and O'Mara, 1993, Richardt, 2004). Value of protein – fat ratio in the range of 0.95–1.0 informs about dysfunction of rumen, induced by ketosis (Cejna and Chladek, 2005; Looper et al., 2001).

Dynamics of changes in chemical composition of milk during the successive months of the whole period of studies has been presented in Diagrams 1 and 2. Monthly changes in fat content are similar during the successive years of the tests; we should only pay attention to higher fat level during summer months of 2005 as compared to the analogical months of the previous year. It should be supposed that the increase of fat content in the milk, purchased in summer months of 2005 was caused by better balancing of feeding ration in respect of energy. Considerable monthly variations in protein content were found in the milk, purchased in 2004. During the next year, we could record a distinct equalization of the level of the discussed component in the milk, being purchased in the particular months.

All the results of analyses of the raw bulk milk constitute the basis for the milk processing plants to pay the suppliers for the milk they deliver. The analyses covered the raw milk, allowed by the requirements of Polish standards (PN-A-86002, 2005). The year 2004 was still characterized by the purchase of considerable lots of the raw milk of worse quality grade, differing from the standard of

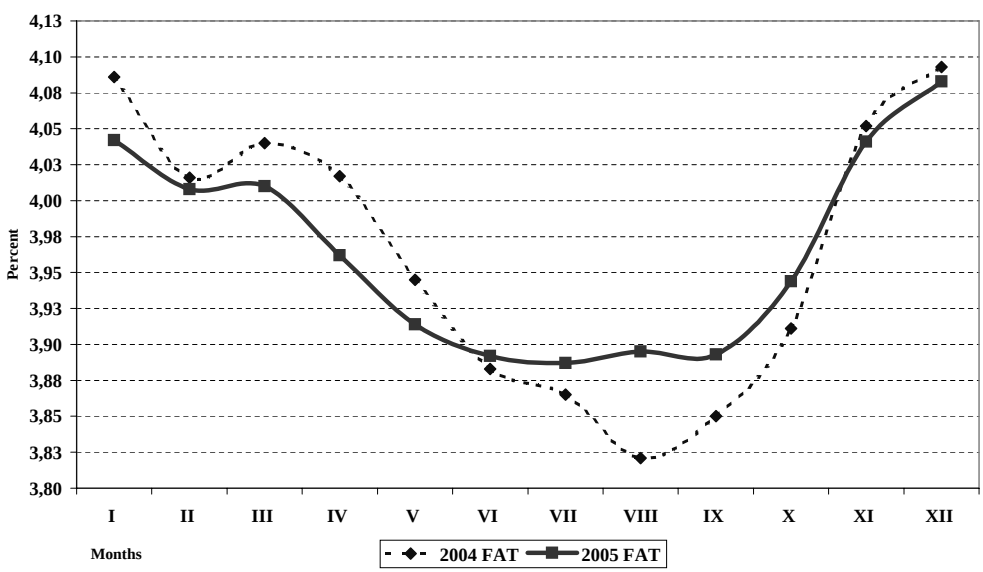

Diagram 1. Fat content in bulk milk in the successive months of calendar years 2004 and 2005

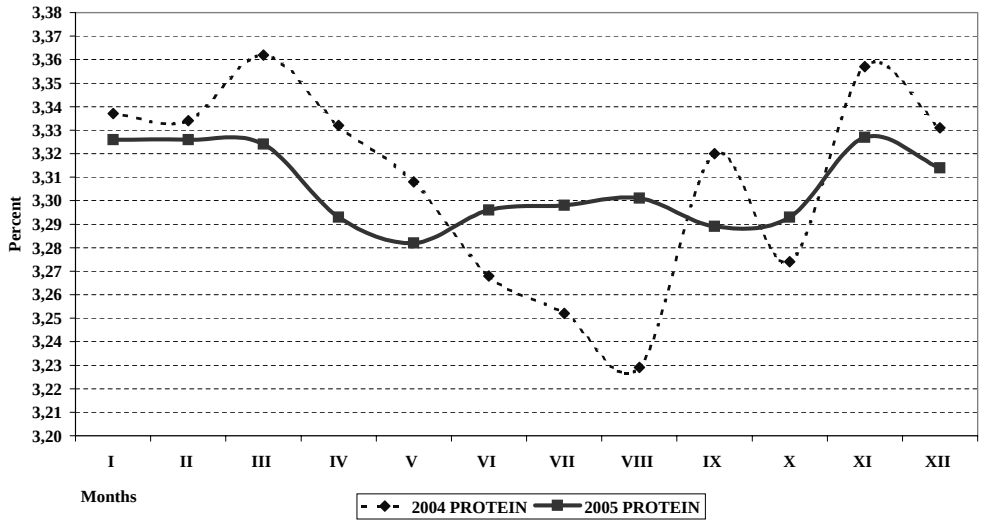

Diagram 2. Protein content in bulk milk in the successive months of calendar years 2004 and 2005

the European Union which was obligatory for the receivers. In 2005, as much as 95% of the milk, being purchased in Poland received Extra grade. By this, the raw milk with the increased quantity of non-casein proteins, occurring in subclinical states of *mastitis* in cows has been considerably eliminated (Jurczak, 2005).

As protein level has a significant influence on milk price, lowering of its level in the supplied raw milk causes an attempt of optimizing the feeding ration by the producer. Shaping of protein – fat index during the successive months of the particular years of observations has been illustrated in Diagram 3. Irrespectively of the season of the year, value of the discussed ratio was similar in winter months. The greatest differences between the years of the studies (in favour of the raw milk in 2005) occurred during summer months: June–September. It results from the equalized protein content in the milk, purchased in 2005 (Diagram 2) and lowered fat content in the previous year (Diagram 1) during summer period. Fact of equalization of protein level in the milk throughout the whole year is a positive phenomenon and is an evidence of employing modern feeding technologies by the breeders. During the pasture period, dairy cows may reveal deficit of energy, with the simultaneous excess of protein feeds. Easily fermenting carbohydrates are the main source of energy for microorganisms. The quantity of microbial protein, as being synthesised in rumen, is dependent on the quantity of energy available for rumen microorganisms (Krzyżewski and Grądziel, 1992; Kuczaj, 2001; Looper et al., 2001; Murphy and O'Mara, 1993; Richardt, 2004). Technological quality of milk from cows

Diagram 3. Dynamics of changing protein-fat ratio (PFR) in the successive months of calendar years 2004 and 2005

with metabolism disturbances is worse. Single cases of subclinical metabolic diseases of dairy cattle (ketosis) cannot be excluded from bulk milk. Such milk, as possessing higher content of ketone bodies, has a bitter taste and burns during heat treatment and shows low quality of rennet gel. Hence, it is stressed in literature that P/F ratio is suitable only when it is monitored in the individual milk samples and not in the bulk milk samples (Cejna and Chladek, 2005). Conducting analyses of chemical composition of the udder milk exceeded, however, the possibilities of the present studies.

The obtained coefficient of correlation between fat and protein content in the bulk milk occurred to be statistically significant ($r = 0.36$) but the mentioned relationship is not sufficiently strong (small inclination of regression line at $r^2 = 0.13$) to cause the selection for fat content to lead to distinct improvement of protein participation. The increase of value of protein – fat ration, as being observed in the present studies should be ascribed to improvement of feeding basis and modernized feeding technologies.

CONCLUSIONS

1. The level of protein – fat ratio, in spite of seasonal variations, was maintained within standard values during the whole studied period what indicates the employment of correctly balanced feeding rations by the breeders of dairy cattle.
2. During the second year of the studies, a tendency to standardize the

content of usable milk components (especially of protein) during the successive months was recorded.

3. The improvement of chemical composition of the milk during summer period in 2005 did not eliminate the problem of varying technological suitability of raw milk for butter and cheesemaking production in a full degree.

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Streszczenie: *Badania stosunku białkowo-tłuszczowego mleka zbiorczego w Polsce.* Praca zawiera analizę wyników badań laboratoryjnych mleka uzyskanych w latach 2004 i 2005, na podstawie których oszacowano średni poziom tłuszczu i białka w kolejnych latach, sezonach żywieniowych i miesiącach obserwacji, oraz wyliczano wskaźnik białkowo-tłuszczowy. Uzyskane wyniki wskazują na sezonową zmienność składu chemicznego surowca oraz stosunku białkowo-tłuszczowego, co powoduje, że skupiony na przestrzeni roku kalendarzowego surowiec prezentuje różną przydatność technologiczną. Wielkość stosunku białkowo-tłuszczowego, pomimo sezonowych wahań, utrzymywała się w normie w całym badanym okresie, co wskazuje na stosowanie przez hodowców bydła mlecznego poprawnie zbilansowanych dawek żywieniowych. Wpływ kolejnych lat obserwacji na zawartość w mleku białka okazał się istotny statystycznie. W drugim roku badań zaobserwowano tendencję do ujednolicenia zawartości składników użytkowych mleka (zwłaszcza białka) w kolejnych miesiącach. Poprawa składu chemicznego mleka w sezonie letnim 2005 roku nie wyeliminowała w pełni problemu różnej na przestrzeni roku przydatności technologicznej surowca do produkcji maślarskiej i serowarskiej.

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The observations concerning reproduction and young development in captive giraffe (*Giraffa camelopardalis*) at Warsaw ZOO

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Abstract: *The observations concerning reproduction and young development in captive giraffe (Giraffa camelopardalis) at Warsaw ZOO*
The reproductive behaviour in group of three adult giraffes (*Giraffa camelopardalis*) and born specimens behavioural ontogeny were observed at Warsaw ZOO during 2002–2005 period. The whole reproductive behaviour was described from estrus to parturition as similar to data of the wild giraffe. Behaviour of two calves was observed for 133 hours from early post birth period up to one year of age. The sequences of changes in young giraffe behaviour to great degree resembled the other data. from the literature. However, the abnormal stereotyped behaviour was observed in two-days calves. The possible origin of this behaviour in young giraffe was shortly discussed.

Key words: giraffe, behaviour, calf, ZOO.

INTRODUCTION

Although giraffe have been kept at Warsaw ZOO from seventies last century the efforts to reproduce this species in this zoological garden for long time has been fruitless. Thus, successful mating which finally took place few years ago created opportunity to observe in detail the whole process of reproduction in this remarkable mammal. Particularly calving and behavioural ontogeny observed in young giraffe were of great interest since the information concerning these topics is rather sparse (e.g. Estes, 1991). Moreover, in captive adult giraffe there is problem of rather mysterious abnormal behaviour such as metal bar licking and some forms of stereotypy (Lee, 1991). It was interesting to find out whether this behaviour will occur in very young giraffe calf.

MATERIAL AND METHODS

The breeding group of giraffes at Warsaw Zoo consisted of three specimens: male Largo (born 1998) and two females-Teby and Lessy (born 1996 and 1997 respectively). The observations were carried out during 2002–2005 period. Adult giraffes behaviour was observed in day to day routine to determine the onset of estrous. Three youngs – progeny of Largo and females matings were also observed. The behavioural development of young giraffes was determined during the first three days of life, and later, more irregularly to the first year of age. Two calves were observed since third was found dead short after parturition. The details of material and method are shown in Tables 1 and 2.

TABLE 1. Giraffe reproductive activity observed at Warsaw ZOO in 2002–2005 period

Female	Born	Year of reproductive activity	No of copulations*	Time of copulation	Time of calving	Born as a result (name)
Lessy	1997	2002	5	12.07–28.09	4.01.2004	1 F (Syrenka)
		2004	1	27.05	22.08.2005	1 M (Traper)***
		2005	1	8.11**		–
Tebi	1996	2004	4	27.01–10.02	16.05.2005	1M (Tomi)
		2006	3	9.02–22.02		–
Total			14	–	–	3

*All copulations performed by male Largo.
**Copulation with pregnant female.
***Neonate was fund dead after 48 hours.

TABLE 2. The observation schedule

Young	Age	Number of observations	Span of time	Total number of hours
Syrenka	first day	1	13–19	6
	second day	1	8–19	11
	third day	1	8–19	11
	up to three months	5	12–15, 9–15, 8–12, 12–14, 13–15	14
	3–6 months	4	11–14,9–12, 14–16, 16–18	10
	6 months-one year	4	8–10, 12–13, 10–12, 13–15	7
	total	16		59
Tomi	first day	1	8–19	11
	second day	1	8–19	11
	third day	1	8–19	11
	up to three months	7	9–11,11–13, 13–15, 6–18, 8–12, 13–15, 15–17	16
	3–6 months	5	9–12, 11–14, 13–15, 8–12, 12–14	14
	6 months – one year	6	9–11,13–14, 11–14, 13–15, 10–11, 9–11	11
	total	21		74

RESULTS

The reproduction parameters

The observed giraffes were sexually active in 5–6 years of age, thus perfectly in accordance with data delivered by Hall-Martin and Skinner (1978). Giraffe living under natural conditions is described as nonterritorial ungulate without definite breeding peiod. In the wild

most conceptions take place during the rains (Estes, 1991). At the Warsaw ZOO many copulations were observed during the summer and the winter. The most accurate calculation as regards the length of gestation could be done in the case the birth of Traper (see Tab. 1). It was nearly 15 months. In the other cases an exact time of conception was hard to determine but it seems that gestation was similar (ca 15–16 months). Hayssen et al (1993) recorded upper limit of gestation in captive and wild giraffe as 480 days.

To sum up, the above mentioned findings concerning the reproduction parameters in giraffe confirmed data obtained by the other scientists.

Sexual behaviour

The bull Largo showed the whole behaviour spectrum typical for wild giraffe during mating period. Although there was only one male in group kept at Warsaw ZOO his tendency to maintain tending bond (Estes, 1991) with estrous cow was visible. He followed female, licked and nudged her, testing her urine with a flehmen response. The frequency of urine testing changed as time of full receptivity approached. Firstly, it was observed only 1–2 times daily, later several times during the day. Occasionally burst of male aggression – "head slamming" directed towards female was observed. Since this behaviour is observed only during intermale conflicts in the wild it may be seen as abnormal behaviour caused by artificial keeping conditions.

Giraffes at Warsaw ZOO have mated for 1–2 days. In this time several copulations took place but probably only some of them ended with ejaculation. Copulation posture was as described in literature (Estes, 1991). During copulation only one thrust lasting 2–3 seconds was observed.

Gestation and birth

The developing fetus was located in the right side of female belly. This characteristic of giraffe reproduction result in fact that fetus movement and its head and neck position were visible. It took almost five hours to complete the birth. The mother giraffe gave birth standing. During the birth process at the first stage the female paced nervously around her enclosure with raised tail. Then, the embryonic sac burst and the young appeared, firstly the legs, than the rest of the body The baby fell to the ground. In two observed successful births young giraffes seemed to be in good conditions. Their measurements of body weight were as follows: Syrenka – nearly 60 kg, Tomi – 55 kg, Traper – ca 65 kg. In the literature neonates were recorded to weight between 30 and 100 kg (Bernischke, 2007) The first adoption standing position was observed only in the case of Syrenka. It occurred 105 minutes after the calving. This was markedly later than in the wild where young giraffe could suckle within the first hour after calving (Estes, 1991).

Development of behaviour

Time spent on various behaviour during giraffe development was shown in Table 3. Two calves were observed for 133 hours from post birth period up to one year of age Since there is lack of knowledge as regards the behavioural ontogeny of young giraffe in the first days of life in the wild and in captivity as well it should be interesting to look at the development during this period more closely.

In the first day neonate exercised its motor activity. It tried to get up and walk usually to approach the mother. The great effort was visible since young needed frequent rest and/or sleep pauses. The neck and head position during the rest was troublesome and young tried various positions. The contact with the mother was frequent. Firstly, she licked remnants of embryonic sac covering the neonate body. The later contacts were linked with suckling. Self-grooming was also observed. However, as a whole in the first day inactivity of the young prevailed.

In the second day the motor activity markedly improved. Running and jumping were observed Young giraffe intensively explored the surroundings. There was also calf prolonged contact with the mother. The bouts of suckling lasted for 2–6 min. Young giraffe was groomed and licked by the cow. The troubles with head and neck position remained. It is interesting that some forms of stereotyped behaviour were observed in the second day of life e.g. licking the window panes and the other elements of an enclosure. This behaviour was classified as stereotypy because in this context seemed to be aimless and repeated.

In the third day young giraffe was more active than previously. Walk, run, exploration and play were the typical forms of motor activity. Bouts of sleep became shorter and neck and head positions were stable. When moving young tried to adopt more demanding body position e.g. bending down The stereotyped behaviour was visible like before. In the three days of age bond between young and mother was very strong and distance between them was usually very small.

The giraffe in one month of age was fully developed as regards its motor activity and could take various obstacles. Its recumbent position was also typical for adult giraffe. Calf in this age begun to feed on plant matter. Young giraffe was markedly more independent from the mother and was interested in contact with the other giraffes and humans as well.

In the three months of age young giraffe like adult was able to stand nearly motionless just looking for over longer periods of time. Well developed browsing and ruminating were visible in this age. The interactions with all members of giraffe group were frequent although the reactions towards father were rather frightful.

In the age of six months young giraffe resembled adult specimen. The bouts of feeding lengthened thus, tendency to stereotypy diminished. The interactions with father became quite frequent.

A giraffe in first year of age may be seen as fully developed as regards its behaviour. The bond between young and its mother and the other adults was to some degree loosened.

Besides the stereotypy in the young giraffe observed at Warsaw Zoo development of behaviour was similar to some data obtained in the wild and captivity (Langman, 1977, Estes 1991). Very early occurrence of stereotyped behaviour-licking window panes would be explained in various ways for example as effect of boredom and strong hunger and exploration drive. Since this is a common problem in adult captive giraffes also those kept at Warsaw ZOO social imitation was possible mechanism.

CONCLUSIONS

1. Giraffes kept at Warsaw ZOO showed reproductive behaviour with three calvings in 2002–2005 years. The reproductive parameters and behaviour resembled other data from the wild and captivity.
2. The first three days of giraffe life turned out to be important period in development since the behaviour such as motor activity and relationship with mother markedly changed.
3. The stereotyped activity typical for the giraffes kept in zoos also took place during the very first period of life.

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TABLE 3. The mean % of two calves behaviour distribution in the observation period

	Age					
Behaviour	first day	second day	third day	three months	six months	first year
Motor activity	7,7	10,2	30,8	18,6	17,8	20,0
Feeding	8,4	9,8	8,9	15,9	33,9	36,9
Grooming	0,23	0,6	2,2	2,8	1,1	1,4
Eliminative	not observed	0,2	2,0	1,3	0,5	0,3
Social	21,0	3,8	9,0	4,3	4,9	1,1
Stereotypy	not observed	0,7	0,9	0,8	0,9	not observed
Others (mainly sleeping, resting)	62,7	74,7	46,2	56,3	40,9	40,3
	100					

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Streszczenie. W ZOO Warszawa w latach 2002–2005 r. obserwowano zachowania rozrodcze w grupie składającej się z trzech dorosłych żyraf (*Giraffa camelopardalis*) oraz ontogenezę behawioru u urodzonych osobników. Opisano cały cykl zachowania rozrodczego począwszy od rui, a na porodzie skończywszy. Zachowania te okazały się zbliżone do danych podawanych dla dziko żyjących żyraf. Obserwowano też zachowanie się dwóch cieląt przez 133 godziny od okresu krótko po wycieleniu do wieku 1 roku. Zmiany zachodzące w behawiorze młodych żyraf również w dużym stopniu odpowiadały danym z literatury. Jednakże u dwudniowych cieląt odnotowano występowanie anormalnego zachowania stereotypowego. Krótko przedyskutowano możliwe pochodzenie tego zachowania.

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The influence of Polish-bred Arabian horses on the results of international shows

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Abstract: *The influence of Polish-bred Arabian horses on the results of international shows.* The aim of the study was to assess the influence of Polish-bred Arabian horses on the results of international shows. An analysis of four international Arabian horse shows of the highest rank (of the "A" category) between the years 1992–2001 was conducted: the International Arabian Horse Show at Towerlands (Great Britain), the All Nations Cup in Aachen (Germany), the European Championships and the World Championships in Paris (France). The results of 40 championships were examined, taking into consideration horses awarded with the titles of Champion (Male and Female) and Reserve Champion (Male and Female). The study included 159 pure-bred Arabian horses, bred in 17 countries. In order to determine the influence of Polish-bred Arabian horses on the results of the "A" shows, an analysis of the pedigrees of the Champion and Reserve Champion title holders was conducted, by compiling their pedigrees up to the fourth generation and searching them for Polish-bred ancestors. It was discovered that among the 159 horses awarded at "A" shows during the years 1992–2001 – 29 horses (18.2%) were bred in Poland and in the pedigrees of 65 horses (40.9%) Polish-bred ancestors were found. Out of the 269 examined titles 160 (59.5%) distinctions were awarded to Polish-bred horses or horses with Polish-bred ancestors. In the pedigrees of A show champions in the years 1992–2001 58 Polish-bred ancestors were found. In the pedigrees of foreign horses with Polish ancestors a record number of times appear the stallion Arax (in 32 horses) and the mare Mammona (in 23 horses).

Key words: Arabian horses, Polish horse breeding, international shows, champions, championships.

INTRODUCTION

Polish Arabian horse breeding is one of the oldest in the world – it has been documented for over 200 years. Evidence of the quality of the domestic Arabian horse breeding is the fact that Poland, possessing a rather small herd of mares, continues to achieve significant breeding success (Tomczyk-Wrona, 1999).

Polish horses are known for their beauty and leveled type, which results from the fact that show results still play a dominating role in the selection of Arabian horses and the primary traits taken into consideration during selection are: correctness of type, beauty and conformation (Brzeski, 1985). Shows and championships held all over the world, thanks to which Polish horses have a chance to present themselves before a broad public, play a selective role and at the same time have a huge significance in the building of a high status of Polish Arabian horse breeding in the world.

The aim of this study was to assess the participation of Polish-bred Arabian horses in the population of international Arabian horse show winners during the years 1992–2001.

MATERIAL AND METHODS

The research material consisted of the results of four international Arabian horse shows of the highest rank (of the „A" category), taking place during the years 1992–2001: the International Arabian Horse Show at Towerlands (Great Britain), the All Nations Cup in Aachen (Germany), the European Championships and the World Championships in Paris (France). The following titles, awarded to mares and stallions depending on their age, were taken under consideration: Champion and Reserve Champion Filly, Champion and Reserve Champion Mare, Champion and Reserve Champion Colt, Champion and Reserve Champion Stallion. To the junior horse championships qualified the winners of the yearling, 2-year-old and 3-year-old classes, while the senior championships saw the winners of the respective classes for horses aged 4 and above. The results of 40 championships were examined, in which horses awarded with titles were taken into consideration (8 horses from each show).

The study consisted of 159 pure-bred Arabian horses, bred in 17 countries: Argentina, Australia, Austria, Belgium, Brazil, France, Holland, Israel, Qatar, Germany, Poland, Russia, the United States, Sweden, Hungary, Great Britain and Italy. Due to the fact that some of the horses won more than once, the list of Champion or Reserve Champion titles obtained during that time amounted to 269 entries.

In order to assess the influence of Polish-bred Arabian horses on the results of the A shows, an analysis of the origins of the Champion and Reserve Champion title winners was conducted, by compiling their pedigrees up to the fourth generation, after which Polish-bred ancestors were searched for. Based on this two groups of horses were isolated: Polish-bred horses and foreign-bred horses with Polish-bred ancestors in their pedigrees (appearing up to the fourth generation). A profile of both groups of horses was made, with a division into stallions and mares.

RESULTS AND DISCUSSION

Among the 159 horses awarded at the A shows during the years 1992–2001 29 (18.2%) were bred in Poland and in the pedigrees of 65 horses (40,9%) Polish-bred ancestors could be found (Tab. 1). Out of the 269 awarded titles, 160 distinctions (59,5%) belonged to Polish-bred horses and horses with Polish-bred ancestors.

The average number of awards won among Polish-bred horses is higher, both among the mares and the stallions, from the average of the entire population of champions. Based on this it can be assumed that a Polish horse, which has

TABLE 1. Number of Polish-bred horses or horses with Polish-bred ancestors in their pedigrees at A shows during the years 1992–2001

	Polish-bred horses			Horses with Polish-bred ancestors in their pedigrees			A show champions – in total*		
	Number of horses	Number of obtained titles	Average number of awards per horse	Number of horses	Number of obtained titles	Average number of awards per horse	Number of horses	Number of obtained titles	Average number of awards per horse
Stallions	11	21	1,91	33	62	1.88	72	134	1.84
	37.90%	40.40%		50.80%	57.40%		45.30%		
Mares	18	31	1,72	32	47	1.47	87	135	1.55
	62.10%	59.60%		49.20%	42.60%		54.70%		
Total	29	52	1,79	65	109	1.68	159	269	1.69
	100%	100%		100%	100%				

* Lack of results from 7 shows during the years 1992–1994.

once achieved glory on the show arenas has a bigger chance of repeating its success than the other champions.

Polish-bred horses. Among Polish-bred horses at the shows there was a noted domination of the mares (18 individuals), which gathered 31 titles, including 18 championships and 13 reserve championships (Tab. 2). These feats were achieved by the following mares: Aldara, Czata, Egina, El Dorada, Emanacja, Emanda, Emilda, Emmona, Eskalopka, Esklawa, Estarda, Fallada, Kwestura, Maesta, Palba, Pikieta, Wioleta and Zagrobla. Whereas 11 Polish stallions obtained 21 titles at the world show arenas (12 championships and 9 reserve championships). These stallions were: Ekstern, Elart, Emigrant, Endel, Ganges, Kordelas, Pesal, Piechur, Pilot, Piruet and Wadim. Many times there was a situation where acknowledged horses, after winning a title, stepped off the rings to re-enter them after 3 or 4 years and again claim honors (Emanda, Piechur, Pikieta, Piruet, Zagrobla). Polish breeding currently possesses 15 dam lines and 7 sire lines. Polish-bred horses awarded at A shows represented 6 sire lines and 9 dam lines. The most representatives had the dam line of Milordka – 13 horses and the sire line of Kuhailan Afas – 8 horses. Many superb sires in the last couple of years were stallions imported to Poland (Palas, Probat, Monogramm) or the sons of imported stallions (Bandos by Negatiw or Wojsław by Tallin).

Foreign-bred horses with Polish-bred ancestors in their pedigrees. Among the horses with Polish-bred ancestors in their pedigrees were 33 stallions and 32 mares (Tab. 1). The stallions triumphed 62 times – 33 times as champions and 29 times as reserve champions. The mares won 27 championships and 20 reserve championships. The horses originated mostly from Germany, USA, Great Britain and Russia (Grabowski, Detkens, 1972).

Descent through the sire line. The awarded horses were sired by 109 stallions. After analyzing the pedigrees through the sire line of the 159 horses it was asserted that a group of sires, which had more than one awarded progeny, stood out. There were 27 sires, which gave at least 2 such sons. This was 24.8% of all sires of awarded progeny during that time. A total of 77 champions descended from them. Among these 27 stallions were 3 bred in Poland: Banat 1967 (El Azrak – Bandola), Eukaliptus 1974 (Bandos – Eunice) and Partner 1970 (Eleuzis – Parma) and 10 stallions (37.0%) with Polish ancestors in their pedigrees. Outstanding in this regard were the stallions Monogramm 1985 (Negatraz – Monogramma) – with 9 individuals, El Shaklan 1975 (Shaker El Masri – Estopa) – 6 individuals, as well as Kubinec 1987 (Balaton – Kosmetika) – 6 individuals. Though this assessment includes only the successes of the progeny during the years 1992–2001, an assertion can be risked that those stallions

TABLE 2. Number of titles obtained by Polish-bred horses or horses with Polish-bred ancestors in their pedigrees at A shows during the years 1992–2001

	UK International Show, Towerlands		All Nations Cup Aachen		European Championships		World Championships		Total
	Polish-bred horses	Horses with Polish-bred ancestors	Polish-bred horses	Horses with Polish-bred ancestors	Polish-bred horses	Horses with Polish-bred ancestors	Polish-bred horses	Horses with Polish-bred ancestors	
Ch.F.		5		3	1	4	1	4	18
Res.Ch.F.		3	2	2		3		2	12
Ch.M.	4	3	6	1	4	3	2	4	27
Res.Ch.M.	2	2	3	3	3	1	3	3	20
Ch.C.		3		6		5		7	21
Res.Ch.C.		5		5		3		4	17
Ch.St.	4	2	2	4	4	3	2	3	24
Res.Ch.St.	1	3	4	2	3	4	1	3	21
Total	11	26	17	26	15	26	9	30	160
	37		43		41		39		

Abbreviations:

Ch.F. – Champion Filly
Res.Ch.F. – Reserve Champion Filly
Ch.M. – Champion Mare
Res.Ch.M. – Reserve Champion Mare
Ch.C. – Champion Colt
Res.Ch.C. – Reserve Champion Colt
Ch.St. – Champion Stallion
Res.Ch.St. – Reserve Champion Stallion

may have a huge breeding significance in regard to the passing on of beauty traits. The entire progeny of the stallion Monogramm awarded at A shows was bred in Poland and such a huge number of offspring is the result of a broad use of this stallion at Michałów Stud, who leased him in the years 1993–1994. He is not a Polish-bred horse, but possesses the blood of Polish ancestors – the stallion Bask 1956 (Witraż – Bałałajka) and the mare Mammona 1939 (Ofir – Krucica).

In all 6 awarded horses (3.8% of all champions) were sired by Polish-bred stallions and 38 champions (23.9%) were sired by stallions with Polish blood in their pedigrees.

Chmiel (2002) studied the influence of Arabian sires on the passing on of traits assessed during shows. The material included the results of Polish National Shows and Junior Shows. The ability to pass on traits to the progeny was described as "breeding value" (WH) expressed in points. This index means the supremacy of the progeny of a given sire over their peers in the assessed period. The author assessed the influence of Arabian sires used in Polish breeding on the five traits evaluated at shows (type, head and neck, body, legs and movement). Each of the 38 analyzed stallions had a certain influence on breeding, however only in a couple the influence was significant. For example in regard to the legs, a trait usually evaluated the lowest at shows, the progeny of only 5 stallions was assessed higher that their peers (Balon, Bandos, Eldon, Eukaliptus, Penitent).

According to Budzyński et al. (1996) the biggest influence on the creation of a high quality population of horses in the period of 1970–1995 had the sires used at that time. The assessment conducted by the Authors regarded the abilities to pass on the most coveted traits: conformation, breeding value and use value. One of the criterions of the evaluation was the amount of Polish Championships and Reserve Championships won by the progeny of sires, who during the research period had at least 5 progeny. Among the stallions whose progeny won championships and reserve championships frequently, the best proved to be the stallions Palas, Probat and Bandos. It is worth noticing that they were either horses imported to Poland (Palas, Probat) or by imported sires (Bandos by Negatiw). As fathers of sires among the 37 horses the stallions Probat, Bandos, El Paso and Palas stood out and once again part of them are horses imported to Poland. In the research period 38 sires of broodmares distinguished themselves, however the first three stallions are a long way ahead of the others – they are Palas, Bandos and Probat, who left 75, 68 and 67 daughters in breeding respectively. As we can see in regard to

the passing on of conformation traits and production of valuable breeding horses the same stallions lead.

Descent through the female line. The champions of the A shows during the years 1992–2001 were out of 150 dams. In regard to the number of awarded progeny, 9 mares stood out with two titled offspring. Taking into consideration that mares have a considerably smaller amount of progeny compared to a stallion, this result attests to a huge breeding potential of the mentioned mares. Among them were two mares of Polish breeding: Emanacja and Emigrantka, as well as one mare with Polish ancestors – Saskia RJ (Plakat – Barwna), who has the Polish mare Biruta in the third generation.

Polish horses in the pedigrees of champions. In the pedigrees of 159 champions 58 Polish ancestors were found. In total they appeared 171 times in the pedigrees. A record number appearance in the pedigrees was noted in the case of two Polish horses: the stallion Arax 1952 (Amurath Sahib – Angara), bred by Klemensów Stud and the mare Mammona 1939 (Ofir – Krucica), bred by Janów Podlaski Stud. The stallion Arax was the progenitor of 32 horses, in whose pedigrees he appeared twice (Kubinec, Nadir I, Narissa and Verena) or thrice (Marenga, Nevnitza). Among the progeny of Arax the most distinguished was the stallion Nabeg, who through five offspring became the progenitor of 14 champions. Also one of Arax's daughters – the mare Karta – became a progenitor of 12 title holders, but the credit for this belongs to her grandson – the stallion Kubinec, who himself a champion, gave 6 awarded offspring. The mare Mammona appeared in the pedigrees of 23 horses, a total of 32 times. Among her progeny the mare Metropolia (mainly due to her son – the stallion Menes) mostly expanded her family, in which 12 champions appeared. Also the family of another Mammona daughter – the mare Nomenklatura – mainly through her son Nabeg, grew to 7 champions.

Among the 58 Polish-bred Arabian horses appearing in the pedigrees of the champions the stallion Comet 1953 (Abu Afas – Carmen), bred by Nowy Dwór Stud, appeared most frequently in the sire line in 6 individuals: Derwisz, Essauł, Gdynia, Mimika, Muza, Sedan. This confirms the general opinion, that this stallion had a positive influence on Polish Arabian horse breeding. Three progeny each had the stallions: Wielki Szlem (Alfa, Algier, Latawica) and Witraż (Bask, Caliope, Nureddin). Both stallions played a huge role in the establishing of the Polish Arabian horse type. The analysis of the descent through the female line of the 58 researched Polish ancestors showed a group of mares, who were dams of a couple of horses: Darda (Dardir, Dornaba), Dziewanna (Piołun,

Skrzyp), Elana (Edykt, Essauł), Gazella II (Najada, Taraszcza), Gwara (Gerwazy, Gwarny), Pentoda (Pedant, Pers) and Salwa (Sedan, Szarża).

CONCLUSIONS

1. Polish-bred Arabian horses, as well as Arabian horses with Polish-bred ancestors in their pedigrees had a significant influence on the results of international shows of the highest rank.
2. The strong influence of Polish-bred Arabian horses on the results of the most important international championships can be seen in the fact that over 1/3 of the sires that gave a couple of champions have Polish blood in their pedigrees.
3. In the pedigrees of champions of the A shows from the years 1992–2001 58 Polish-bred ancestors appear. A record number of times in the pedigrees of foreign horses with Polish-bred ancestors appears the stallion Arax (in 32 horses) and the mare Mammona (in 23 horses).

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Streszczenie: *Wpływ polskich koni czystej krwi arabskiej na wyniki championatów międzynarodowych*. Celem badań było określenie udziału koni arabskich polskiej hodowli w populacji zwycięzców najważniejszych międzynarodowych championatów koni czystej krwi rozgrywanych w latach 1992–2001. Dokonano analizy wyników czterech międzynarodowych championatów koni czystej krwi arabskiej najwyższej rangi (A), odbywających się w latach 1992–2001: Międzynarodowy Pokaz Koni Arabskich w Towerlands (Wielka Brytania), Puchar Narodów w Aachen (Niemcy), Championat Europy, Championat Świata (Paryż). Analizom poddano wyniki 40 championatów, w których brano pod uwagę konie nagrodzone tytułami Championa (Championki) i Vicechampiona (Vicechampionki). Badaniami objęto 159 koni czystej krwi arabskiej, wyhodowanych w 17 krajach świata. W celu określenia wpływu koni czystej krwi arabskiej polskiej hodowli na wyniki pokazów klasy A przeprowadzono analizę pochodzenia zdobywców tytułów championa i vice-championa, zestawiając ich rodowody do IV pokolenia po czym wyszukiwano w nich przodków polskiej hodowli. Stwierdzono, że wśród 159 koni nagradzanych w pokazach klasy A w latach 1992–2001 29 koni (18,2%) wyhodowano w Polsce, a w rodowodach 65 koni (40,9%) występowali przodkowie polskiej hodowli. Z 269 tytułów przyznanych koniom hodowli polskiej i z polskimi przodkami przypadło 160 wyróżnień (59,5%). W rodowodach championów pokazów klasy A z lat 1992–2001 występuje 58 przodków polskiej hodowli. Rekordową liczbę razy w rodowodach zagranicznych koni z polskimi przodkami pojawia się ogier Arax (u 32 koni) oraz klacz Mammona (u 23 koni). Wśród koni polskiej hodowli na pokazach dominowały klacze (18 szt.), które zebrały 31 tytułów, w tym 18 championatów i 13 vicechampionatów

natomiast 11 polskich ogierów zdobyło na światowych ringach 21 tytułów (12 championatów i 9 vicechampionatów). Konie czystej krwi arabskiej polskiej hodowli oraz z polskimi przodkami w rodowodzie miały istotny wpływ na wyniki międzynarodowych championatów najwyższej rangi.

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Mineral composition of loin meat in the Polish maternal and paternal breeds of pigs

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Abstract: *Mineral composition of loin meat in the Polish maternal and paternal breeds of pigs.* In the presented research on total 95 gilts, which were fed the same mixed meals and were slaughtered at the same body weight, the influence of breed: Polish Large White, Polish Landrace, Line-990, Pietrain and Duroc on mineral content in MLD was estimated. There was no significant effect of pigs' breeds on Ca and Na contents. The highest level of Fe was tested in MLD of Pietrain, together with the lowest content of Mg ($p < 0.01$). The highest level of K ($p < 0.01$) and the lowest of Zn ($p < 0.05$) were observed in MLD of Polish Landrace. There were not significant relationships between mineral level in MLD (except Mn) and selection traits: daily body gain and leanness.

Key words: minerals, loin muscle, breeds, pigs.

INTRODUCTION

The minerals take place in many important roles in body as constructive elements, they regulate the water-electrolyte management, go into erythrocytes composition and into chemical, which control metabolism: enzymes and hormones (Gawęcki and Hryniewiecki, 2003). The level of mineral consumption in human diets is the aim of research (Rutkowska et al., 1993 and 1994, Dybkowska et al., 2005), that indicate the significant deficiency of Ca, Mg, Cu, Zn and Fe. The meat is the important source of some minerals, especially Fe, Zn as well as Mg (Kunachowicz et al., 2005).

The minerals content in swine body is depended on their level in diet (Migdał et al., 1993: Weremko, 2005) and they are changed in growing pigs together with their body weight (Mahan and Shields, 1998). The research of Rekiel and Surdacki (1985) showed the possibility of breed effect on minerals level in pork.

In the presented paper, the level of minerals in MLD was estimated and compered between gilts of maternal and paternal breeds, which are using in current crossbreeding. The gilts were fed the same diet during fattening period and were slaughtered at the same body weight.

MATERIAL AND METHODS

Material included the meat samples, collected from M. longissimus dorsi (MLD) between 7 and 14 thoracic vertebrate of fatteners, gilts from mating of pure-bred breeds (number of samples in the brackets): Polish Large White – WBP (17), Polish Landrace – PBZ (16),

Line-990 (18), Pietrain (17) and Duroc (15). The gilts derived from 2–3 boars from each breed. MLD samples originated from fatteners, managed in the same conditions in SKURTCh in Pawłowice. Genotype of the gilts in locus RYR 1 was determined by PCR – RFLP method. The studies covered the individuals with genotype RYR 1 where the following breeds are presently dominating: WBP, PBZ and Duroc – exclusively RYR^{CC}, Pietrain – RYR^{CT} (7), RYR^{TT} (10), line 990 – RYR^{CT} (12), RYR^{CC} (6). The gilts were kept in individual pens and fed ad libitum with the same mixture up to the weight of 100 kg according to the SKURTCh methods (Różycki, 1996). The content of basic and mineral feed components are given in Table 1. The minerals content Ca, Fe, P, K, Na, Mg and Zn had estimated by using atomic spectrophotometric method ICP – OES, but Cu and Mn by absorption atomic spectrometry under ZAF procedure. All assays were realised in the Analytic Centre of the Warsaw University of Life Sciences. The results were statistically analysed, using single factor variance analysis. Statistical program SPSS (2003) was applied.

TABLE 1. Nutritional value and mineral composition of diet.

Item	ontent of feed
Dry matter [%]	87.43
Crude protein [%]	18.94
Ether extract [%]	3.17
Crude fiber [%]	3.28
Ca [g]	7.64
P [g]	5.41
Fe [mg]	23.00
K [g]	6.53
Na [g]	1.42
Mg [g]	1.62
Mn [mg]	7.00
Zn [mg]	160.00
Cu [mg]	30.00

Mineral components in 1 kg of feed.

RESULTS AND DISCUSSION

Values of fattening, slaughter and MLD composition traits are given in Table 2. The are mainly used for statement whether the gilts as constituting the sample from the population of all breeds are representative for discussed population. It is, therefore purposeful to compare the results of the gilts which are the subject of minerals content analysis, with the results of the evaluation of the breeds in evaluation centres, as given by Różycki and Tyra (2003). The gilts, representing the breeds in the present analysis, reached (excluding Duroc breed) slightly higher daily gains and possessed higher meat content in carcass as compared to the whole controlled population. The differences between maternal (Polish Large White and Polish Landrace) and paternal (Duroc, Pietrain, Line-990) breeds were, however consistent with those ones observed in the total controlled population in respect of growth rate as well as meatness in the analysed sample.

There were statistically significant ($p < 0.01$) differences in content of dry matter, ash, crude protein and intramuscular fat, which were depended on breeds. The highest content of dry matter was in

TABLE 2. Least square means for growth of fatening pigs, thein meatness and MLD components data by maternal and paternal breeds (slaughter live weight – 100 kg)

Trait	Breed of gilts						
	Polish Large White	Polish Landrace	990 synthetic line	Pietrain	Duroc	SE	P
Daily gain 30–100 kg [g]	931^{Aab}	914^{C}	862^{a}	869^{b}	785^{AC}	14	0.00
Meat in carcass [%]	60.51^{Aa}	61.97^{BC}	58.41^{Ba}	65.88^{ABC}	58.67^{C}	0.31	0.00
Loin weight without backfat and skin [kg]	8.04	8.67^{A}	8.68^{Ba}	8.27^{AB}	8.38^{a}	0.05	0.02
Dry matter [%]	25.93^{ab}	25.32^{AB}	25.67^{CD}	26.56^{AC}	26.76^{BDb}	0.10	0.00
Ash [%]	1.09	1.11^{A}	1.06^{AC}	1.12^{C}	1.09	0.01	0.00
Crude protein [%]	22.51^{A}	22.52^{B}	22.29^{C}	23.80^{ABCD}	21.65^{D}	0.11	0.00
Intramuscular fat [%]	1.64^{A}	1.03^{B}	1.64^{C}	1.70^{D}	3.77^{ABCD}	0.12	0.00

Means in the same row with the same letters differ significantly at the 0.05 (a, b) or at 0.01 (A, B) level of probability.

MLD from Duroc, the lowest – from Polish Landrace. The highest content of ash was characterised of Pietrain and the lowest was estimated in Line – 990.

The significant differences were rather small (for ash content lower than 0.06%). The intramuscular fat in MLD of Duroc was the highest 3.77%, together with lower level of crude protein. Phenomen of considerably high content of intramuscular fat in the Duroc breed is given by Wood et al. (2004).

In comparison of minerals content in MLD samples the differences of breeds were confirm (Table 3). There were significant differences in Fe, K, Mg, Mn, Cu ($p < 0.01$) and Zn, P ($p < 0.05$) content. There was no dissimilarity between Ca and Na levels. The Fe content in MLD of Pietrain was 0.74 mg/100g of meat and was higher than Fe level of the other breeds by about 0.2–0.3 mg. Probably, the Fe content is reflected the amount of hem in the muscles (Mahan and Shields, 1998). The highest content of K was in MLD samples from Polish Landrace – 519 mg/100 g of meat. The potassium is a main intercellular component of muscles and its content is increased during intensive growth of body weight. The leanness of Polish Landrace was higher than the other breeds except Pietrain.

TABLE 3. Least square means for mineral composition in *musculus longissimus dorsi* of Polish maternal and paternal breeds (mg in 100 g of muscle)

Mineral Concentration	Breed of gilts						
	Polish Large White	Polish Landrace	990 synthetic line	Pietrain	Duroc	SE	P
Ca	5.9	5.3	5.4	4.8	4.6	0.17	0.15
P	230^{A}	231^{B}	254^{ABa}	239	234^{a}	2.20	0.02
Fe	0.50^{A}	0.46^{B}	0.45^{C}	0.74^{ABCD}	0.55^{D}	0.02	0.00
K	490^{abc}	519^{ABad}	491^{de}	464^{Abe}	460^{Bc}	4.01	0.00
Na	47	46	52	46	48	0.81	0.11
Mg	33^{AB}	34^{CD}	34^{EF}	29^{ACE}	30^{BDF}	0.23	0.00
Mn	0.008^{Aa}	0.007	0.006^{AB}	0.008^{Bc}	0.006^{ac}	0.001	0.00
Zn	1.36^{a}	1.25^{abc}	1.28	1.37^{b}	1.37^{c}	0.02	0.04
Cu	0.05^{AB}	0.04^{ACE}	0.04^{BDF}	0.05^{CD}	0.05^{EF}	0.159	0.001

Means in the same row with the same letters differ significantly at the 0.05 (a, b) or 0.01 (A, B) level of probality.

In the samples from maternal breeds Polish Large White and Polish Landrace as well as Line – 990 the higher content of Mg was estimated (more than 33 mg). The lower level of Mg was noted in paternal breeds: Pietrain and Duroc (low than 30 mg). The higher content of Zn was in Pietrain, Duroc and Polish Large White, and lower in Polish Landrace and Line-990. In samples of MLD from Line – 990 the content of P was the highest (254 mg) in comparison with other breeds of about 230–239 mg.

The information about correlation between minerals content of MLD and main selection trait: daily body weight and leanness was showed in Table 4. The correlation between estimated parameters and majority of minerals was nearly naught ($-0{,}1 > R < 0{,}1$). The only significant correlation was observed between Mn content: positive for daily gain and negative for leanness. Manganium in a component in cellular enzyme, content of this mineral in muscles of gilts slaughtered in the same weight and fed the same diet, should be relatively constant, so this correlation is difficult to explain by biological way.

In Table 5 the average content of minerals in MLD from our research and in the loin of beef and in the chicken fillet from tables of nutrient value in food products (Kuchanowicz et al., 1998) was showed. The meat and the meat products are the main source of Fe and Zn (25–35%) as

TABLE 4. Relationship between mineral contents of *musculus longissimus dorsi* and daily gain or meat carcass content

Mineral Concentration	Daily gain (25–100 kg)		Meat in carcass %	
	R	t_R	R	t_R
Ca	0.12	1.05	–0.11	0.99
P	–0.09	0.80	–0.13	1.16
Fe	–0.03	0.24	0.03	0.25
K	0.02	0.20	0.05	0.41
Na	–0.03	0.22	–0.07	0.59
Mg	–0.15	1.34	0.02	0.16
Mn	0.27^{x}	2.49	–0.41^{xx}	3.94
Zn	–0.12	1.09	0.05	0.44
Cu	0.06	0.56	0.21	1.90

* $P < 0.05$, ** $P < 0.01$.

TABLE 5. Means for mineral composition in loin and from bibliography (mg in 100 g of probe)

Mineral Composition	Loin of pork (our research)	Beefs loin[1]	Chicken fillet[1]
Ca	5.3	4.0	5.0
P	236	212	240
Fe	0.54	3.1	0.4
K	484	382	385
Na	48	52	55
Mg	32	26	33
Mn	0.01	0.04	0.01
Zn	1.32	2.93	0.49
Cu	0.04	0.10	0.01

[1]Kunachowicz et al., 2005.

well as Cu and Mg (10–13%) in diets for human. There is the deficiency of those minerals in diet for Polish people in relation to recommendation (Rutkowska et al., 1993 and 1994; Dybkowska et al., 2005). The content of Fe, Zn and Cu in MLD as an average for 5 breeds, and in Pietrain, which has higher level of those minerals, were distinctly lower than in beef loin. The level of Mg in pork was similar to its level in chicken fillet but higher of Fe, Zn and Cu content.

Comparing the content of minerals in MLD in papers of Migdał et al. (1993), Nowakowski and Pełczyńska (1986), Rekiel and Surdacki (1985) as well as Kunachowicz et al. (2005) the big differences are observed (in mg/100 g meat): Ca 8–21, Fe 0,8–3,8, K 121–343, Mg 20–71 and Cu 0,03–0,44. The lower fluctuations are referred to content Na 42–53 and Zn 1,4–1,9. In own research the level of Ca and Fe was lower and higher of K and P in comparison to literature date. The differences in minerals content in diets for fatteners have probably effect on distinction of their content in MLD.

CONCLUSIONS

1. The breed has the significant influence on P, Fe, K, Mg, Mn, Zn and Cu, but no effect on Ca and Na content.
2. Accounting the content of minerals essential for human balance of diet: Fe, Mg, Zn and Cu – the higher content of three of them were estimated in MLD from Pietrain.
3. The average content of minerals: Fe, Zn, Cu in samples of MLD was distinctly lower than in beef loin and higher than minerals level in chicken fillet.

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Streszczenie: W badaniach na ogółem 95 loszkach żywionych tą samą paszą i ubijanych przy tej samej masie ciała badano wpływ rasy: Wielkiej Białej Polskiej, Polskiej Białej Zwisłouchej, linii 990, Pietrain i Duroc na zawartość składników mineralnych w mięśniu najdłuższym grzbietu (MLD). Nie stwierdzono istotnego wpływu rasy na zawartość Ca i Na. Najwyższą zawartość Fe stwierdzono w MLD rasy Pietrain przy niższej niż u innych ras zawartości magnezu ($p < 0,01$). Najwyższą zawartość potasu ($P < 0,01$), a najniższą cynku ($p < 0,05$) stwierdzono w MLD rasy Polskiej Białej Zwisłouchej. Nie stwierdzono znaczących istotnych statystycznie zależności między zawartością składników mineralnych MLD (z wyjątkiem manganu), a cechami selekcyjnymi: przyrostem dziennym w tuczu i zawartością mięsa w tuszy.

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