Szent István University

ANALYSIS OF IGF-I IN RELATION TO THE PRODUCTIOANAL TRAITS OF DAIRY CATTLE

PhD Theses

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1. INTRODUCTION

Those processes that has main role in the development of a production feature are getting more and well-known by physiological examinations. This study is based on the knowledge of the milk production is being under complex hormone regulation. The diversities among the different subspecies or within the subspecies are originated from the genetic variety of physiological processes controlling milk production so by getting to know these processes better the present selective system would be possible to develop.

To maintain milk production ***IGF-I factor*** that is produced in the liver has direct effect. This effect is caused by the increased STH secretion. The IGFs are from the family of polipeptide and shows great structural homology with proinsulin. However these molecules both *in vivo* and *in vitro* has developing effect on animal production in such way.
The IGFs can be described by their function, which can be divided into three parts: metabolic, mitogenic and differentiating. There are several metabolic operations and long-term mitogenetic effects are stimulated *in vitro* cultures. *In vivo* IGF-I can be the mediator of the causing effects of milk production and somatotropin increase.
The IGF-I stimulates the transport, oxidation of glucose and lipidsynthesis from glucose being an obstacle to lypolisis [ZAPF ET AL. $1978_{a,b}$]. Comparing to insulin the growth of glucose metabolism is in 1/50 and 1/100 commensurate with the changing of IGF-I and IGF-II [ZAPF ET AL. 1980]. The mitogenic function leads to cell-reproduction by increased DNA, RNA and protein synthesis [BAXTER 1978; FROESCH ET AL. 1986]. The IGF-I treatment in udder tissue causes DNA decision in physiological amounts [BAUMRUCKER 1986; SKAAR ET AL. 1990]. BAUMRUCKER ET AL. proved that IGF-I & the insulin independently increase the building-in of timin into the dairy cow's uddertissue. This development is amount-based and increase to the end of the period of pregnancy and also during lactation.

2. OBJECTIVES

I studied **IGF-I** *(insulin-like growth factor-I)*, earlier called somatomedin C that can show correlation with milk production features as biochemical-physiological parameter. Consequently beside the genetic background and production analysis the study of this hormone in relation with the age can be a help in the judgement of milk production. The experiment what is the base of this study was originated from the concept that if we find individually measurable differences in the concentrate of that hormone during the

bringing-up period, and if this individual difference is appearing as productional difference later among the individuals, so then this characteristic could be useful as preselectional parameter of female animals.

I defined the change of plasma IGF-I concentration with age, body weigh and growth-rate.
I examined the genetic background-analysis of the concentration-changes of plasma IGF-I on five descendant groups (father half-sibling groups). I estimated the hereditability plasma IGF-I concentration. At last I searched for correlation between the plasma IGF-I concentration during the bringing-up period and the milk production features and between the length of the service-period and the first pregnancy period.

3. MATERIALS AND METHODS

For developing the examination pattern it was a main standpoint to provide the necessary number of individuals for the reliable statistic evaluation (we also counted with the expectable deaths or falling out for other reasons). I choose the Mezőhegyes State Stud farm Rt. 11th Holstein-Friesian Cow Farm (1200 places for individuals are possible) where the number of cows and reproduction rate made it possible to develop the examination individuals.
I intended to examine same individuals from the point of view of age and environmental conditions in nearly four months (from the beginning of March to the end of June) approximately 100 pure blood Holstein-Friesian heifers were born, after the deaths 85 remained to be my examination group that was suitable for the experimental arrangements.

During the examinations we stored plasma from the blood what was taken from the neck vein after feeding, always in the same time. We stored it on – 20 C° to the later use. We defined the IGF-I concentration of the plasma by radioimmunoassay (RIA) in cooperation with the UER Molecular Biology & Physiology Faculty (Belgium) by the worked out method of DAUGHADAY ET AL. in 1980.

For data, analysis of correlation, regression and variance (ANOVA) (STATISTICA, SPSS 0.10 version) were used as a global test, and L.S.D. was used to determine whether there was a significant difference between the parameters studied. A value of $p < 0.05$ was chosen as the minimal level of statistical significance.

4. RESULTS

The featuring hormone-concentration change of the bringing-up period became describable by defining the plasma IGF-I values of the monthly blood-samples that were taken from the birth to 14 month old age. The results seem to show that the plasma IGF-I concentration and the age-change is in direct ratio. Furthermore the bringing-up period can be described by there peaks: ① *the birth period*, ② *sexually matured period*, ③ *breeding season*.

I only did step-by step regression-analysis for the three defining period of bringing-up period, for the birth period, for the sexually matured period, for the breeding season and for the analysis of the correlation of the other periods. The examination of the individual concentration values showed that both sexual maturity and breeding season can be divided into two, an earlier and a later period. 42,86% of the examined group according to the hormone concentration reach its sexual maturity at the age of 5-moth, the other 57,14% reach it at the age of 6-month. 39,29% of the group reach its breeding season at the age of 11-month, 60,71% can be regarded as matured for the breeding season at the age of 12-month. According to these the variable quantities in regression-analysis are these months.

By applying the measure I could prove significant correlation among the IGF-I concentrations of the birth period (y) and the first (x_1), the fourth (x_2), the twelfth (x_3) and the thirteenth (x_4) month old states. The multiple correlation co-efficient is R=0,458, the mistake of the estimation is 27,02.
The data has the consequence that if the hormone-concentration of the birth-period is high than at the age of one-month and 13 months the IGF-I concentration will also be high and vice versa. It is also signed that if the birth period has high hormone-concentration, then the 4 month and 12 month old individuals will have low hormone-concentration and vice versa.
The hormone concentrate of the birth period has no statistically proved effects in other periods of bringing up.

Based on the hormone values featuring the supposed period of sexual maturity if can be declared that the hormone concentration typical for the age of 5 months (y) has positive correlation with the values typical for the age of 4 month (x_1) (b_{xy}=0,581) and 10 month (x_2) (b_{xy}=0,241). It has no statistically proved correlation with other periods.
According to the correlations we can state that if the hormone concentration is high at the age of 2 month that it will also be high at the age of 6.,7.,8., months, though it will be low in the 13th month. The IGF-I concentration typical for the age of 11 month old (y) shows moderated correlation with the IGF-I concentration typical for the age of 8 month (x_1) (b_{xy}=0,262) and 12 month (x_2) (b_{xy}=0,282). I found moderated positive correlation among

the IGF-1 concentrations typical for the age of 12 month (y), 1 month (x_1) (b_{xy}=0,262), 13 month (x_2) (b_{xy}=0282) and 14 month (x_3) (b_{xy}=0,203).

I defined the average IGF-I concentration featuring the individual for the whole bringing-up. The theory of the calculation is that the monthly individual values can also be regarded as a repetition of the fenotypical appearance of a given feature. Based on the extreme side-values the following hypothesis was made: though the presented and described IGF-profile for the bringing-up period must be true for each individuals, it is possible that it is realised in different concentration level.
Despite the great variance and dispersion values the IGF-I profile featuring the bringing-up period can e regarded the same for each individual. The individuals of the population can be quality according to the featuring hormone-concentration during the bringing-up period.
The comparison analysis of the five father side half-blood offspring group was taken by variance analysis. With it my goal was to find reason to the differences and similarities of the plasma IGF-I concentration – groups of the bringing-up period.
Based on the results of the variance analysis I declared the fathers has specific effect on the birth, 5-month-old, 13-month-old,14-month-old IGF-1 concentration ($p<0,05$) .
Based on the *Post Hoc Test* the value of the descendant-group of the *Stardow* bull significantly lower compared to the other descendant groups and to the whole population in the birth period IGF-1 concentration. It is also the effect of the fathers that the ***Legacy*** and ***Lincoln*** offsprings has low IGF-I concentration during the period of sexual maturing, and they also lack the IGF-I peak. In the 13. and 14. months the lower IGF-1 level of the ***Showboy*** offspring group proved to be father-originated significant difference.

I did the estimation of the possible inheritage of average IGF-I concentration during the bringing-up period by variance analysis based on the performance of the father side half blood-groups. The estimated h^2–value based on the 5 father side half blood-groups is 0,054 though I got lower, 0,042 value for h^2 for the 4 groups.
The h^2 value of the average plasma-concentration is 0,121 that is twice the average IGF-I hereditableness during the bringing-up period. The estimated value is significant on the level of $p<0,1$.
The estimated h^2 value of the average IGF-I concentration is 0,13 during the *sexually matured period* (it is significant on the level of $p<0,05$) I also studied the correlation between the change of body weigh and IGF-1 concentration during the *bringing-up period.*

BREIER ET AL. has found close positive correlation between the birth weigh of the calves and the IGF–I concentration. In contradiction with it I observed that by comparing the values of the whole population and the correlation values of the certain offspring-groups the relation between the birth-period plasma IGF-I concentration and the body weigh is negative (-031 $p<0,05$) for the whole population.

It is also true that there are negative and positive relations within the descendant groups. There is a negative relation between the two parameters in case of *Bellton* (r_{xy}= -0,34), *Lincoln* (r_{xy}= - 0,36), *Showboy* (r_{xy}= -0,30) and *Stardow* (r_{xy}=-0,11) descendants. In case of *Legacy* offsprings r_{xy}= 0,50 so only this results concerning this offspring-group is the same with the results of the literature.
In order to decide the possible reasons for the different results from the literature I analysed the relation of the birth weigh and IGF-I plasma concentrate within the father side half blood groups.
I have found two reasons for the negative relation: *1* Low IGF-I concentration associates with the high birth body weigh in the three groups while the IGF-1 concentration was high in case of low birth body weigh. *2* In a group, where the individuals were born with higher body weigh than it is featuring for the gender, all the individuals had low birth IGF-I concentration. There is a positive correlation between two features only in case the individuals are born with average birth body weigh or just with a little difference in it so the plasma IGF-1 concentration is average.

By analysing the correlation between the IGF-I concentration and the change of body weigh I declared that compared to the average IGF-1 concentration the 1st partpopulation that has been qualified under the average has lower monthly average values though the values of the 2nd partpopulation with the IGF-I concentration below the average are higher than the average body weigh values of the population.
Based on this I got the consequence that if there is a derivation of the IGF-I average hormone concentration in the examined population and if the individuals can be categorised in to lower and higher hormone concentration groups because of this, and the body-weight changes also follow this than the speed of growth should adjust to this level. That means the individuals of the group must be separable into a shower and a more intensive growth speed group. In order to prove the theory I defined the growth-speed of the individuals and compared to the average growth-speed. I put them into a group that has a growth-speed below the average and into another group that has a growth speed above the average. Then I examined what kind of individuals belong to these groups. According to the developed group codes I counted rank correlation coefficient. The calculated rank correlation coefficient is r_{rank}=0,9996.
It can accordingly be declared that the individuals with IGF-1 concentration below the average grows slower than the ones with IGF-I concentration above the average.

I have done correlation examination in order to define the relation between the milk-production features and the monthly plasma IGF-I concentration during the bringing up period. I have found negative significant ($p<0,05$) correlation between the quantity of the *100-day lactation milk production* and the IGF-I concentration of the birth-period, and 13th-, 14th- month. There is positive correlation ($p<0,05$) with the IGF-I concentration featuring for the sexual matured period.
The IGF-I concentration of the birth-period has no significant effect on the quantity of the *305-days-old lactation milk production*. Though the correlation is also negative with the

1, 13, 14-month old IGF-I concentration ($p<0,05$), similarly to the 100-day-old lactation. The *quantity of the 100-day-old lactation milk fat* shows negative correlation ($p<0,05$) with the 14-month IGF-I concentration. The same is true for the quantity of *the 305-day-old lactation milk fat* with the only difference that this feature is negatively effected by the 1, 10,11,12 month-old ages.

The *100 day-old lactation milk fat content* has negative correlation with the level of the 11 month IGF-1 concentration ($p<0,05$), the sae is true for *the 305 day-old lactation milk fat content*. This also has negative effect with the 2 month-old IGF-1 concentration ($p<0,05$). The *quantity of the 100-day.old lactation milk protein* shows positive correlation with the level of IGF-I concentration but the relation is negative with the values featuring for the 11-month-old age ($p<0,05$). The *quantity of the 305-day-old lactation milk protein* has negative relation with the level of 1-month-old IGF-I concentration.

The *100-day-old lactation milk protein content* does not depend on the level of IGF-1 concentration. The *305-day-old lactation milk protein content* has positive correlation with the level of the 14-month-old IGF concentration.

Both the one-month-old and 11,13,14, month-old IGF-I concentration shows negative correlation to the level of FCM (*fat corrected milk*). The highest daily milk production value is effected negatively by the level of the 12, 13, 14 month-old IGF-concentration.

There is a negative correlation between the *first fertility age* and the IGF-I of the birth-period ($r_{xy}=-0,25$). There is also a negative correlation between the *length of the service period* and the 12-month-old IGF-I cc. ($r_{xy}=-0,25$).

Regarding the relatively easily financiable and executable laboratory methods I applied and the fact that the IGF-I takes active part in the regulation of special anabolic metabolism in cows – that is the α and ω of the economic milk production- I strongly recommend the definition of IGF-I c.c. as a possible genetic marker that can significantly shorter the selection period and causes remarkable cost cut.

4.1. NEW SCIENTIFIC RESULTS

- The results seem to show that the plasma IGF-I concentration and the age-change is in direct ratio. Furthermore the bringing-up period can be described by there peaks: ① *the birth period*, ② *sexually matured period*, ③ *breeding season*.

- Despite the great variance and dispersion values the IGF-I profile featuring the bringing-up period can e regarded the same for each individual. The individuals of the population can be quality according to the featuring hormone-concentration during the bringing-up period.

- I estimated h^2-value of the average IGF-I concentration in the birth period, during the bringing-up period, during the *sexually matured period.*

- I observed that the relation between the birth-period plasma IGF-I concentration and the body weigh is negative for the whole population, anyway there are negative and positive relations within the descendant groups.

- It can accordingly be declared that the individuals with IGF-1 concentration below the average grows slower than the ones with IGF-I concentration above the average.

- I have found negative significant ($p<0,05$) correlation between the quantity of the *100-day lactation milk production* and the IGF-I concentration of the birth-period, and 13^{th}-, 14^{th}- month. There is positive correlation ($p<0,05$) with the IGF-I concentration featuring for the sexual matured period.

- The *100-day-old lactation milk protein content* does not depend on the level of IGF-1 concentration. The *305-day-old lactation milk protein content* has positive correlation with the level of the 14-month-old IGF concentration.

- There is a negative correlation between the *first fertility age* and the IGF-I of the birth-period (r_{xy}=-0,25). There is also a negative correlation between the *length of the service period* and the 12-month-old IGF-I cc. (r_{xy}=-0,25).

5. LIST OF PUBLICATIONS

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