MILKING BEHAVIOUR OF SAANEN GOATS

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Abstract

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The aim of the study was to evaluate the effect of intensive rearing conditions on behaviour of Saanen goats. The focus of the investigation was the milking behaviour and the effect of age and productivity on it. A strict hierarchical order was established in the herd. The major part of animals built up a reflex towards the place in the milking parlour, which sometimes resulted in technological problems. The production performance had a lower effect than age on the social rank. The effect of the age on the four studied traits: milk yield, rate of milk flow, persistence in using a milking place and order of entering the parlour was the most pronounced in high-production animals.

Key words: goats; milking behaviour; milk production; age

Introduction

The last five years have witnessed an increased interest in consumption of goat milk products in Europe, as seen from the more intensive trade and the sector growth of 18%.

Goat milk is more and more preferred dietetic foodstuff. It is a source for production of cheese and other dairy products. Its curative properties are acknowledged. The lower volume of fat globules and the finer structure of the casein mycelium make it more easily digestible (Park, 1994; Park et al., 2007; Raynal-Ljutovac et al., 2008). Its alkaline pH is very appropriate for people with gastric acidity issues. It is used in children with allergies to cow milk. Goat yogurt is an especially valuable means in such allergies as its proteins are assimilated better as compared to cow yogurt. According to Park (1994) between 40 to 100% of patients allergic to cow milk proteins tolerate goat milk. Its amino acid content is the closest to that of human milk. Goat milk is rich in aminosulfonic acid taurine, involved in detoxication of poisons in the liver, and is superior to cow milk with respect to phosphorus and potassium. It has also significantly higher content of two fatty acids: linoleic and arachidonic, which are essential for some vital functions of the human body. The fatty acids of goat's milk are absorbed better in the body than those in cow milk, resulting in generally lower total blood cholesterol concentrations (Seaton et al., 1986; Kasai et al., 2003). The body of goats is capable to convert all carotene into vitamin A that is why goat milk is rich in vitamin A and has a white colour as it does not contain free carotene. Furthermore mineral and vitamin contents and iron bioavailability are stated to be mostly higher in goat milk than in cow milk (Park et al., 1986; Park, 1994; Park et al., 2007). It is highly valued because of the good antiviral activity with respect to RNA viruses, therefore it is hardly infected with them. Goat milk is mainly used for production of soft cheeses which are demanded and preferred to cows and sheep cheeses in many countries (Raynal-Ljutovac et al., 2008).

The production of goat milk in Bulgaria decreased from 101 767 t in 2002 to 39 622 t in 2015, representing 3.5% of total amount of milk produce (Source: MZH, Agrostatistics Department, Survey "Livestock up to 1-st November"). The main part of goat milk is consumed by households, and the rest is mixed with the milk of other animal species.

The increasing demand for dietetic and ecologically pure dairy products on the foreign market favours the export and at the same time, necessitates the separated purchase of goat milk.

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On the basis of expert data, 6.7% of Bulgarian goat population is from the Bulgarian Dairy White breed, 24.5% are high-yielding dairy crosses with Bulgarian white and Toggenburg bucks, and 68.8% are local goats and their crosses with different percentage of blood from improvement breeds. This breed structure explains the relatively low productivity of the national goat population.

The future development of goat farming would be important from economic point of view as a promising branch of livestock husbandry. In the near future, this would result in stimulation of technological research on curative, luxurious and gourmet dairy products from goat milk and would increase goat milk production through implementation of intensive rearing systems.

The analysis of the present situation in France – one of the leading countries in dairy goat farming, showed that it involved mainly three types of farms. Those producing only milk are 48%, farms specializing in production of cheese are 47% and a very small part (about 5%) are of the mixed type – produce milk and cheese. Large dairy farms house about 233 animals on the average, and the others are smaller. French dairy goat industry comprises 350 000 Saanen and 450 000 Alpine goats. These are the two principal breeds, and the Alpine breed is superior with respect to the number of lactations. The lactation period is also different – 296 in Alpine and 313 days in Saanen goats. The average lactation milk yield of Alpine goats is 915 kg, and of Saanen goats – 996 kg.

Saanen goat breed is created in Switzerland in regions with altitude of 1000-2000 m and abundant pastures. Under good nutrition and rearing conditions, goats could produce more than 1000 kg milk. Milk fat content is 3.8-4.0%. The record for lactation is 2950 kg in the USA. Saanen goats are among the largest in size: the average weight of does is 50-60 kg, and this of bucks is 80-100 kg. The prolificacy is 180-250%. The animals have good body shape and strong skeleton. The udder is very well developed, usually pear-shaped and with big teats. The Saanen goat has a good acclimatization capability. It is widely spread in Europe, America (CAPRITEC, 2011; Paulo and Lope, 2014), Africa and Asia, where it serves as principal improvement breed.

The interest to the breed in Bulgaria is constantly increasing, which renewed the research interest. So far, the main research topics in goats were milk quality and composition, some weight and exterior traits etc.

Goats have some specific features distinguishing them from other domestic animals. This implies the need from application of species-adapted research methods. It is known that goats utilize very well roughages with high cellulose content and they satisfy their feeding needs with them during most of the year. They profit the best from mountainous and semi-mountainous pastures, including steep and inaccessible lands. They clean the pastures from shrubs and weeds, which could not be utilized by pother animals. Their adaptation potential is good and could be reared both alone in private yards and intensively in goat farms for industrial production of milk and dairy products.

The trends that have marked the development of dairy goat farming during the recent years are: consolidation of farms, import of breeders for improving the existing genetic potential, improvement of the material base with regard to production of high-quality and safe raw and processed products. Novel types of premises are introduced due to the rearing on manger. The number of animals reared in the same premise, as well as in one group increases. Machine milking is practiced because of the following economic reasons: increased labour efficiency, mechanization and automation of production processes, reduced costs mainly on the account of lighter constructions. The aim is through the use of novel technologies to provide comfort to animals and finally, better utilization of their genetic potential.

Goats live in social groups in a definite hierarchy, existing for the definite period of time. Some authors describe the hierarchy as linear (Barroso et al., 2000), and others – as non-linear and complex (Fournier and Festa-Bianchet, 1995; Keil and Sambraus, 1996). In linear hierarchy, one animal dominates over all the others, the second – over all except for the first etc. and the last in rank is subordinated to all others. Such hierarchical order is observed most commonly in small animal groups. In non-linear hierarchical order, three or four animals dominate over all the rest, and in the complex one – first rank animals are in linear hierarchy, while the ranks of other are not clearly established. The non-linear and complex hierarchical orders are characteristic for larger groups and for groups with equal potential of members. In general, dominance is more expressed in goats. From evolutional sense, social groups are favourable and unfavourable the main advantage is the early detection of predators, while the competition for food is the main drawback. Competition results in agonistic interactions within the herd. The establishment of hierarchy reduces the time and energy spent for constant aggression episodes and fights. Goats are the only livestock species exhibiting intervention behaviour, e.g. friendly interactions between herd members (Keil and Sambraus, 1998; Sambraus, 1991). The authors have observed positioning of individuals between other fighting subjects that has resulted in fight termination. It is supposed that interveners are high-ranked individuals, having more specific relationships with their competitors (Sambraus, 1971). The goats possess strong exploring reflex. In general, goat populations are character-

ized with stable hierarchical order. The presence of horns is the primary dominance trait (Mobini, 1991; Loretz, et al., 2004; Wechsler, 2004; Szabó, 2011).

Fear is an emotional state provoked by unfamiliar sights, noises, heights, as well as by danger signals emitted by other herd members, from previous experiences etc. Fear sensation is a trait of the temperament that reflects the general sensitivity of the individual and its capability to react to different menaces (Boissy, 1995). The main characteristics of the temperament are often evaluated on the basis of the way animals cope with challenges or the level of their sense of fear. The temperament could be defined as a feature of subjects manifesting a constant emotional and behavioural pattern (Pervin, 1997). Most commonly, fear is exhibited with respect to men. During the last decades, methods for investigation of fear to men are extensively developed. The main motivation in animal behaviour during their contact with men and machines is fear, which motivates animals to avoid human, and the active avoidance of men is an evidence of fear response (Ivanov et al., 1993; Dimitrov, 1998; Hemsworth, 2004). This reaction occurs after improper treatment of the animal. The unknown – change of routine, lighting, surfaces, height and material of fences could evoke stress (Gudev et al., 2014). Goats have an evolutional inborn sense of fear which helps them to avoid life-threatening situations – fear from heights, sudden movements, acts of menace or aggression, continuous eye contact and large objects rising above them. These menaces could be reduced to a minimum through proper milking parlour designs and adequate handling of animals.

Having invested a substantial financial resource, the modern goat milk producer should be aware about the intersection point between economic interest and biological potential of animals. The willingness for rapid return of considerable investments is often compromised by ignoring or neglecting the biological requirements of goats. Only an expert ethological evaluation of the environment could provide the correct answer to this problem.

The only research team in Bulgaria that performs modern ethological experiments for thirty years, is from the Animal Physiology Unit to the Faculty of Agriculture, Trakia University. So far, numerous approaches from the European and world practice are adopted along with extensive own experience (Varlyakov, 1989, 1997, 2011; Varlyakov et al., 1995, 2007, 2010, 2011, 2012). Publications from the last few years devoted on the suitability of difference audio-visual technologies for registration of the behaviour and the methods of analysis of results have raised a particular interest.

The information presented as far provides a sufficient body of evidence for the motivation of our team to perform the present research.

The aim of the study was to evaluate the behaviour in machine-milked Saanen goats and the effects of milk yield, age and temperament type.

Material and methods

The studies are performed at a goat farm near to Yabalkovo settlement, Dimitrovgrad municipality, rearing 225 lactating Saanen goats. The main herd was created in 2012 after import of 124 purebred Saanen goats and 6 bucks from Cyprus. The animals were reared in tie-stalls all the year round. The feeding is ad libitum and the ration comprises 3 kg alfalfa hay, 1 kg corn silage and 1 kg concentrate. During the milking, goats receive about 100-150 g concentrate. A constant access to water is provided, and goats are allowed to walk freely in open yards or to rest in areas bedded with straw. The milking is performed in a milking parlour designed for sheep and consequently adapted to goats.

During two consecutive days (morning and evening), individual milk control of all 225 lactating goats was performed at the time of milking. The data served for allotment of animals according to their productive performance. When included in a group, the temperament of each goat was assessed as well as its milking behaviour. The groups were homogenous and animals demonstrating unwanted behavioural reactions or having morphological and functional udder defects were eliminated. The conditional division of goats in 2 herds was done with respect to the number of lactation: "old herd" – at 3rd and subsequent lactation; and "young herd" – at 1st and 2nd lactation.

Six experimental groups with not less than 10 animals with different productivity and lactation number were formed: Group 1 – 13 high-yielding goats from the old herd; Group 2 - 10 medium-yielding goats from the old herd; Group 3 – 12 goats from the old herd with low productivity; Group 4 – 12 high-yielding goats from the young herd; Group 5 – 10 medium-yielding goats from the young herd and Group 6 – 13 low-yielding goats from the young herd.

The system for observation of the behaviour of animals included dome vandal-resistant video cameras with infrared sensors, working in the absence of light (0.5 Lx), allowing manual correction of the focus distance and the scope of visual control and receiver adapted for aggressive environment– harmful gases, humidity, dust etc.

Macro- and microclimatic indices were monitored and controlled.

Investigated ethological parameters:
In these ethological studies, the method of individual observation by means of infrared video cameras allowing reg-

istration of behavioural activities without additional lighting was used. The order of entering the milking parlour and the occupied milking position were registered during two consecutive days in the spring, summer and autumn. The voluntary entering and leaving the parlour, the response to milking machine, behaviour during milking including interactions with neighbours were evaluated.

The method of data analysis was adapted and implemented by us for more than 5 years. Ethological data was analyzed with standard software, adapted, tested and configured in Microsoft Excel environment.

For each goat from the herd the following parameters were calculated: index of milking order (***Iom***), index for persistence in using a milking place (***Ip***) and milk flow rate (***kg/min***).

The data was processed through analysis of discrete variables, and for the 6 experimental groups, correlation coefficients of all possible combinations of the four variables (the 3 outlined above and milk yield in ***kg)*** were additionally calculated.

Results and discussion

The data showed that the goats from the so-called old herd exhibited a stable order for entering the milking parlour – only 2% of all goats (109) entered spontaneously (***Iom***<0.6), while 67% had deviations up to 2 groups in observed 12 cases. Seven goats entered always in the same order (Fig.1). Data showed convincingly that there was a strict hierarchical order in the herd.

The social behaviour of goats, including dominance, has been researched by many authors (Stewart and Scott, 1949; Sambraus, 1971; Shank, 1972; Escós et al., 1993; Engel, 1997; Feuerriegel, 1997; Sambraus and Keil, 1997; Barroso et al., 2000), but was rarely associated to milking (Donaldson et al., 1967). In modern production systems – all year round on mangers, in large groups and with machine milking, including by robots, social behaviour is a key factor for achieving the targeted economic results (Varlyakov, 1989; Varlyakov and Ivanov, 1994; Varlyakov et al., 2011). In this sense, the knowledge for the social behaviour and the opportunities for its modulation are at the basis of the success or failure of a given technological solution.

Data from Fig. 1 were closely related to the reflex for occupying a place. It was evident that goats or at least half of them – those with ***Ip***>0.90, exhibited preference to milking place (Fig. 2). Only 36% had deviations of < 3 places out of the 8 possible places in the parlour, and 8% of animals occupied the available, not preferred place for milking (Fig. 2). We have observed an interesting phenomenon – a goat that en-

tered earlier did not occupy the available place in the beginning of the parlour, but a place at the entrance, on a preferred by it position, causing sometimes disturbances of parlour occupation and even inducing need for human interference. The animals with the highest rank, which practically occupied the same place in all investigations, occupied the places with conditional numbers 8, 1 and 6 – entering the last or the first from the group of eight (equal to the parlour capacity).

In the goats from the so-called young herd – born in Bulgaria and grown under the same conditions, the hierarchical order was even stricter (Fig. 3). In fact, entering for milking with difference of more than 4 groups (***Iom***<0.60) was not observed and in 82% of goats there was a deviation of up to 2 groups (***Iom***>0.80). Almost all goats entered voluntarily the milking parlour except for the last 5–8 goats entering for milking. These were most commonly young animals or goats with udder problems.

A similar tendency was exhibited when the reflex for using a parlour place was manifested – obvious in 29% of studied animals with ***Ip***>0.90, in 50% - sufficiently clearly expressed preference (***Ip***>0.66) and in only 21% - lack of persistence; 6% occupied an available, not preferred place (Fig. 4).

The comparison of data for both herds suggested, at first glance, more favourable values e.g. superiority for the young goats. This was not the case however, as could be seen from the mean ranks and especially from the variations within the group. It turned out that the goats form the "old herd" had ***Iom***=69.54±1.53 and ***Ip***=74.5±7.14 vs ***Iom***=50.90±1.59 and ***Ip***=78.82±8.35 in the young herd. Only the integral interpretation of data from the standard statistical analysis with values obtained from our method could provide convincing arguments for a consistent conclusion. In this case, the conclusion is that the groups exhibited stable statistical order and that the goats built up a reflex to the milking parlour place which should be considered when developing technological rules that should be observed by milkmen workers.

According to most researchers, goats are fast learners, have a good short-term and long-term memory because of which they are rapidly adapted to environments (Addison and Baker, 1982; RSPCA, 2008). Briefer et al. (2014) demonstrated that goats could learn complex tasks and repeat them after 10 months. The researchers managed to teach a group of 12 goats to obtain food from a box after pulling and then, lifting a lever, after average of 10 repetitions. Before each session of training, goats were allowed to watch a "demonstrator goat". The time for learning with and without a demonstrator was the same. On the other hand, the changes in the environment during milking acted as stressors – a fact established long ago not only in goats, but also in sheep (Dimitrov et al., 1993; Varlyakov and Ivanov, 1994; Wasilewski, 1999; Gudev et al.,
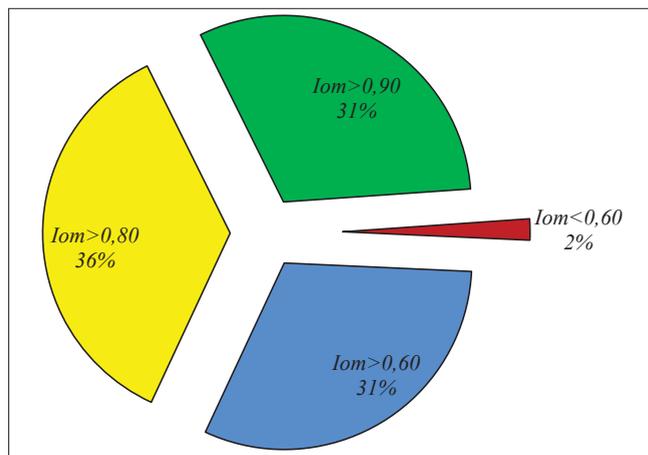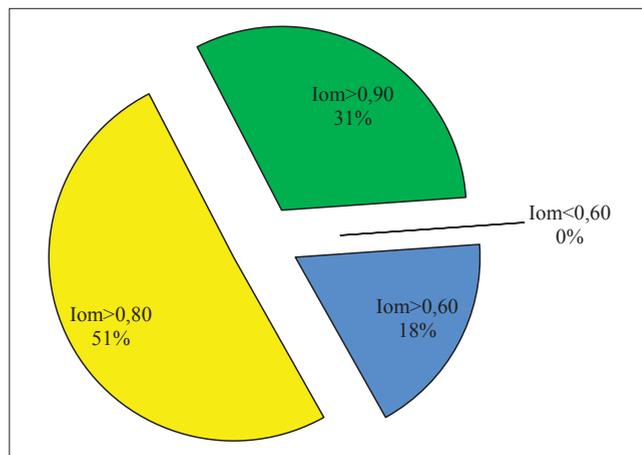
Fig. 1. Index of milking order (*Iom*) - Old herd

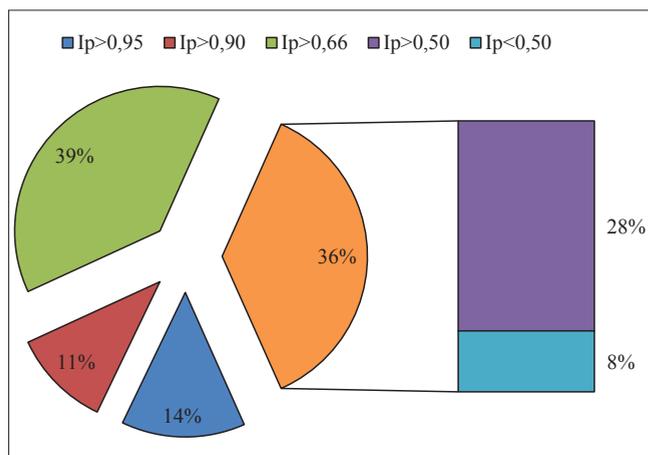**Fig. 3. Index of milking order (*Iom*) - Young herd**

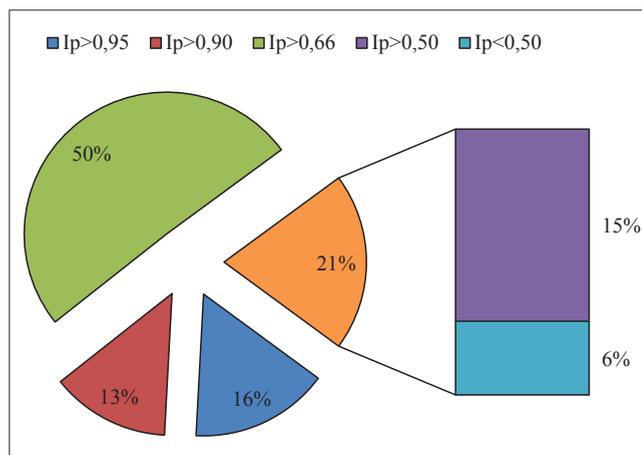**Fig. 2. Index for persistence in using a milking place (*Ip*) - Old herd**

Fig. 4. Index for persistence in using a milking place (*Ip*) - Young herd

2014) and cows (Reinhardt, 1973; Rathore, 1982; Lauwere et al., 1988; Varlyakov, 1989; Hopster et al., 1998; Paranhos da Costa and Broom, 2001; Grasso et al., 2007; Varlyakov et al., 2011; Broucek et al., 2015).

After establishing the order for entering the parlour and the preference to a milking site, we try to answer the question whether this was related to the productivity level and the stage of lactation. We found out four significant values of the correlation coefficient in high-yielding animals from the old herd. Three positive correlations were observed: the strongest (r=0.363) was between milk yield and order for entering the parlour (*Iom*), followed by milk flow rate and the persistence in choosing a milking place (*Ip*) – r=0.306 or *Iom* – r=0.203 and one negative relationship: r=-0.206 between milk yield and *Ip* (Fig. 5).

Figure 5 Parameters: 1 – milk yield (*kg*); 2 – milk flow rate (*kg/min*); 3 – index of persistence in using a milking place (*Ip*); 4 – index of milking order (*Iom*)

The following differences in studied parameters were established (Table 1):

• As age advanced, two opposite trends of within-group variation were present: increase in the amount of milk and milk flow rate and reduction of *Ip* and *Iom*;

• All studied parameters had higher values in the goats from the old herd.

Table 1. Values of studied traits in high-yielding goats

Some of tendencies in the goats from the old herd – high-yielding group, were also preserved in the medium-yielding group (Fig. 6). Positive correlation was found (r=0.419) be-
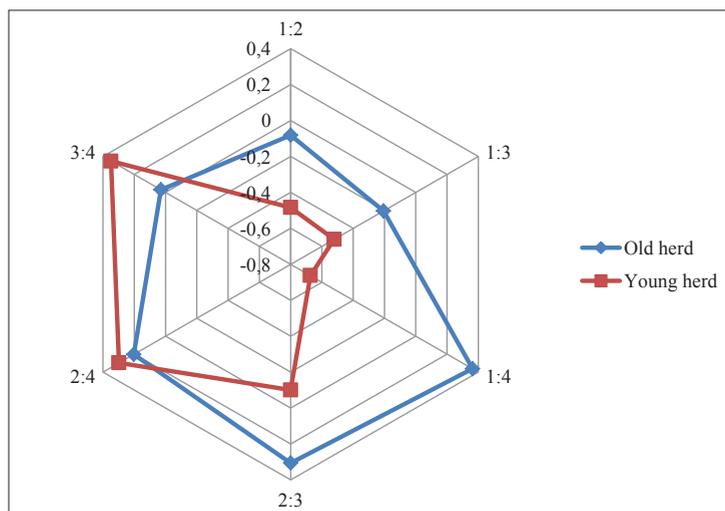
Fig. 5. High-yielding goats - correlation coefficients (r)

Table 1
Values of studied traits in high-yielding goats

		kg	*kg/min*	*Ip*	*Iom*
Old herd	x	1.510***	0.731*	68.27**	81.92
Group 1	SD	0.206	0.178	19.79	26.82
	MIN	1.300	0.473	47.50	31.00
	MAX	1.975	1.099	97.50	127.00
Young herd	x	1.183	0.592	39.92	71.81
Group 4	SD	0.089	0.093	20.54	17.44
	MIN	1.100	0.437	11.00	33.33
	MAX	1.400	0.722	77.00	96.67

Statistical significance level among the groups: * - P<0.05   ** - P<0.01   *** - - P<0.001
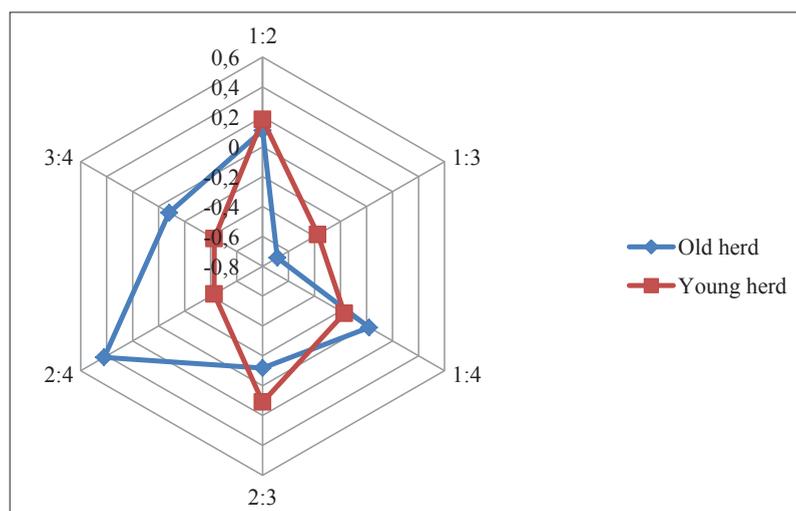

Fig. 6. Medium-yielding goats - correlation coefficients (r)

tween milk flow rate (2) and milking order (4) and a significantly stronger negative relationship (r=-0.687) between 4 and persistence in using a milking place (3). Medium-yielding animals of the young herd showed mainly negative correlations: between 4 and 3 (r=-429), between 4 and 2 (r=-0.427) and between milk yield (1) and 3 (r=-0.375).

Figure 6 Parameters: 1 – milk yield (*kg*); 2 – milk flow rate (*kg/min*); 3 – index of persistence in using a milking place (*Ip*); 4 – index of milking order (*Iom*)

The statistical analysis of the data (Table 2) showed a statistically significant difference (P<0.01) only between average milk yields. Higher milk flow rate and index of persistence in using a milking place (*Ip*) was demonstrated in the old herd as anticipated, and a slightly lower value of the index of milking order (*Iom*).

For the first time, in the groups with low milk yield, we detected a moderate positive correlations between milk yield (1) and milk flow rate (2), r=0.468 in the old and r=0.316 in the young herd (Fig. 7). In the young group with low productivity, all correlations were positive while in the old group with low productivity there were an equal number of positive and negative relationships. In this group, the highest correlation coefficient between parameters 1 and 4 was found out (r=-0.774).

Figure 7 Parameters: 1 – milk yield (*kg*); 2 – milk flow rate (*kg/min*); 3 – index of persistence in using a milking place (*Ip*); 4 – index of milking order (*Iom*)

The average values of all parameters in low-yielding goats from the old herd were higher than those of the young herd (Table 3). Only indices of persistence for using a milking place differed statistically significantly (P<0.05). Here, the

Table 2
Values of studied traits in medium-yielding goats

		kg	kg/min	Ip	Iom
Old herd	x	1.100**	0.521	63.75	73.13
Group 2	SD	0.125	0.140	22.00	26.13
	MIN	0.900	0.338	33.33	36.00
	MAX	1.250	0.685	92.50	99.00
Young herd	x	0.895	0.491	52.80	79.67
Group 5	SD	0.162	0.131	27.70	20.95
	MIN	0.700	0.305	5.00	48.33
	MAX	1.050	0.648	102.00	97.50

Statistical significance level among the groups: ** - P<0.01
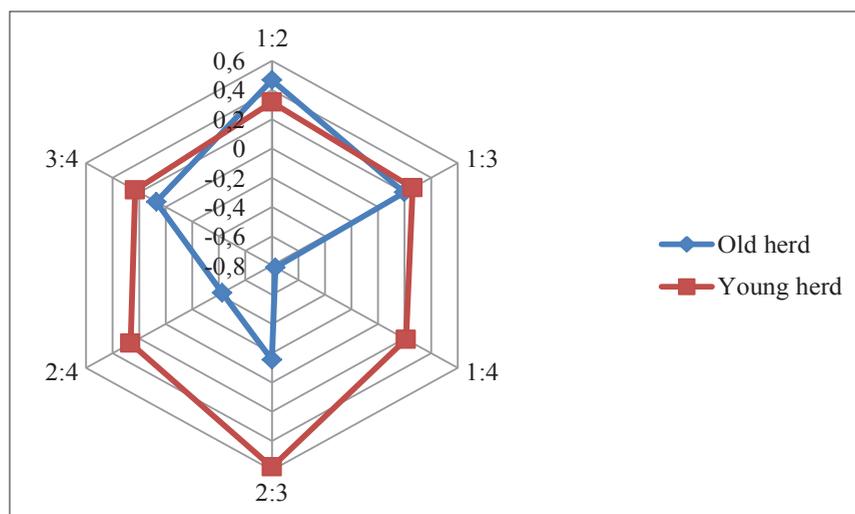
Fig. 7. Low-yielding goats - correlation coefficients (r)

Table 3
Values of studied traits in goats with low productivity

		kg	kg/min	Ip	Iom
Old herd	x	0.648	0.367	71.11*	71.92
Group 3	SD	0.173	0.087	16.02	34.52
	MIN	0.400	0.192	48.33	11.00
	MAX	0.900	0.465	100.00	126.00
Young herd	x	0.540	0.314	58.28	81.39
Group 6	SD	0.130	0.161	20.72	13.71
	MIN	0.300	0.139	35.25	53.33
	MAX	0.750	0.834	92.50	97.50

Statistical significance level among the groups: * - $P<0.05$

indices **Ip** and **Iom** assumed the highest values compared to the other 4 groups.

To our best knowledge, no data have provided a categorical answer as to the effect of productivity of goats on their milking behaviour (Margetínová et al., 2003). Such data are numerous for cows and sheep (Rathore, 1982; Varlyakov, 1989; Dimitrov et al., 1993; Wasilewski, 1999; Paranhos da Costa and Broom, 2001; Grasso et al., 2007; Varlyakov et al., 2011). Hence, this is a convincing reason to continue these studies in the future.

Conclusions

The performed experiments and obtained results allowed assuming convincingly that there was a strict hierarchical order in Saanen goats herd.

The majority of animals built up a reflex to the milking site, which sometimes resulted in technological problems.

The effect of age was stronger than that of milk yield for occupying a given social rank.

The effect of age on the four studied parameters: milk yield, rate of milk flow, persistence in using a milking place and order of entering the parlour was the most pronounced in high-production animals.

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