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EFFECT OF HOLSTEIN-FRIESIAN HEIFERS' GROWTH AND DEVELOPMENT ON MILK PRODUCTION IN THE FIRST LACTATION

EFECTUL CREŞTERII ŞI DEZVOLTĂRII VIŢELELOR DE RASĂ HOLSTEIN-FRIZĂ ASUPRA PRODUCŢIEI DE LAPTE DIN PRIMA LACTAŢIE

KOVÁCS A.*, †BÁDER E.*, GERGÁCZ Z.*, BARTYIK J.**, PONGRÁCZ L.*, SZÜCS E.*

**Faculty for Agricultural and Food Science, University of West Hungary, Mosonmagyaróvár*
***Enying Agrár PLC, Kiscséripuszta, Hungary*

The aim of this study was to evaluate growth and development of heifers from birth to 24 months of age and the effects on milk yield in first lactation. Body weight and height at withers of female calves (N=4167) were taken at monthly intervals. At 3 months of age the average height at withers of calves, live weight and wither index was 80.9 kg, 86.1 cm and 1.0, respectively. Figures taken at 6 months of age the height at withers, live weight and wither index increased by 17.6 cm, 92.3 kg and 1.7. Respective mean values at 9, 16 and 24 months of age were 250.0, 413.9 and 603.7 kg; 116.0, 128.5 and 139.7 cm; and 2.2, 3.2 and 4.3. The heifers with the ideal or lower ones at 3, 9 and 16 month of age produced higher milk yields in the first lactation milk yield by 200-500 kg as compared with the highest index category. Higher index values at 6 months of age resulted in increase of milk yields in the first the lactation. At 24 months of age first lactation milk yields were similar in all index-categories (8647.2, 8703.5 and 8717.5 kg, respectively). No variations neither in butterfat (3.6%) nor milk protein (3.1%) content were present within the index categories at any ages. In conclusion, findings reveal that the withers height index seems to be an appropriate tool in monitoring of growth and development of replacement heifers for taking corrective actions in feeding and breeding practice.
Key words: Holstein-Friesian, heifer, growth, milk yield, height at withers, body weight, withers height index

Introduction

For raising excellent replacement heifers it is essential to check on the growth regularly. Growth figures provide important information for the breeder, like the milk production of dairy cows, SCS, or the service period and number of insemination, because they can indicate failures of feeding practice and management.

The body weight merely cannot be used for monitoring the development of heifers. In terms of the development of skeleton is important to measure the height at withers. Evaluation of height at withers is necessary, because lesser weight than ideal one, at given age, can be compensated by feeding, however that cannot be attained for development of skeleton. For this reason the withers height index (the ratio of body weight and height at withers) may be a suitable procedure to control growth in replacement heifers. According to Pirlo et al. (2000) the Holstein-Friesian heifers should calve at 24 month of age and start milk production in first parity. Replacement heifers must have an optimal body size in order to produce satisfactory milk yield in the first parity and later (Hoffman and Funk, 1992).

Previously, it was a common practice to evaluate body size development exclusively by live weight. During the recent decade sufficient data were recorded to evaluate the relationship of height, weight and their association to performance in dairy cows in first and later parities. If earlier growth standards (Ragsdale, 1934; Davis and Hathaway, 1956) are compared with recent ones (Matthews and Fohrman, 1954; Heinrichs and Hargrove, 1987), it can be seen that height and weight figures have increased by 5 to 15% at a given age. Heinrichs and Hargrove (1987) studied 6000 Holstein-Friesian heifers in Pennsylvania for a period from 1983 to 1985 in order to better describe the correlation between body size and performance under field conditions. The herd average for milk yield was positively correlated with height (+0.41) and live weight (+0.34) and negatively with age at first calving (-0.22). Cows of higher live weight and height at withers produced more milk yields in the first parity. Van Amburgh et al. (1997) used 273 Holstein heifers to study the effects of prepubertal rearing rate on first and later lactation yields. Heifers were assigned to one of three dietary energy treatments that achieved average daily weight gain ADG 0.6 (treatment 1), 0.8 (treatment 2) and 1.0 kg (treatment 3). By higher ADG reduced the date of first calving from 24.5 to 21.3 month of age. The final hip height was 128, 127, and 125 cm respectively. The pre-calving weight was 550, 529, and 520 kg. Cows produced 9873, 9620 and 9387 kg milk in the first lactation. Heinrichs and Losinger (1998) collected data on the heart girth (n = 8565; a measure of body weight) and height at withers (n = 8568) of Holstein dairy heifers from 659 dairy farms in the period of 1991-1992 and determined weight and height parameters from 0.5 to 23.5 month of age. Polynomial regression equations were derived to study the relationship of weight and height to age. In their study heifers were heavier and taller at the withers than standards published 30 to 50 years ago. Herd average of milk production was positively correlated with body weight and height. Carson et al. (2002) used in study one hundred and thirteen high genetic merits of Holstein-Friesian heifers to determine the effect of rearing regime, in terms of offered diet and target calving weight, on body size, reproductive performance and milk production. The heifers were divided into 4 groups based on the live weight and genetic merit. The target weights at calving were 540 kg (treatment 1) and 620 kg (treatments 2, 3 and 4). The body weight at 3 month of age in conformity with treatment was 104, 118, 115 and 117 kg, the height was 90, 94, 93 and 92 cm, respectively. Weight was 214,

243, 242, and 242 kg, their height was 111, 115, 115 and 115 cm at 10 months of age, respectively. At 23.5 months of age live weights and heights at withers were recorded: body weight 527, 599, 608, 581 kg and heights at wither 134, 137, 139, 139 cm, respectively. Differences were significant at 10 and 23.5 months of age. The first lactation milk yield was 7222 liters in treatment 1, 8020 liters ($P< .01$) in 2, 7956 liters ($P< 0.01$) in 3 and was 7901 liters ($P< 0.05$) in 4.

Materials and Methods

Data were collected in a large scale dairy operation in Hungary. The aim of this study was to examine growth and development of heifers from birth to 24 month of age and its effect on milk production in the first lactation. The calves were housed in individual pens up to 60 days of age, then in a little group penning. At 6 month calves were turned to loose housing conditions with deep litter. Body weight and height at withers of calves (N=4167) were recorded at monthly intervals. The withers height indexes were calculated and compared with wither height indexes of Holstein-Frisian heifers developed by Greg Bethard (1997) in the USA based on the rate of body weight and height at withers. Data processing and statistical analysis of data were calculated by Microsoft Excel and Statistic 7.0. program packages.

Results and Discussions

Results are presented and summarized in Table 1. At 3 months of age the height at withers, live weight, and ratio of withers to live weight was 86.1 cm, 80.9 kg and 1.0, respectively. The later figure slightly differs from the standard range of values (1.14-1.17). At 6 months of age the withers height increased by 17.6 cm, the live weight by 92.3 kg, so the index was 1.7 on the average. At 9 months of age the withers height index of heifers was 2.2 with 116 cm height and 250 kg live weight. As a rule, in Hungary the age at first service is 15-16 month. By this age the height at withers was 128.6, the live weight 413.9 kg and the index 3.2. At 24 month of age the height at withers increased by 53.6 cm, that of the weight by 522.8 kg from the parameters recorded at 3 months of age, so the average of calculated index attained at 4.3.

Table 1

Means and standard deviations of body weight, and heights at withers and height index in Holstein-Friesian heifers at 3, 6, 9, 16 and 24 months of age

Age (months)	Traits	Mean	SEM	Standard values
3	live weight (kg)	80.9	8.1	102.5-110.7
	height at withers (cm)	86.1	1.5	89.4-94.2
	wither height index	1.0	0.1	1.14-1.17
6	live weight (kg)	173.2	14.5	168.7-185.1
	height at withers (cm)	103.8	2.1	101.1-106.7
	wither height index	1.7	0.1	1.67-1.73
9	live weight (kg)	250.0	12.4	234.9-259.4
	height at withers (cm)	116.0	1.0	110.2-116.1
	wither height index	2.2	0.1	2.13-2.23
16	live weight (kg)	413.9	20.8	389.2-433.6
	height at withers (cm)	128.5	1.4	124.5-130.0
	wither height index	3.2	0.2	3.12-3.33
24	live weight (kg)	603.7	22.8	65.7-631.8
	height at withers (cm)	139.7	1.6	132.6-143.5
	wither height index	4.3	0.2	4.27-4.40

In the next part of our study we analyzed, the effect of the index (at 3, 6, 9, 16 and 24 months of age) on 305 days milk production in first lactation. Data set was divided to three groups by standard values of height index. 305 days milk yield production and the wither height index at 3 month of age. At 3 months of age the ideal wither height index is between 1.15 and 1.18 (Figure 1).

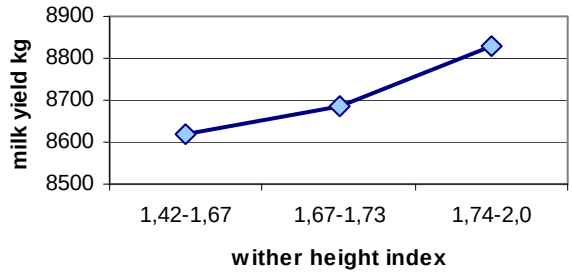

Figure 1. The effect of wither height index at 3 months of age on 305 days milk yield in first lactation

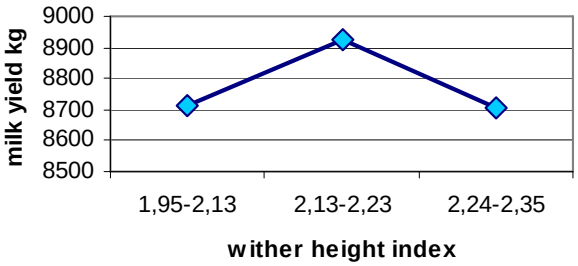

Figure 2: The effect of wither height index at 6 month age on the 305 days milk yield in first lactation

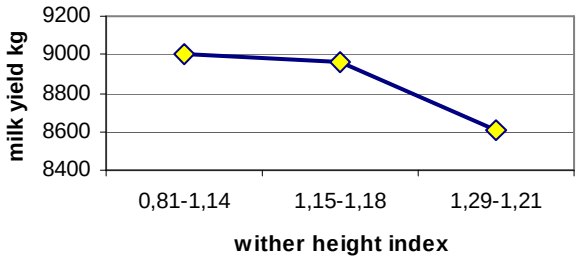

Figure 3: The effect of wither height index at 9 month age on the 305 days milk yield in first lactation

Relevant literature reveals that the optimal weight and height ratio is between 3.12 and 3.33. Those heifers achieved higher 305 days milk yield the index was ideal (8863.3 kg) or with smaller one below the limitations (8826.7 kg) at 16 month of age. When heifers had the index higher then 3.33, produced less milk by 500 kg ($P<0.05$). The milk fat (3.6, 3.7%) and milk protein (3.1%) content was same in all index-categories (Figure 4).

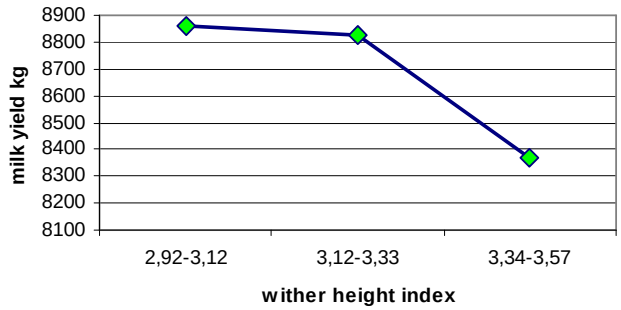

Figure 4: The effect of wither height index at 16 month age on the 305 days milk yield in first lactation

Only with increase of index calculated at 24 month of age the milk yield in the first lactation grew only slightly (Figure 5). The milk production was 8703.5 kg at ideal index range (4.27-4.4), 8717.5 kg within the index-category between 4.40 and 4.64, and 8647.2 kg in the smallest index-category. The difference was not significant. The butterfat and protein content was the same (3.6 and 3.1%).

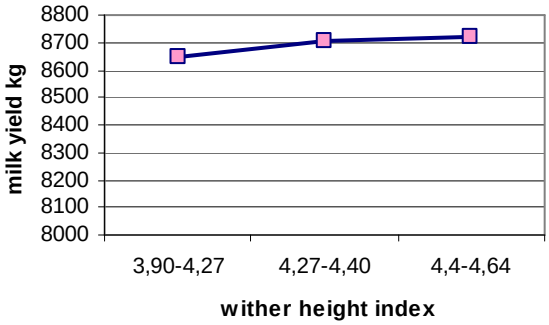

Figure 5: The effect of wither height index at 24 months of age on the 305 days milk yield in first lactation

Table 2

The effect of wither height index at 3, 6, 9, 16 and 24 months of age on e 305 days milk yield in first lactation

Age (mo.)	Withers height index category		Milk kg	Fat %	Protein %	Live weight kg	Height at withers cm	Withers height index
3	0.81-1.14	mean	8998.8	3.73	3.73	83.4	86.2	0.97
		SD	1341.8	0.40	0.40	6.6	1.5	0.1
	1.15-1.18	mean	8963.5	3.71	3.71	95.0	85.0	1.12
		SD	2032.2	0.28	0.28	0.0	0.00	0.000
	1.19-2.00	mean	8612.5	3.75	3.75	102.5	86.5	1.18
		SD	2615.6	0.10	0.10	3.5	0.71	0.031
6	1.42-1.66	mean	8620.1	3.74	3.12	162.6	104.2	1.56
		SD	1504.8	0.42	0.17	7.0	2.0	0.06
	1.67-1.73	mean	8684.5	3.79	3.15	176.3	103.7	1.70
		SD	1433.7	0.45	0.19	4.5	2.2	0.02
	1.74-2.00	mean	8828.8	3.84	3.12	188.6	103.5	1.82
		SD	1445.7	0.42	0.17	7.1	2.1	0.06
9	1.95-2.12	mean	8710.5	3.66	3.09	236.8	116.2	2.04
		SD	1531.2	0.34	0.16	5.8	1.1	0.05
	2.13-2.23	mean	8927.6	3.65	3.07	252.3	116.0	2.18
		SD	1161.3	0.39	0.18	4.9	1.1	0.03
	2.24-2.35	mean	8707.8	3.62	3.06	265.7	115.7	2.30
		SD	1351.5	0.42	0.19	4.2	0.9	0.04
16	2.92-3.11	mean	8862.4	3.67	3.09	391.1	128.5	3.04
		SD	1529.3	0.43	0.17	6.1	1.4	0.05
	3.12-3.33	mean	8826.8	3.63	3.09	415.85	128.60	3.23
		SD	1599.0	0.42	0.18	9.74	1.33	0.06
	3.34-3.57	mean	8366.0	3.70	3.16	440.24	128.29	3.43
		SD	1773.2	0.47	0.19	6.81	1.39	0.05
24	3.90-4.26	mean	8647.2	3.62	3.12	577.93	139.88	4.13
		SD	1659.8	0.51	0.19	13.60	1.82	0.09
	4.27-4.40	mean	8703.5	3.57	3.11	602.58	139.82	4.31
		SD	1496.9	0.40	0.17	12.32	1.67	0.07
	4.41-4.64	mean	8717.8	3.69	3.15	627.76	139.27	4.51
		SD	1585.7	0.42	0.18	9.13	1.31	0.06

Conclusions

Findings of this study indicated those heifers with ideal index or small one at 3. 9 and 16 months of age attained at higher milk yields in first parity. Neither butterfat nor milk protein content seemed to differ among the three index categories. Height at withers was same and live weight differs among index ranges.

The reason of the difference in milk yield was that from about 3 to 9 months of age is an especially critical period in mammogenesis. In this period the mammary gland is developing at a much faster rate as compared with body growth. Raising heifers on inappropriate way of feeding (e.g. high energy supply of nutrition) during prebubertal mammary growth has been shown to have a negative effect on milk yield.

With increase of index calculated at 24 months of age the milk yield increased only slightly in the first lactation. Those heifers had larger live weight at 24 month age. The weight gain of fetus is larger in the last phase of gestation. The change of the mass of allantoidal liquid, uterus and placenta as well as the change the mass of mamma is major; therefore the cows have an increase in energy and protein requirements. Primiparous cows have less energy intake after calving than multiparous counterparts. At the same time primiparous cows are in development. Their total nutrient requirements are higher because in addition to nutrients for maintenance and fetus they have to require nutrients for gain, too.

The withers height index is an easy tool to control growth and development of replacement heifers. In case of feeding failures the index may provide an appropriate way in making corrections.

Bibliography

1. **Carson, A.F., L. E. R., Dawson, M. A., McCoy, D. J., Kilpatrick, F. J., Gordon** (2002)- *Effects of rearing regime on body size reproductive performance and milk production during the first lactation in high genetic merit dairy herd replacements*. Animal Science, 74, 553
2. **Bethard, G.B.** (1997) - *A microcomputer simulation to evaluate management strategies for rearing replacement heifers.* Ph.D. Dissertation. Virginia Technical University. USA
3. **-Davis, H. P, I. L., Hathaway** (1956)- *Comparative measurements of Holstein. Ayrshire. Guernsey and Jersey females from birth to seven years*. Nebraska Agric. Exp. Stn. Res. Bull. 179. University of Nebraska. Linclon
4. **Heinrichs, A. J. and G. L. Hargrove** (1987)- *Standards of weight and height for Holstein heifers*. J. Dairy Sci. 70, 653
5. **Heinrichs, A. J. and W. C. Losinger** (1998)- *Growth of Holstein dairy heifers in the United States*. J. Anim. Sci. 76, 1254
6. **Hoffman, P. C., D. A., Funk** (1992)- *Applied dynamics of dairy replacement growth and management*. J. Dairy Sc. 75, 2504

7. **Matthews. C. A., M. H., Fohrman**. (1954)- *Beltsville growth standards for Holstein cattle*. U. S. Dept. of Agric. Technol. Bull. 1099. USDA. Beltsville. MD.

8. **Pirlo, G., F., Miglior, M., Speroni** (2000)- *Effect of age at first calving on production traits and on difference between milk returns and rearing costs in Italian Holsteins*. J. Dairy Sci. 83, 603

9. **Ragsdale, A. C.,** (1934)- *Growth standards for dairy cattle*. Univ. Missouri College of Agric. Exp. Stn. Publ. No. 336.

10. **Van Amburgh, M E., D. M., Galton, D. E., Bauman, R.W., Everett, D. G., Fox, L. E., Chase, H. N., Erb** (1998)- *Effects of three pubertal body growth rates on performance of Holstein heifers during first lactation*. J. Dairy Sci. 81, 527