ISSN 1644-0714
ISSN 2300-6145 (online)
www.asp.zut.edu.pl

Acta Sci. Pol. Zootechnica 14(4) 2015, 141–150

INFLUENCE OF THE EM™ SERIES PROBIOTIC AGENTS ON THE RESULTS OF REARING OF POLISH HOLSTEIN-FRIESIAN CALVES

Małgorzata Szewczuk[1], Piotr Nowik[2], Katarzyna Olejnik[1], Leszek Jędrych[2], Wojciech Kruszyński[3]

[1] West Pomeranian University of Technology, Szczecin, Poland
[2] Cooperative Agrofirma Witkowo, Witkowo, Poland
[3] Wrocław University of Environmental and Life Sciences, Poland

Abstract. The aim of the study was to demonstrate the influence of the Effective Microorganisms (EM™) probiotic agents on the result of calves rearing during the first 6 months of life. The study included 50 Polish Black-and-White Holstein-Friesian (PBWHF) heifers, of which 25 were in the experimental group (EXP) and 25 in the control group (C). Starting on the second day of life the calves received the EM™ Probiotic, firstly added to the colostrum and later to milk. Starting on the 14th day of life the calves received the EM™ – Bokashi Probiotic in the CJ feed. The calves were kept in booths, previously sprayed with EM™ Refresh solution. The calves were weighted after birth as well as in the 30th, 60th, 90th and 180th day of rearing. The obtained data allowed calculation of daily mass gains. Throughout the study there was also health assessment carried out. In each of the rearing stages the mean body masses and daily mass gains were significantly higher in the experimental group (EXP) than in the control group (C). There was no diseases observed in the EXP calves between birth and 6th month of life, whilst digestive system disorders as well as pneumonia were observed in the control group.

Key words: calves, probiotic, health

Corresponding author: Małgorzata Szewczuk, Department of Ruminant Science, West Pomeranian University of Technology, Szczecin, Doktora Judyma 10, 71-460 Szczecin, Poland, e-mail: malgorzata.szewczuk@zut.edu.pl

INTRODUCTION

The rearing period significantly influences calves subsequent productivity. The way of animal maintenance and feeding are directly reflected in mass gains and their health. Any malpractice in this field negatively influences growth and development of calves, extending the rearing period [Macdonald et al. 2005, Uys et al. 2011, Szewczuk et al. 2015] and increasing the cost of maintenance, which often decreases the profitability of a farm [Passille et al. 2008, Gajos 2010]. In order to maintain a farm's productivity on high levels it is important to maintain an appropriate microclimate, watering hygiene and pens' cleanliness. During the first months of life calves' mortality is very high [Lundborg et al. 2003, Pardon et al. 2012, Raboisson et al. 2013]. Apart from the losses caused by birth defects or by delivery problems the most common reason for calves' death is weakened immune system of a newly born animal. Lower immunity favours diarrhoea and lung diseases, which can cause weakening of a young organism, and if untreated it can lead to severe dehydration and fatalities [Pardon et al. 2012, Raboisson et al. 2013]. That is why it is getting more common to supplement animal feed with additives which are supposed to increase the passive immunity and enhance the development of the active immunity [Szewczuk et al. 2011b]. For the same reasons farmers apply various additives to milk replacers and feeds. These include herbal agents [Bombik et al. 2012, Klebaniuk et al. 2013], probiotics [Jatkauskas and Vrotniakiene 2010, Zábranský et al. 2013], prebiotics [Górka and Kowalski 2007, Górka and Kowalski 2008, Szewczuk et al. 2011b, Zábranský et al. 2013] as well as ß-carotene and vitamin A [Kume and Toharma 2001]. A promising trend is also the application of Effective Microorganisms TechnologyTM developed by prof. Teruo Higa from Ryukyus University in Okinawa in early eighties of XX century. The technology uses naturally occurring microorganisms. The intention of the inventor was to propagate the technology in order to ensure health of societies and access to safe and valuable food, as well as environment preservation and restoration of natural environment. Currently the EM Technology is used in 140 countries, which use microorganisms optimal for their ecosystem. Since 2000 Greenland Technologia Sp. z o.o. company is the official distributor of EM RESEARCH ORGANIZATION (Japan) in Poland. Currently the EM agents are used in various industries: farming, gardening, animal breeding, medicine, industry, building, food processing and environment preservation [Paśmionka and Kotarba 2015]. They are also used in bovine production. Adding the EM^{TM} agents to milk and later to feed may improve the functioning of a young organism by introduction of beneficial microorganisms into digestive system, where they enhance production of appropriate microflora in case of lowered immunity, metabolism disorders and during antibiotic treatments [Baranowski 2004]. For comprehensive protection of young animals the best effects are observed during ap-

plication of Effective MicroorganismsTM as hydrates (water, colostrum, milk), in feed and as solution for spraying the place of rearing. The aim of the study was to demonstrate the influence of the Effective Microorganisms (EM™) probiotic agents on the result of calves rearing during the first 6 months of life.

MATERIAL AND METHODS

The experiment was conducted in one of the farms belonging to a production cooperative in Zachodniopomorskie district. The research material included Polish Black-and-White Holstein-Friesian (PBWHF) heifers aged from birth to 6th month of rearing.

After birth the calves received colostrum from buckets with teats. Initially the calves received approximately 1 liter of colostrum four times a day. The dose was gradually increased and in 3–5th day the calves received 2–2.5 l three times a day. From 6–7th day until 3rd month of rearing the calves received 2 l of milk replacer twice a day. From 2nd month of life the calves received corn ensilage (0.5 kg/individual per day) and CJ feed (200 g/individual per day). From 2nd month the heifers received hay as well as TMR (Total Mixed Ration) three times a day (corn ensilage – 4 kg, lucerne – 0.5 kg, CJ feed – 2 kg / individual per day). Additionally, the calves had free access to water. Starting on the second day of life the calves received the EM™ Probiotic (Greenland Technologia EM, Trzcianki, Poland), firstly added to the colostrum and later to milk (10 ml twice a day). Staring on the 14th day of life the calves received the EM™ – Bokashi Probiotic (Greenland Technologia EM, Trzcianki, Poland) in the CJ feed (10 ml per individual). EM Bokashi Probiotic is a modern form of EM™ probiotic based on bran. It stabilises microflora in alimentary canal, which is responsible for good digestion, stimulates immunity and prevents development of pathogenic bacteria. It is easy to use due to powdery texture. The probiotic in such doses was applied until 6th month of life. An important element of the experiment was to prepare wooden booths for cold calf rearing. Before the calves' introduction the booths as well as separating fences were gradually whitewashed with lime starting in March. The booths were disinfected with 0.1% Despadac solution and additionally the booths and hay was sprayed with EM™ Refresh (Greenland Technologia EM, Trzcianki, Poland) (2 l of the agent in 5 l water). After Despadac application there was 24 h grace period administered. The heifers were kept in individual booths until the 3rd month of life and afterwards they were moved to collective pens. The booths were positioned on concrete ground with 3 cm slope. The booths were everyday cleaned and sprayed with EM™ Refresh, new hay was also placed in the booths.

The experiment included 50 subsequently born heifers, which were divided into two groups, 25 individuals in each (excluding calves from twin pregnancies):

a control group (C) and an experimental group (EXP). Only the animals in the EXP group received the EM^{TM} probiotic / EM^{TM} Bokashi Probiotic and the place of their rearing was sprayed with EM^{TM} Refresh.

The calves were weighted after birth as well as in the 30, 60, 90 and 180th day of rearing. The obtained data allowed calculation of daily mass gains for the periods: birth – 1st month, birth – 2nd month, birth – 3rd month, and birth – 6th month. Throughout the study there was health assessment carried out based on staff and veterinarian observations. The data was processed statistically using the Statistica 10.0. PL [StatSoft, Inc. 2011]. Processing included mean values ($\bar{x}$), standard variation (SD) and variance (V) calculatios. The mean body masses and daily mass gains were compared using the Student *t*-test.

RESULTS AND DISCUSSION

Mean body masses of calves after birth in both analysed groups were similar (Table 1). Comparable results were obtained by Stenzel et al. [1999] in their study over application of herbs in animal feeding, as well as studies by Szewczuk et al. [2011b] on calves receiving Cotosan® colostrum agent. In the subsequent months the calves receiving EM^{TM} probiotics had higher body mass gains compared to the heifers of the same age in the control group in analogical periods of life. Statistically significant differences ($P \leq 0.01$) were observed in 1st, 3rd and 6th month of animals' life (Table 1).

Table 1. Mean body weight (kg) and daily weight gains (kg) during calf rearing

Tabela 1. Średnie masy ciała (kg) oraz przyrosty dobowe cieląt (g) w okresie ich odchowu

Group – Grupa	Parameters Parametry	Body weight, kg – Masa ciała, kg					Daily gains, g – Przyrosty dzienne, g			
		months – miesiące					periods – w okresie			
		U	1	2	3	6	U-1	U-2	U-3	U-6
Control (C) Kontrolna (K)	$\bar{x}$	31.2	49.2**	75.7	104.2**	194.4**	601**	742	811**	907**
	SD	1.98	6.78	7.62	8.30	12.66	242.5	135.7	96.5	69.6
	V%	6.34	13.78	10.06	7.97	6.51	40.34	18.3	11.9	7.7
Experimental (EXP) Doświadczalna (D)	$\bar{x}$	31.6	58.2**	76.4	128.3**	205.5**	886**	746	1074**	966**
	SD	2.29	5.82	8.58	17.08	15.27	216.0	143.15	193.8	84.5
	V%	7.25	10.01	11.23	13.31	7.43	24.4	19.18	18.0	8.8

$\bar{x}$ – mean; SD – standard deviation; V% – coefficient of variation; U – birth; 1…6 – months; ** – statistically significant differences $P \leq 0.01$.

$\bar{x}$ – średnia; SD – odchylenie standardowe; V% – współczynnik zmienności; U – urodzenie; 1…6 – miesiące; ** – różnice istotne statystycznie $P \leq 0,01$.

In the 1st month of life the control heifers were 9 kg lighter than the heifers in the experimental group (58.2 kg) ($P \leq 0.01$). In the research by Szulc et al.

[1992] the masses of the calves receiving the Biogen B and Biogen N probiotics were similar to those of the control group (C). The calves in experimental group had masses close to those fed with herb mixtures in the study of Kraszewski et al. [2002] as well as to those of four birth seasons in the study by Szewczuk et al. [2011a].

In the 3rd month of life the highest body masses (128.3 kg) were also achieved by the animals in the experimental group ($P \leq 0.01$). The obtained values were close to those presented by Bilik et al. [2013] in the study concerning calf rearing optimalisation according to organic farming conditions (in the group of calves fed with colostrum ad libitum and later with mother's milk – from 5th to 42nd day of life). Doroszewski et al. [1999] conducted a study concerning Fructin Plus® agent use in calves' feeding where they observed lower body masses in the experimental group (112.6 kg) compared to masses of the calves supplemented with EM^{TM} probiotic in the named study.

In the subsequent months the heifers in the EXP group had higher mass gains and in the 6th month of life they achieved body mass of 205.5 kg. 6 months old heifers in the EXP group were heavier (+11.1 kg) than the calves of the same age in the control group ($P \leq 0.01$). Bilik et al. [2006] replaced whole milk with the PRO-MILK replacer in the 2nd week of life and they observed significantly lower mean body masses in the 6 month old calves (180 g).

Higher body masses of heifers in the EXP group in the analysed period were reflected in increased mass gains. The mean daily gains after the 1st month of life were higher in the calved supplemented with the EM^{TM} probiotic ($P \leq 0.01$). In the period from birth to 3rd month of life the body mass gains were also higher in the EXP group ($P \leq 0.01$). The mean body mass gains for the whole experimental period in the EXP group came to 966 g and in the control group – 907 g. The differences were statistically significant ($P \leq 0.01$). Such tendencies were maintained until 6th month of calves' life. The results obtained during the entire experimental period are similar to those presented by Strzelski et al. [2001]. Significantly lower body mass gains (660 g) were observed by Bilik et al. [2011] in their study concerning calves' rearing in an organic farm.

In the period from birth to 1st month of life mass gains of the calves in the control group were lower than in the study by Szewczuk et al. [2011b], where the calves received a probiotic agent in milk (679 g). The gains were also lower in the study by Kraszewski et al. [2002] who applied herb mixtures (667 g), whilst in the studies by Bilik et al. [2011] and Szewczuk et al. [2006] the calves achieved significantly higher gains around 30th day of rearing (695 g and 691 g, respectively). Compared to above results, the EXP group achieved significantly high mass gains (+200 g).

Statistically significant differences ($P \leq 0.01$) were observed in the period from birth to 90th day of live between body mass gains in the experimental group and the control groups. The calves in the experimental group gained on average 1074 g a day, whilst the calves in the control group – only 811 g. Significantly lower gains in the analogical life periods were reported by Bilik et al. [2006] (692 g) and Niwińska et al. [2011] (581 g). Probably such high gains achieved by the calves in the EXP group in the 1st three months of life were linked to their health. This period is considered the most important for calves' development, as then the animals are exposed to viral and bacterial infections causing diarrhoea and therefore loss of body mass [Szewczuk et al. 2011b]. In this group there was no disorders observed in neither digestive system (diarrhoea) nor breathing system. The calves were healthy, they did not show apathy and ate eagerly. In the control group however, there were incidents of diarrhoea (5 individuals) late in the milk feeding period and during withdrawal (2nd–3rd month). The transition from liquid to solid feed was not tolerated well by the calves in this group, which may have been caused by not sufficiently developed digestive system and poor microflora of forestomach. In the control group there were cases recorded of breathing system disorders (two incidents of pneumonia). The calves were weak and did not tolerate the weather conditions well. It could have negatively influenced the mass gains during the study period. The manure and faeces of the calves supplemented with EM^{TM} probiotics and for which the bedding was sprayed with EM^{TM} Refresh were also observed. It was noticed that after few days of storage (2–3 days) the manure was already fermented and suitable for crops fertilisation (information from staff). The manure neither rotted nor smelled unpleasantly. Due to inhibited decay later on flies were not attracted and thus it created good zootechnic conditions as well as working conditions.

CONCLUSIONS

During the entire experiment it was possible to observe benefits of adding EM^{TM} probiotic to colostrum and milk replacer as well as of adding EM^{TM} Bokashi Probiotic to young animal's feed. In each of the rearing period mean body masses and daily gains were significantly higher in the experimental group than in the control group. The calves in the experimental group had 5% higher mean body masses in the final period of rearing and 6% higher daily mass gains in the period from birth to 6th month of life than the animals in the control group. Also there were no diseases observed in the EXP calves from birth to 6th month of life, whilst in the control group the calves had digestive system disorders (with diarrhoea) as well as pneumonia with characteristic persistent coughing. At the current stage it can only be estimated that the addition of EM™ probiotic may

positively influence growth and development of calves and additional bedding spraying with EMTH Refresh agent improves their health and creates possibilities for manure use for fertilisation of neighbouring fields.

REFERENCES

Baranowski, A. (2004). Preparat „Efektywne Mikroorganizmy" (EM^{TM}) – próby zastosowania w rolnictwie [The Effective Microorganisms preparation – attempts at using in agriculture]. Prz. Hod., 4, 26–27 [in Polish].

Bilik K. (2006). Pierwsze pasze dla cieląt [The first feed for calves]. Hod. Byd., 9, 18–25 [in Polish].

Bilik, K., Łopuszańska-Rusek, M., Fijał, J. (2011). Odchów cieląt ras mlecznych według zasad ekologicznych z uwzględnieniem badań Instytutu Zootechniki PIB [Rearing of dairy breed calves according to organic principles with reference to studies at the National Research Institute of Animal Production]. Wiad. Zootech., 1, 131–147 [in Polish].

Bilik, K., Niwińska, B., Łopuszańska-Rusek, M., Fijał J. (2013). Optimization of rearing dairy breed calves according to organic principles. Ann. Anim. Sci., 13(2), 341–355.

Bombik, T., Bombik, E., Frankowska, A., Trawińska, B., Saba, L. (2012). Effect of herbal extracts on some haematological parameters of calves during rearing. Bull. Vet. Inst. Pulawy, 56, 655–658.

Doroszewski, P., Podkówka, Z. (1999). Preparat Fructin Plus w żywieniu cieląt [Preparation Fructin plus in nourishment of calves]. Chów Bydła, 9, 9–10 [in Polish].

Gajos, E. (2010). Dobrostan bydła mlecznego – implikacje ekonomiczne [Economic aspects of dairy cattle welfare norms]. Zesz. Nauk. SGGW, Ekon.Org. Gosp. Żywn., 84, 123–131 [in Polish].

Górka, P., Kowalski, Z. (2007). Preparaty mlekozastępcze w odchowie cieląt ras mlecznych [Milk substitutes for dairy calves]. Med. Weter., 63, 1296–1299 [in Polish].

Górka, P., Kowalski, Z. (2008). Pasze stałe w odchowie cieląt ras mlecznych [Solid feed for dairy calves]. Med. Weter., 64(12), 1384–1388 [in Polish].

Jatkauskas, J., Vrotniakiene, V. (2010). Effects of probiotic dietary supplementation on diarrhoea patterns, faecal microbiota and performance of early weaned calves. Veter. Med., 55(10), 494–503.

Klebaniuk, R., Grela, E.R., Kowalczuk-Vasilev, E., Florek, M., Góźdź, J., Pecka, S., Danek-Majewska, A., Olcha, M. (2013). Ochrona zdrowia zwierząt. Wpływ ekologicznych dodatków ziołowych w żywieniu zwierząt, w tym ryb, na ich zdrowotność z uwzględnieniem efektów produkcyjnych [Animal health protection. The effect of organic herbal additives in animal nutrition, including fish, on their health and productivity]. http://www.up.lublin.pl/files/biologia/Struktura/01zywienie/raport_koncowy_2-013.pdf; date of access: 25.09.2015 [in Polish].

Kraszewski, J., Wawrzyńczak, S., Wawrzyński, M. (2002). Odchów cieląt żywionych dawkami z różnym udziałem mieszanki ziołowej [Rearing of calves fed diets with a different proportion of herbal mix.]. Rocz. Nauk. Zootech., 29(1), 145–154 [in Polish].

Kume, S., Toharma, T. (2001). Effect of colostral β-carotene and vitamin A on vitamin and health status of newborn calves. Live. Prod. Sci., 68, 61–65.

Lundborg, G.K., Oltenacu, P.A., Maison, D.O., Svensson, E.C., Liberg, P.G.A. (2003). Dam-related effects on heart girth at birth, morbidity and growth rate from birth to 90 days of age in Swedish dairy calves. Prev. Veter. Med., 60, 175–190.

Macdonald, K.A., Penno, J.W., Bryant, A.M., Roche, J.R. (2005). Effect of Feeding Level Pre- and Post-Puberty and Body Weight at First Calving on Growth, Milk Production, and Fertility in Grazing Dairy Cows. J. Dairy Sci., 88(9), 3363–3375.

Niwińska, B., Hanczakowska, E., Węglarzy, K. (2011). Efektywność wychowu cieląt otrzymujących pasze wzbogacone w glutaminę, glukozę lub maślan sodu [The effectiveness of rearing calves receiving diets enriched with glutamine, glucose or sodium butyrate]. Rocz. Nauk. Zootech., 38(1), 61–72 [in Polish].

Pardon, B., De Bleecker, K., Hostess, M., Callens, J., Dewulf, J., Deprez, P. (2012). Longitudinal study on morbidity and mortality in white veal calves in Belgium. BMC Vet. Res., 8, 26.

Passillé, A.M., Marnet, P.G., Lapierre, H., Rushen, J. (2008). Effects of twice-daily nursing on milk ejection and milk yield during nursing and milking in dairy cows. J. Dairy Sci., 91, 1416–1422.

Paśmionka, I., Kotarba, K. (2015). Możliwości wykorzystania efektywnych mikroorganizmów w ochronie środowiska [Possibile application of Effective Microorganisms in environmental protection]. Kosmos. Probl. Nauk Biol. PTP im. M. Kopernika, 1, 306, 173–184 [in Polish].

Raboisson, D., Delor, F., Cahuzac, E., Gendre, C., Sans, P., Allaire, G. (2013). Perinatal, neonatal, and rearing period mortality of dairy calves and replacement heifers in France. J. Dairy Sci., 96, 2913–2924.

StatSoft, Inc. 2011. Statistica (data analysis software system). Version 10.PL.

Stenzel, R., Wideński, F., Saba, L., Chabuz, W. (1999). Wpływ mieszanek ziołowych na wzrost, rozwój i termin zacielenia jałówek [Herb mixtures onto height, development and deadline of heifers]. Zesz. Nauk. PTZ Prz. Hod., 44, 491–498 [in Polish].

Strzetelski, J., Niwińska, B., Maciaszek, K. (2001). Wpływ źródła białka w paszy płynnej i postaci fizycznej mieszanki treściwej, skarmianej w okresie pojenia cieląt mlekiem lub preparatami mlekozastępczymi, na wyniki ich odchowu [The effect of a protein source in liquid feed and the physical form of a concentrate mixture fed to calves given milk or milk replacers on calf rearing results]. Rocz. Nauk. Zootech., 28(2), 143–152 [in Polish].

Szewczuk, M., Bogacka, A., Czerniawska-Piątkowska, E. (2011a). Effect of calving season on the course of parturition and rearing results of polish Holstein-Friesian calves. Acta Sci. Pol., Zootechnica, 10(2), 77–88.

Szewczuk, M., Czerniawska-Piątkowska, E., Palewski, S. (2011b). The effect of colostral supplement on the serum protein fractions, health status and growth of calves. Arch. Tierz., 54, 115–126.

Szewczuk, M., Kamieniecki, H., Czerniawska-Piątkowska, E., 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., Zootechnica, 5 (2), 119–124 [in Polish].

Szewczuk, M. Turek, K., Sablik, P. (2015). Analysis of the growth and development of Holstein-Friesian and Simmental calves held in an "igloo"type hutches. Acta Sci. Pol. Zootechnica, 14(1), 127–136.

Szulc, T., Zachwieja, A., Gawliczg, B. (1992). Probiotyki Biogen N i Biogen B w żywieniu krów i cieląt [Probiotics Biogen N and Biogen B in the diet of cows and calves]. Przeg. Hod., 8, 12–15. [in Polish].

Uys, J.L., Lourens, D.C., Thompson, P.N. (2011). The effect of unrestricted milk feeding on the growth and health of Jersey calves. J. S. Afr. Vet. Assoc., 82(1), 47–52.

Zábranský, L., Šoch, M., Novák, P., Brouček, J., Šimková A., Švejdová, K., Čermák, B., Jirotková, D., Pálka W. (2013). Utilization possibilities of prebiotics and probiotics in prevention and health care of calves. Acta Univ. Cibiniensis, Food Technol., 2, 121––127.

WPŁYW STOSOWANIA PREPARATÓW PROBIOTYCZNYCH Z SERII EM^{TM} PROBIOTYK NA WYNIKI ODCHOWU CIELĄT RASY POLSKIEJ HOLSZTYŃSKO-FRYZYJSKIEJ ODMIANY CZARNO-BIAŁEJ

Streszczenie. Celem pracy było wykazanie wpływu stosowania preparatów probiotycznych „Efektywne Mikroorganizmy" (EM^{TM}) na wyniki odchowu cieląt w pierwszych 6 miesiącach odchowu. Badaniami objęto 50 jałówek rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej, w tym 25 w grupie doświadczalnej (D) i 25 w grupie kontrolnej (K). Od 2 dnia życia cielęta otrzymywały EM^{TM} Probiotyk początkowo do siary, następnie do mleka. Od 14 dnia cielętom podawano EM^{TM} – Bokashi Probiotyk do paszy treściwej CJ. Cielęta przebywały w budkach, które przed ich wprowadzeniem opryskiwano roztworem EM^{TM} Refresh. Cielęta ważono po urodzeniu, w 30, 60, 90 i 180 dniu odchowu, a na podstawie uzyskanych wyników obliczono przyrosty dobowe. Prowadzono ocenę zdrowotności. Na każdym etapie odchowu średnie masy ciała oraz przyrosty dobowe cieląt z grupy doświadczalnej były znacząco większe od średnich wartości uzyskanych w grupie kontrolnej. Zaobserwowano, że cielęta z grupy (D) od urodzenia do 6 miesiąca życia nie chorowały, podczas gdy u cieląt z grupy kontrolnej stwierdzono schorzenia układu pokarmowego oraz zapalenia płuc.

Słowa kluczowe: cielęta, probiotyk, zdrowotność

Accepted for print: 11.12.2015

For citation: Szewczuk, M., Nowik, P., Olejnik, K., Jędrych, L., Kruszyński, W. (2015). Influence of the EM^{TM} series probiotic agents on the results of rearing of Polish Holstein-Friesian calves. Acta Sci. Pol. Zootechnica, 14(4), 141–150.