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Impact of Housing System on Health and Rearing of Calves Based on Examination of Nasal Cavity Swabs

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Authors' Contribution
MS performed zootechnical part of the work, acquired, analyzed and interpreted the data. BCS drafted the manuscript. JK and KF performed microbiological part of the work. ECP obtained funding and supervised the work.

Key words
Calves, Pathogenic bacteria, Opportunistic bacteria, Traditional rearing in a room, Cold rearing.

ABSTRACT

The aim of the study was to analyze calves rearing on the basis of selected parameters of growth in different housing systems with regard to the assessment of microbial flora taken from the nasal cavity of animals. The study was performed on 28 calves of Polish Holstein-Friesian Black-and-White variety (PHF HO). The average weight of calves at the age of three months differed depending on the housing system. Individuals in igloo type booths were heavier as compared to the traditionally reared calves. The differences regarding the final weight of heifer calves were statistically significant ($P \leq 0.05$). In the cold and traditional rearing bulls had a larger mass than heifer calves. In traditional rearing, results of analysis of the swabs from the nasal cavities revealed the presence of pathogenic or opportunistic bacteria at the level of the average number of micro-organisms (11-50 CFU) or high (> 50 CFU), which negatively affected the health of the calves. However, in cold rearing there was recorded absence or presence of microorganisms in the nasal cavity in a small amount (<10 CFU).

INTRODUCTION

The main task of farms specializing in cattle breeding is proper rearing of calves. It gives the basis to ensure that individuals present good health, fertility and longevity in the future, which may occur through the use of adequate nutrition, awareness of the risks, the proper selection of rearing techniques and prevention (Szewczuk *et al*., 2006; Razzaque *et al*., 2009; Avci *et al*., 2017). The most important threat are diseases, which without compliance with welfare rules can contribute to economic losses inhibiting the progress of production on the farm. There have been many experiments analyzing the factors influencing the presented issue (Aslan *et al*., 2002; Arcangioli *et al*., 2008; Lorenz *et al*., 2011; Blanchard, 2012).

The study of microflora present in the nasal cavities of ruminants are of great practical importance for rearing of dairy cattle, as they underline the quality of the conditions in which they live and allow to analyze the various technologies of rearing of calves (Ziebuhr *et al*., 1997; Jarmillo-Arango *et al*., 2007; Seker *et al*., 2009; Mork *et al*., 2012). The microorganism naturally colonize the mucosa in the upper respiratory tract of animals and do not cause disease symptoms. The microbiota consists of both Gram-positive and Gram-negative bacteria. The Gram-positive bacteria are represented by the following genera *Staphylococcus* (70%), *Bacillus* (about 13%), *Micrococcus* (11%), *Streptococcus* and *Corynebacterium*. The most common Gram-negative microorganisms are *Mannheimia* spp. (25%), *Escherichia* spp. (17%), and also *Neisseria* spp., *Pseudomonas* spp., *Moraxella* spp., and *Pasteurella* spp. (Jarmillo-Arango *et al*., 2007; Seker *et al*., 2009). Krysińska-Traczyk (2000) have in addition reported the presence of *Enterobacter* spp., *Proteus* spp., *Salmonella* spp., *Shigella* spp., *Yersinia* spp., *Aerococcus*

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spp., *Lactococcus* spp., *Candida* spp., *Cryptococcus* spp., *Geotrichum* spp., *Saccharomyces* spp. and *Torulopsis* spp., and molds *Aspergillus* spp., *Penicillium* spp., *Fusarium* spp., *Cladosporium* spp., *Alternaria* spp. and *Mucor* spp. in the nasal swab. In the case of an imbalance of bacterial flora or the appearance of opportunistic microorganisms and conditions favorable to their development, diseases can occur. Conducive environmental factors include a lack of hygiene and inadequate conditions for maintenance.

The source of microorganisms in livestock buildings is feed, litter, manure, animals themselves, man and air introduced by the ventilation. Microorganisms mostly create bio-aerosols and through the air colonize all elements of the production environment, such as walls, floor, feed, water and even the surface of the skin of animals (Kołacz and Dobrzański, 2006).

Inadequate composition of the air in calf stables resulting from poor ventilation, high dust and humidity in livestock buildings makes the microbiological contamination of the air determine to a large extent the state of health of livestock. Calves are very sensitive to high concentrations of irritating gases in the air such as sulfur dioxide or ammonia resulting from congestion. These gases significantly impair the functioning of the respiratory system, which ceases to be a barrier to potentially harmless opportunistic bacteria. Too dry air can result in drying of the mucosal surfaces of the respiratory system, which loses its protective properties against pathogens (Verbrugghe *et al*., 2012).

The aim of the study was to determine the effect of different housing systems (cold and traditional rearing) on the growth and microbial flora of the nasal cavity of calves.

MATERIAL AND METHODS

The study was conducted on a farm located in West Pomerania province in 2015 during spring-summer season (from May to August). West Pomerania province is located in the north-western part of Poland. The climate of this region is mild. Average air temperature in the spring-summer season in 2015 was 15.02 Celsius degrees (www.pogodynka.pl). Livestock production was based on breeding of Polish Holstein-Friesian Black-and-White variety (PHF HO). 28 calves were selected for the study, and were divided into two groups of 14 individuals. One group after birth was placed in individual igloo type booths for cold rearing and the other in calf stable for traditional rearing. The weights of calves were recorded at birth and at 90 day of age.

Cold rearing of calves is based on keeping the animals from 12 h of life in individual igloo type booths in the open space or under shelter. Traditional rearing of calves involves placing calves after birth in calf stable. Such spaces designed for rearing calves, their convenience and ease of use. Calves were divided into age groups and their fodder was tailored to their nutritional requirements. Both groups of calves were fed with milk.

The body weight and symptoms of diseases occurring in calves during the period of study such as, respiratory diseases (pneumonia, common cold), gastrointestinal disorders (diarrhea, bezoars), and "other" (mechanical stress, fungal infections of the skin) were regularly monitored. In order to identify threats to the health of the calves coming from the environment, nasal swabs were taken from both the nostrils under sterile conditions and transported to the laboratory in Stuart's medium (Oxoid, UK) at 4° C and analyzed within 24 h. Each swab was inoculated parallel on the Mannitol Salt Agar medium (Oxoid, UK) for *Staphylococcus* spp. identification, the MacConkey Agar medium (Graso, Poland) for *Enterobacteriaceae* identification, the Edward's Agar medium (Graso, Poland) for *Enterococcus* spp. and *Streptococcus* spp. identification and the Sabouraud Agar medium (Graso, Poland) for identification of fungi. All inoculated media were incubated aerobically at 37° C for 24-48 h. Obtained bacterial isolates were Gram stained and catalase activity was determined. The ability to produce coagulase was determined using rabbit plasma (Biomed, Poland).

The results are presented as mean ± SD. The significance of differences was calculated by ANOVA using Duncan's multiple range test, using Statistica®10 PL.

Table I.- The average birth body weight and body weight at the age of 3 months of calves depending on housing system and calf sex.

	n	Body weight (kg)			
		Cold rearing		Traditional rearing	
		Day 0	Day 90	Day 0	Day 90
Bulls	7	38.25± 2.16	105.93± 2.56	38.93± 2.27	103.71± 3.45
Heifers	7	37.93± 1.94	103.86± 2.67*	37.79± 1.76	99.86± 2.91*

*, statistically significant difference at $P \leq 0.05$.

RESULTS AND DISCUSSION

Table I shows weight of calves at the age of three months under two different housing systems. Individuals in booths of igloo type are characterized by a significantly ($P \leq 0.05$) higher body weight compared to the ones reared in the traditional system. In the cold and traditional rearing

bulls had larger mass than heifer calves. It should be emphasized that sex is a factor of the variation of body weight of calves at birth and their subsequent growth. Bulls at birth are usually heavier than heifer calves and grow faster in the postnatal period (Choroszy *et al*., 2003).

Table II shows the microorganism found in the nasal swabs of calves from two different housing system type booths. Fungi and molds were present in 50% of the samples obtained from the calf stable. There was recorded a moderate (11-50 CFU) number of lactose-negative *Enterobacteriaceae* in eight cases and a large number of these microorganisms (> 50 CFU) in three individuals. In the case of six calves the presence of moderate (11-50 CFU) number of coagulase-negative staphylococci was demonstrated, whereas in five cases a large number (> 50 CFU) of these bacteria was shown. In five calves the presence of *Enterococcus* spp. was at moderate level (11-50 CFU) and in six calves at high level (> 50 CFU). In samples collected from animals kept outside the booth, there were no or very low level of *Enterobacteriaceae Enterococcus* spp. and *Staphylococcus* spp. (<10 CFU). There was no occurrence of mold and yeast. Absence of microorganisms in the nasal cavity may indicate too intensive disinfection, but their excess poses a greater threat of the occurrence of diseases.

Cultures of microorganisms were compared with the occurrence of symptoms of disease. Among 85.7% of the calves kept in the building 43% showed gastrointestinal disorders (diarrhea), 21% diseases of respiratory system (coughs, outflow from the nasal cavity) and 14% had skin lesions classified as "other". In animals in the booths only 29% showed disturbing symptoms.

Table II.- Microorganisms isolated from nasal cavity of calves.

Group	*Enterobacteriaceae*		*Staphylococcus* sp.		*Enterococcus* sp.	Yeast
	Lactose (+)	Lactose (-)	Coagulase (+)	Coagulase (-)		
Traditional rearing in a room						
1.	-	++	-	++	+	-
2.	++	++	-	++	+++	-
3.	-	+++	-	+++	+++	-
4.	-	+++	-	+++	++	+
5.	-	+++	++	+	++	+
6.	+	++	++	+	++	+
7.	+	++	-	+++	+	-
8.	-	+	-	++	+++	-
9.	+	++	-	+++	+++	+
10.	+	++	-	+++	++	-
11.	++	++	-	++	+++	+
12.	-	+	-	++	++	-
13.	+	++	-	++	+++	+
14.	-	+	-	+	++	+
Cold rearing						
15.	+	+	+	+	-	-
16.	+	-	+	-	+	-
17.	-	-	+	+	+	-
18.	+	+	-	-	-	-
19.	+	-	-	-	-	-
20.	-	+	-	-	+	-
21.	+	-	-	-	-	-
22.	-	-	-	-	-	-
23.	-	-	-	-	-	-
24.	-	-	-	-	-	-
25.	-	+	-	+	-	-
26.	-	-	-	-	-	-
27.	-	-	-	-	-	-
28.	-	-	-	-	-	-

-, the lack of microorganisms; +, a small number of microorganisms (<10 CFU); ++, moderate number of microorganisms (11 - 50 CFU); +++, large number of microorganisms (> 50 CFU); CFU, colony forming unit (bacterial colony).

Study on the final body weight of calves in the context of the housing system is a disputable issue in the scientific world. Calves in the observed farm had a larger final body mass in cold rearing than in conventional rearing. In the experiment by Adamski *et al*. (2004) calves of the booth are also characterized by intensive growth and development, gained more weight and had a larger chest circumference in comparison to individuals held in the traditional system. This advantage could be caused by higher feed intake of individuals located outside due to higher energy demand associated with the living conditions. Wójcik *et al*. (2012) demonstrated that cold rearing of calves lead to greater health status, as well as greater demand for feed, which resulted in increases in weight of the animals during the period when milk replacer was no longer used. Another study by Wójcik *et al*. (2013) is in favor of the traditional rearing. The older calves kept in calf stables exhibit greater demand for food and, consequently, had the higher body weights. Szewczuk *et al*. (2011) showed that animals in both systems reached similar results with respect to weight gain and growth. It was predicted that the difference may be perceptible at a later age.

Table III.- Percentage distribution of disease symptoms and morbidity in calves, depending on the method of rearing.

Specification	Cold rearing (%)	Traditional rearing in a room (%)
RSD	7	21
ASD	14	43
Others	7	14
Summary	29	85.7

RSD, respiratory system diseases; ASD, alimentary system disease.

Table III shows that for calves kept "outside" had significantly less cases of gastrointestinal diseases (14%) and respiratory diseases (7%) compared to calf stables (43% and 21%). The results were confirmed in the study by Razzaque *et al*. (2009), who also showed that the disease is less frequent when using the cold rearing of calves, especially in relation to diseases of the respiratory tract. Kaczor and Mandecki (2013) and Adamski (2012) have shown that it is desirable to keep the animals out of the barn, *e.g.* in open type rooms, such as individual or group igloo type booths. Limited contact with older cattle makes a calf less vulnerable to infections arising in contact with the immunized adult cattle. Booths are conducive to improving health and strengthening the calf by natural exchange of fresh air and "sunbathing". Lorenz *et al*. (2011) recommend to produce them of fiberglass and to keep calves individually.

Hill *et al*. (2011) conducted an experiment using modernized calf stables and igloo type booths and proved that the conditions in polyethylene booths were less favorable than in the modernized, well-ventilated calf stables with individual pens and deep litter. The booths had elevated temperature and humidity in comparison to modernized calf stable. Results of Nordlund (2008) and Wójcik *et al*. (2013) indicate that the risk of disease occurs in inappropriate microclimate conditions-improper ventilation and humidity, which increases microbial contamination.

Our study shows that the spread of microorganisms is facilitated by environment created in calf stables located near the barn with adult individuals. Jones and Heinrichs (2013) and Maunsell (2015) argue that the presence of large quantities of bacteria is due to inadequate air flow, which may lead to respiratory diseases. Nordlund (2008) examining the content of microorganisms in the air said that in inadequately ventilated barns there may occur 5 times more bacteria that threaten the health. Among them were *Staphylococcus* spp., *Streptococcus* spp., *Bacillus* spp. and *E. coli*. They contribute to respiratory diseases, although they are not specific to this disease. In another experiment Hill *et al*. (2011) confirmed that the concentration of microorganisms in the booths was more favorable.

Our own experience showed that the calves maintained in conventional calf stable with collective pens have a greater tendency to suffer from diarrhea and respiratory symptoms. As it is evident from the analysis, the incidence of disease was significantly lesser with cold rearing, which also took place in the study of Nielsen (2002). This is confirmed by the experiences of Szewczuk and Kamieniecki (2003). Razzaque *et al*. (2010) showed that diarrhea was the most frequent disease, representing 90.6% of calves suffering from diseases. Pathogens included *E. coli*, *Salmonella* spp., *Klebsiella* spp., *Pasturella* spp. and rotaviruses.

In calves with the visible signs of respiratory diseases, on the mucous membranes there were bacteria of the *Enterobacteriaceae* family and *Enterococcus* spp. This indicates that the concentration of microorganisms caused by inadequate zoohygienic conditions can lead to, or predispose for this type of diseases.

CONCLUSION

Based on the research it can be stated that the cold rearing is a suitable housing system for the improvement of health in climate occurring in Poland. Achieved higher body weight favors increasing of resistance in the period of calf's transition to a constant feed and can have a

positive impact on their future productivity. In calves rearing, the basis should be an appropriate nutrition and proper treatments in the first days of life. When choosing a system of housing in the farm, one needs to pay attention to the material from which the booths and equipment are made, and adapted them to the conditions in the area of the farm. It should also be remembered that the determinant of all the action should be the welfare of animal life.

Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

Adamski, M., 2012. Odchów cieląt i jałówek – porady, praktyka [Rearing calves and heifers - tips, practice]. *Trouw i MY*, **2**: 6-9.

Adamski, M., Kupczyński, R. and Zachwieja, A., 2004. Efektywność odchowu cieląt w zależności od systemu utrzymania [The effectiveness of calves rearing depending on the maintenance system]. *Zesz. Nauk. AR Wrocław*, **505**: 19-25.

Arcangioli, M.A., Duet, A., Meyer, G., Dernburg, A., Be´zille, P., Poumarat, P. and Le Grand, D., 2008. The role of *Mycoplasma bovis* in bovine respiratory disease outbreaks in veal calf feedlots. *Vet. J.,* **177**: 89-93. https://doi.org/10.1016/j.tvjl.2007.03.008

Aslan, V., Maden, M., Erganis, O., Birdane, F.M. and Corlu, M., 2002. Clinical efficacy of florfenicol in the treatment of calf respiratory tract infections. *Vet. Quart*., **24**: 35-39. https://doi.org/10.1080/01652176.2002.9695122

Avci, M., Aydin, R. and Kiyici, J.M., 2017. Effects of different ration forms on growth performance and some behavioral traits of Brown Swiss calves. *Pakistan J. Zool.,* **49**: 1429-1435. http://dx.doi.org/10.17582/journal.pjz/2017.49.4.1429.1435

Blanchard, P.C., 2012. Diagnostic of dairy and beef cattle diarrhea. *Vet. Clin. N. Am. Fd. Anim. Pract*., **28**: 443-464. https://doi.org/10.1016/j.cvfa.2012.07.002

Choroszy, B., Czaja, H., Choroszy, Z. and Mazur, M., 2003. Wyniki odchowu cieląt rasy simentalskiej w zależności od sezonu urodzenia [The effectiveness of calves rearing depending on the birth season]. *Zesz. Nauk. Prz. Hod*., **67**: 99-104.

Hill, T.H., Bateman II, H.G., Aldrich, J.M. and Schlotterbeck, R.L., 2011. Comparisons of housing, bedding, and cooling options for dairy calves. *J. Dairy Sci*., **94**: 2138-2146. https://doi.org/10.3168/jds.2010-3841

Jaramillo-Arango, C.J., Hernandez-Castro, R., Suarez-Guemes, F., Martinez-Maya, J.J., Aguilar-Romero, F., Jaramillo-Meza, L. and Trigo, F.J., 2007. Prevalence of *Mannheimia haemolytica* isolated from bovine nasal exudates and associated factors, in dairy farms in the North-Central of Mexico. *J. Anim. Vet. Adv*., **6**: 404-409.

Jones, C. and Heinrichs, J., 2013. *Heat stress in dairy calves.* http://www.extension.psu.edu/animals/dairy/nutrition/calves/feeding/heat-stress-in-dairy-calves/extension_publication_file

Kaczor, A. and Mandecki, A., 2013. Wioska dla cieląt [The village for calves]. *Hodowla i Chów bydła*, **8**: 36-39.

Kołacz, R. and Dobrzański, Z., 2006. *Higiena i dobrostan zwierząt gospodarskich [Hygiene and welfare of livestock]*. Wyd. AWR, Wrocław.

Krysińska-Traczyk, E., 2000. *Grzyby pleśniowe i mikotoksyny jako czynniki narażenia zawodowego [Filamentous fungi and mycotoxins as potential occupational risk factors]*. Instytut Medycyny Wsi, Lublin.

Lorenz, I., Early, B., Gilmore, J., Hogan, I., Kennedy, E. and More, S.J., 2011. Calf health from birth to weaning. III. Housing and management of calf pneumonia. *Ir. Vet. J.,* **64**: 14-23. https://doi.org/10.1186/2046-0481-64-14

Maunsell, F., 2015. *Preventing respiratory disease in dairy calves.* http://acv.com.au/site/wpcontent/uploads/2015/02/2015_Hobart_Proceedings_ebook.pdf#page=234

Mork, T., Jorgensen, H., Sunde, M., Kvitle, B., Sviland, S., Waage, S. and Tollersrud, T., 2012. Persistence of staphylococcal species and genotypes in the bovine udder. *Vet. Microbiol*., **159**: 171-180. https://doi.org/10.1016/j.vetmic.2012.03.034

Nielsen, K.F., 2002. *Moulds growth on building materials. Secondary metabolites, mycotoxins and biomarkers*. PhD Thesis. BioCentrum-DTU, Technical University of Denmark.

Nordlund, K., 2008. Practical considerations for ventilating calf barns in winter. *Vet. Clin. Fd. Anim*., **24**: 41-54. https://doi.org/10.1016/j.cvfa.2007.10.006

Razzaque, M.A., Bedair, M., Abbas, S. and Al-Mutawa, T., 2009. Economic impact of calf mortality and dairy farms in Kuweit. *Pak. Vet. J*., **29**: 97-101.

Seker, E., Kuyucuoglu, Y. and Konak, S., 2009. Bacterial examinations in the nasal cavity of apparently healthy and unhealthy Holstein cattle. *J. Anim. Vet. Adv*., **8**: 2355-2359.

Szewczuk, M., Bogacka, A. and Czerniawska-Piątkowska, E., 2011. Effect of calving season

on the course of parturition and rearing results of polish Holstein-Friesian calves. *Acta Sci. Pol. Zootech*., **10**: 77-88.

Szewczuk, M. and Kamieniecki, H., 2003. Ocena przebiegu wzrostu i rozwoju cieląt w zależności od systemu utrzymania [Effect of housing system and season of birth on the calves rearing results]. *Zesz. Nauk. Prz. Hod*., **69**: 153-158.

Szewczuk, M., Kamieniecki, H., Czerniawska-Piątkowska, E. and Szatkowska, I., 2006. Wpływ sezonu urodzenia na zdrowotność i wyniki odchowu cieląt [Effect of birth season on health and raising performance of calves]. *Acta Sci. Pol. Zootech*., **5**: 119-124.

Verbrugghe, E., Boyen, F., Gaastra, W., Bekhuis, L., Layman, B., Van Parys, A., Haesebrouck, F. and Pasmans, F., 2012. The complex interplay between stress and bacterial infections in animals. *Vet. Microbiol*., **155**: 115-127. https://doi.org/10.1016/j.vetmic.2011.09.012

Wójcik, A., Nałęcz-Tarwacka, T. and Gołębiewski, M., 2012. Effect of housing system and season of birth on the calves rearing results. *Anim. Sci*., **51**: 139-146.

Wójcik, A., Nałęcz-Tarwacka, T. and Gołębiewski, M., 2013. Comparison of calves rearing parameters in two different housing systems: Indoor versus outdoor hutches. *Arch. Tierzucht*, **63**: 628-637.

Ziebhur, W., Heilmann, C., Gotz, F., Meyer, P., Wilms, K., Straube, E. and Hacker, J., 1997. Detection of the intercellular adhesion gene cluster (ica) and phase variation in *Staphylococcus epidermidis* blood culture strains and mucosal isolates. *Infect Immun*., **65**: 890-896.