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IMPACT OF INULIN ON CALVES' GROWTH AND POSSIBLE REDUCTION OF GREENHOUSE GAS EMISSION

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ABSTRACT

To reduce greenhouse gas emission (GGE) researchers propose to shorten the period of breeding calves of dairy breeds (Mirzaei-Aghsaghali et al., 2015, Fao, 2010). However, producers try to prolong the time of rising animals in order to get more valuable production. The aim of this research was to determine the impact of different dosages of inulin concentrate (50%) produced in Latvia by using special technologies on calves' health, amount of obtained production and to evaluate possible reduction of GGE. Research has been supported by the National research programme AgroBioRes (2014-2017).Four week old clinically healthy *Holstein Friesian* calves which were kept in barn in individual cages were included in this research. Ten were in control group (CoG) and thirty were fed with additional flour supplement (groups: Pre6 (n=10), Pre12 (n=10), Pre24 (n=10)) until the groups' median weight was above 90kg. We found out that inulin supplement reduced the cases of diarrhoea especially in Pre12 (P=95%) less than in CoG. Also, the overall health condition in Pre12 was the most stable. The best rate of live weight showed calves from Pre12 and Pre24, the desired weight was exceeded on 42nd test day (median increase rate respectively 0.85 kg/day and 0.95 kg/day). Pre6 reached that goal on day 56 (0.76 kg/day), CoG only on 70 (0.55 kg/day). Conclusion: the optimal dose of that supplement for speeding up the growth rate is 12g which can stabilize the health and reduce breeding time. Besides shortening breeding time minimum to 3 weeks (i.e. 17%), GGE can be reduced too.

Keywords: *calf,inulin, greenhouse gas emission, live weight.*

INTRODUCTION

Climate changes come along with new challenges that are actual in agricultural production both in Latvia and the whole world. After regaining the independence Latvia takes active part in reducing negative climate changes in the world. However since year 2005 due to raise of economic activities in Latvia the GGE in agriculture sector is with progressive tendency furthermore agriculture sector is the second largest source of GGE, creating 21.5% of all GGE in the country. According to collected GGE data about the situation in Latvia in agriculture sector, the main sources of GGE are: 1) from processing agricultural land and from soil nitric oxide (N_2O); 2) from ruminant digestive tract where methane (CH_4) is produced due to biologic food processing and fermentative processes; 3) methane (CH_4) and nitric oxide (N_2O) production from manure management. In addition, ruminants, mostly cattle in year 2013 were the main cause of all GGE in agriculture sector (35%). It is due to ruminant morphofunctional particularities and methanogenic bacteria in digestive tract. Studies reveal that for reducing GGE specific methane inhibitor 3NOP (3-nitrooxypropanol) can be used. Significantly, feed intake, fiber digestibility and milk production by cows that consumed the supplement did not decrease. Author also noticed the increase in milk protein and lactose. The emitted methane reduced by 30% (Hristovet al., 2015). In other studies researchers reached the methane reduction by 20%, at the same time the weight gain increased by additional 75g/day and milk yield increased by 1l/day in dairy cattle (McGinn,Beauchemin, 2009). It means that with significant reduction of CH_4 emission the animal productivity can improve but we need to find out the optimal feeding recipe which will be compatible with conditions and available food sources in Latvia, taking into account economic factors and obtained production. The other way to decrease GGE is to reduce to raisedairy cattle for meat purpose. Therefore it is advised to slaughter those claves which are not used for heard reproduction before they have become full ruminants respectively before the emission of the gases from the rumen (basically greenhouse gas emission) into surrounding environment has not significantly risen.However producers try to prolong the time of rising animals in order to get more valuable production from one animal. We consider that shorter animal rising time can be achieved by making corrections in animal feeding strategy and by using natural food supplements which can promote to use the animal interior body reserves.The aim of this research was to determine the impact of different dosages of prebiotics inulin concentrate on calves' health, amount of obtained production and to evaluate possible reduction of GGE.

MATERIALS AND METHODS

Four week old clinically healthy dairy breed (*Holstein Friesian*) calves which were kept in barn in individual cages were included in this research. All calves after birth within 30 minutes got 2 litres of colostrum, later on they were fed with up to 6 litres of whole milk (depending on age of calves'). At the beginning of this research each calf was clinically exanimated. Only clinically healthy, 23+/-5 days' old calves weighting 50kg +/- were included in this research.

Ten calves were in control group (CoG) (n=10), and thirty calves were fed with additional prebiotic - specially produced flour of Jerusalem artichoke, organized in groups Pre6 (n=10), Pre12 (n=10) and Pre24 (n=10) until the groups' median weight was above 90 kg. Calves' from group Pre6 were fed with additional 6g flour of Jerusalem artichoke (containing 3g of inulin), group Pre12 – 12g of this flour (containing 6g of inulin) and Pre 24 – 24g of prebiotic flour (containing 12g of inulin). Prebiotic was added to milk. The study included prebiotics inulin concentrate flour of Jerusalem artichoke (50%) produced in Latvia by using special technologies on calves' health, amount of obtained production and to evaluate possible reduction of GGE. Usually flour of Jerusalem artichoke contains 10% of inulin, but it is possible to increase its amount up to 48.5%-50% by using special technologies. (Fleming et al., 1979; Valdovska et al., 2012)

All calves had free access to water and hay and starting from the second week of the research they also got fodder.

Each day we evaluated health status of all calves, paying more attention to faecal consistency. It was evaluated in scores 0-3, were 0 was solid faeces but 3 was watery faeces. (Larson et al., 1977).

During the research, every other week (respectively 4., 6., 8., 10. week old) we determined animal weight and performed additional clinical examination (respiratory rate, heart rate, body temperature). To analyse all data we used computer program MsExcel.

RESULTS AND DISCUSSION

Every other week additional clinical examination was performed. We did not find any statistically significant changes in body temperature, respiratory rate and heart rate; all results were in normal physiological range (Table 1).

Table 1. Heart rate, respiratory rate and temperature of all groups.

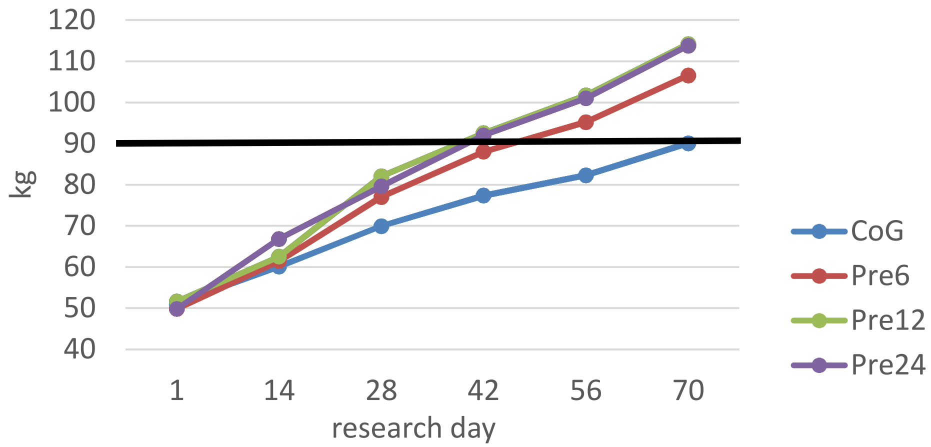
Groups	**Heart rate x/min ±SN**	**Respiratory rate x/min ± SN**	**T^0 ± SN**
CoG	124±16.76	31.3±2.19	39.20±0.87
Pre6	113±10.48	25.75±7	38.81±0.61
Pre12	108±12.00	31.2±3.35	39.02±0.62
Pre24	112.3±10.37	23.8±4.72	38.04±0.38
Normal values (Mohra et al., 2002)	86-125	15-40	38.0-39.5

We found out that inulin supplement reduced the cases of diarrhoea especially in group Pre12 (significantly (P=95%) less than in CoG). Also, the overall health condition (physiological parameters) in Pre12 was the most stable.

Every day the consistency of faeces was evaluated in scores 0-3 (Larson et al., 1977). It should be noted that watery faeces (score 3) we did not notice during this research. The median score during first two weeks of the research was 0.5, later it increased to 0.8 but faeces of seven weeks old calves' got more liquid-like (score 1.47). This could be due to adding fodder to feed.

Comparing CoG to groups Pre6 and Pre 12, faeces of CoG calves' were more watery that normal till week 10 but consistency of faeces of CoG calves' was scored 0.7 and for group Pre24 – scored 0.4. At week 12 consistency of faeces of all groups was close to score 0. This could be because at this age calves eat more

hay and during first 12 weeks of age bacteria grow very rapidly (Yutaka U. et al., 2015) and it provides the stabilisation of gastrointestinal activity.
As it was expected, digestive channel disorders had significant impact on animal live weight increase. Calves fed with inulin supplement showed higher live weight increase than animals from control group (Picture 1).



Picture 1. Live weight increase of calves during the research

On the first day of the research median weight of all calves was without relevant differences. It should be like this because we chose all animal groups with similar age and body weight. On 28th day of the research median weight of CoG calves was already significantly lower than median weight of groups Pre6 and Pre12 (P=95%) and Pre24 (P=99%) (respectively 69.9±7.33 and 77±1.1; 82.0±6.56; 79.6±1.14). At the end of the research on day 56 this difference between CoG and other groups became even greater (P=99%). This significant difference remained till the end of the research.
The best rate of live weight showed calves from groups Pre12 and Pre24, the desired weight of 90kg was exceeded on day 42nd (respectively 92.5± 3.87kg and 92±1.58 kg). Group Pre6 reached that goal on day 56 (95.2±1.92 kg), but group CoG only on day 70 of this research (90.1±4.54 kg).On the Table 2 we can see the average weight gain and standard deviation of each group at 1st and 70th day of research, live weight gain comparing 1st and 70th day of research and average daily body weight gains.

Table 2. Calf growth performance

Groups	Average weight (kg) 1st research day	Average weight (kg) 70th research day	Live weight gains (kg), 1st -70th research day	Average daily body weight gains (kg/d)	Results of T-test comparing Pre with CoG on 70th research day (p value)
CoG	51.1±3.08	90.1±4.54	39.0±7.13	0.55±0.15	-
Pre6	49.8±0.75	106.6±6.23	56.8±3.47	0.76±0.09	0.000225
Pre12	52.0±2.31	114.2±6.87	62.2±6.39	0.85±0.11	0.0001163
Pre24	49.8±0.75	113.8±5.71	64.0±4.29	0.95±0.09	0.0000714

Average daily body weight gain shows that in CoG it was the lowest – only 0.55±0.15 kg/d. Significantly higher it was noticed in groups fed with additional inulin supplement, respectively Pre6 0.76±0.09, Pre12 0.85±0.11 and the highest average daily body weight gain was in Pre24 - 0.95±0.09 kg/d (Table 2). But is it sufficient to be significantly higher? Results of T-test show that calves of Pre6 fed with 6g of prebiotics did not give significantly higher life weight gain comparing to Pre12 (12g of prebiotics) and Pre24 (24g of prebiotics). Calves from Pre24 showed the best average weight gain during 70 research days (64.0±4.09 kg), but this gain was not significantly higher than in Pre12 (62.2±6.39 kg). Our results show that double dose of prebiotics do not give significantly higher body weight gain.

There have been lot of researches about prebiotic impact on reducing GGE. The prebiotics or oligosaccharides are used in rumen manipulation along with nitrate, probiotics and yeast and had potential to reduce methane production. They are speculated to enhance the propionate production by stimulating *Selenomonas, Succinomonas* and *Megasphera* with simultaneous inhibition of acetate producers such as *Rumininococcus, Butyrivibrio* (Mwenyaet al., 2004). Administration of galacto-oligosaccharides (GOS) supplementation decreased nitrite accumulation in rumen and plasma and nitrate-induced methemoglobin, while retaining low methane production. 11% reduction in methane emission (liters/day) in GOS supplemented diet compared to control diet has been reported (Zhou et al., 2004).

Another research also indicates that GOS are efficacious in reducing methane production in dairy cows. Supplementation of dairy cows with GOS resulted in an 11% reduction in methane production (Charalampopoulos and Rastall, 2009). The use of probiotics or the stimulation of rumen microbial populations capable to decrease CH4 emissions remains a potentially interesting approach.

To reduce greenhouse gas emission (GGE) researchers propose to shorten the period of breeding calves of dairy breeds (Mirzaei-Aghsaghali et al., 2015, Fao, 2010).In our research by using inulin containing supplement we achieved significant decrease in breading time (minimum to 3 weeks (i.e. 17%). In groups Pre12 and Pre24 desired body weight, which was set 90kg, was exceeded on 42nd test day but in CoG just on day 70. Feed intake per day, including dry matter intake (DMI), in all groups was the same. Therefore according to the following predictive methane equations developed from measurements in respiration chambers: 1) Methane (MJ/d) = 0.92 × DMI (kg/d) + 5.93 (Mills et al.); 2) Methane (g/d) = 18.5 × DMI (kg/d) 9.5 0 (Grainger et al.) we can conclude that prognostically there is reduction in methane production and its distribution because calves' breeding time significantly decreased. However, more research is warranted in this area and our next step is to continue this research and prove our theory.
Currently, once again, we are studying the effect of inulin supplement on the live weight gain and possible reduction of greenhouse gas emission by direct methane measurements in rumen gases, liquid, as well as in faeces.

CONCLUSION

Calves from Pre24 showed the best average weight gain during 70 research days, but this gain was not significantly higher than in Pre12. Our results show that double dose of prebiotics do not give significantly higher body weight gain. We can conclude that the optimal dose of that special flour of artichoke (inulin 50%) for speeding up the growth rate of calves is 12 grams which can stabilize the health status and reduce fattening time. Average daily body weight gain in control group was significantly lower than in other groups fed with additional inulin supplement. There was no negative impact on calves' health status (heart rate, respiratory rate, body temperature). Consistency of faeces was more stable than in control group. Besides shortening breeding time minimum to 3 weeks (i.e. 17%), GGE can be reduced too.

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