Study on Bone Formation Age and the Optimum Fattening Age of Japanese Black Cattle

Toshio OSHIDA[1], Deng GANZHEN[2], Tsunenori SUGANUMA[1], Hiroshi KITAMURA[3] and Kazuhiko SAWADA[3]

[1]School of Veterinary Medicine, Azabu University, 1-17-71 Fuchinobe, Sagamihara, Kanagawa 229-8501 Japan. [2] Department of Veterinary Clinic Medicine, Animal Science and Veterinary Medical College, Huazhong Agricultural University, Wuhan, 430070, China, [3]Agricultural and Veterinary Division, Meiji Seika Kaisha, Ltd., 2-4-6, Kyobashi, Chuo, Tokyo 142-0031 Japan

Key words: Japanese Black Cattle, bone formation age, optimum fattening age, X-ray film spectrum analysis, bone mineral content

Background and objectives

Between Japan and the United States, farm products had been placed as a symbol of trade friction. As for beef, however, its import and export have been perfectly liberalized since April in 1991, according to the mutual consent of both countries. This liberalization attacked the domestic beef consumption directly and the producers have been cornered. Countermeasures for it are; making the price low by improving of productive efficiency, developing and producing animal products with added values e.g. Japanese original marbling beef, and advertising the safeness of domestic beef. Utilization of cheap feed, advancement of breeding efficiency, a cutback in cost by saving of labor or so on can be the items to improve the productive efficiency. Authors divided the producing period of beef into three duration of nursing, raising and fattening. Calve was nursed for about 5 or 6 months and raised for about 2 or 3 months, after that, fattening duration started. Also fattening was separated into three stages and was feed with different diet, which had different nutrition. In this paper, we tried to find the age of bone formation age of Japanese Black Cattle so as to decide the optimum fattening age. Some sensitive bones were selected for X-ray detection. The area and bone mineral content(BMC) were measured on different sites of different bones: area of fifth metacarpal bone; BMC on the center of ulna ossification line, BMC on the ante-distal end of radius, BMC on the distal end of ulna, BMC on the center of horizontal line on radius from ulna ossification line, BMC on the fifth metacarpal bone and BMC on the accessory carpal bone.

Material and methods

1) Cattle: 2, 3, 4, 8, 9, 10, 11 and 12 months old groups were got from 52 Japanese Black Cattle randomly with the difference of age and sex.

2) Exposure: Cattle stood up naturally, Distal of radius and ulna carpal joint and carpal bone were exposed with aluminum gray scale on same film with same exposing condition. Lateral photo was got. The exposure condition was 90LV, 0.4 seconds 60 cm far. Portable X-ray machine (Unit-model TP-20, Tanka) was used. X-ray films were washed with automatic machine. Aluminum gray scale was used to measure bone mineral content [Deng,G. *et al.*:1993] .

3) Measuring the area of fifth metacarpal bone: At first, shape of fifth metacarpal bone was draft on a paper from X-ray films. Area of the shape was measured with Planimeter X-plan 360d (Ushikata Shokai). The average value of three measuring data was used.

4) Measuring bone mineral content: Six point (Fig.1) on bone were measured, which were center of ulna ossification line, ante-distal end of radius, distal end of ulna, center of horizontal line on radius delayed from ulna ossification line, fifth metacarpal bone and accessory carpal bone. The light absorptivity of every site and aluminum gray scale on X-ray films were detected with Densitometer PDA-85 (Konica). An exponential functional formula was fund according to the absorptivity data of aluminum gray scale. The BMC was calculated with this formula. One film had one formula:

$$Y = e^{A+BX}$$

Y------Bone mineral content
X------Light absorptivity
A------Basic coefficient
B------Curvature
r--------Relative coefficient

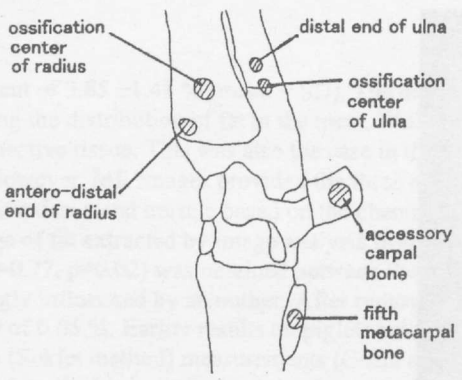

Fig.1. Measurement point of bone

Table 1. The area of fifth metacarpal bone (cm^2)

Age of months	Male	Female
2	0.9739	0.6483
3	0.7128	0.4653
4	—	0.6154
8	2.5832	1.4720
9	2.3467	1.2141
10	2.7004	2.0451
11	2.9907	2.5637
12	2.9012	2.0956

Principal results and Discussions

(1) The area of the fifth metacarpal bone: This bone was relatively stable from the age of 8 and 10 months in male and female group respectively. So, this bone formed basically at the age of 8 and 10 months in male and female Japanese Black Cattle respectively (Table 1).

(2) BMC

① The center of ulna ossification line: BMC on the ulna ossification line was relatively stable from the age of 8 and 10 months in male and female group respectively. So, this site formed basically at the age of 8 and 10 months for male and female Japanese Black Cattle respectively. Male is two months early than female (All BMC data are shown Table 2). ② The ante-distal end of radius: In both male and female group, BMC were relatively stable from the age of 8 months. This means that the ante−distal end of radius formed basically at this age in both male and female Japanese Black Cattle. ③ The distal end of ulna: BMC on the distal end of ulna was relatively stable from the age of 8 and 10 months in male and female groups respectively. So, distal end of ulna formed basically at the age of 8 and 10 months in male and female Japanese Black Cattle respectively. Male was two months early than female.

④ The center of horizontal line on radius from ulna ossification line: BMC on this site both in male and female groups were relatively stable from the age of 8 months. So, center of horizontal line on radius from ulna ossification line was formed BMC on fifth metacarpal bone. ⑤ The fifth metacarpal bone was relatively stable from the age of 8 and 10 months in male and female groups respectively. This revealed that fifth metacarpal bone formed basically at the age of 8 and 10 months in male and female Japanese Black Cattle respectively. Male was two months early than female. ⑥ The accessory carpal bone: BMC on accessory carpal bone were relatively stable after the age of 8 and 10 months in male and female groups respectively. This showed that accessory carpal bone formed basically at the age of 8 and 10 months in male and female Japanese Black Cattle respectively. Male was two months early than female.

Table 2. BMC with the difference of age and sex (mg/cm²)

Points	the center of ulna		the ante—distal end of radius		the distal end of ulna	
Age of months	Male	Female	Male	Female	Male	Female
2	723	742	1319	1191	778	735
3	1006	828	1733	1075	1056	845
4	—	811	—	1702	—	850
8	2092	1354	3370	3252	2353	1399
9	1885	1087	3343	2351	1932	1121
10	2148	1642	3189	3669	2209	1638
11	2017	1919	3160	2959	2034	1943
12	2125	1719	3324	2917	2061	1769

Points	the center of horizontal line on radius from ulna ossification line		the fifth metacarpal bone		the accessory carpal bone	
Age of months	Male	Female	Male	Female	Male	Female
2	1172	1128	630	636	710	665
3	1346	907	958	796	1175	828
4	—	1265	—	609	—	733
8	2701	2430	1330	849	1407	1104
9	2720	1715	1093	739	1332	848
10	2718	2933	1383	1022	1600	1397
11	2699	2613	1385	1378	1780.	1747
12	2941	1392	1438	1392	1597	1884

Only a few papers about Japanese Black Cattle had published. Quality and quantity of muscle tissue and fat tissue, which are utilized as meat, are varied according to the process of each cattle's growth, and are significant for fattening [Mitsumoto, M.*et al* .: 1989] . The weight of some leg bone were high relative with muscle volume [Fukuhara,R. *et al.*: 1968] , this was used for the estimation of meat yield. The authors [Oshida *et al.*: 1989] thought that both area and bone mineral content of Japanese Black Cattle increased sharply until the age of 10 months, after that, they stayed at a relatively stable condition. Though, the fattening duration of Japanese Black Cattle in order to start at this age practically.

Bone growth and formation ages were affected by many factors, such as age, sex, nutrient, weather etc in one species. Usually weight load bone, such as radius formed and matured early than the others.

With our results, BMC on ante-distal end of radius and on center of horizontal line on radius from ulna ossification line formed basically at the age of 8 months in both male and female Japanese Black Cattle. Area and BMC on the other sites were relatively stable from the age of 8 and 10 months in male and female groups respectively, therefore that all of these bone formed basically at 8 and 10 months in male and female Japanese Black Cattle respectively, male was two months early than female. Ulna, fifth metacarpal bone and accessory carpal bone are more useful than radius for estimating the formation and mature age of bone in Japanese Black Cattle.

Conclusion

With the difference of sex, the basic formation age of bone in male was two months early than female Japanese Black Cattle, so, the fattening duration should start at the age of 8 months for male and 10 months for female. Male and female Japanese Black Cattle should be raised separately for beef business.

References

Deng,G., Xiong,D., Li, C.Y., *et al.*(1993). New method to measure bone mineral content---- X-ray film chromatography. Journal of Chinese Veterinary Medicine, 19 (5): 16—17.

Fukuhara,R., Tsuchiya,H., Nishimoto,T. *et al.*(1968). Study on changes in body composition and carcass characters of beef cattle during fattening, 2. Growth and development of yearling steers with advancement of age from 8 months to 18 months. Bull. Chugoku Natl. Agric. Exp. Stn, B-16: 123—162.

Mitsumoto, M. and Ozawa,T. (1989). The influence of finishing weight, series and kinds of concentrate during the latter fattening period on the carcass characteristics of Japanese Black steers. Japanese Journal of Zootechnology and Science, 1989. 60: 351—358.

Oshida, T., Kozakai,T., Nagajima,M., *et al.*(1999). A study on bone formation of Japanese Black Cattle. Congress Proceeding of International Congress of meat Science and Technology. Yokohama, Japan. 1: 92—93.