RELATIONSHIPS BETWEEN OSSIFICATION MATURITY AND DENTITION-BASED MATURITY FOR CHINESE YELLOW STEERS

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Background

Physiological maturity is an important age indicator for beef grading, in the Chinese, USDA, and Australian beef grading standards, and it can be evaluated by skeletal ossification or dental development (AUS-MEAT, 1995; USDA, 1997; Zhou et al., 2001a). Dentition-based maturity can reflect animal physiological maturity more accurately (Graham and Price, 1982) but it is inconvenient to use. Bone ossification is the basis for maturity determination in the USDA beef grading system, but its accuracy is lower than dentition-based maturity (Lawrence et al., 2001). The Chinese beef grading system was established following the development and enlargement of the Chinese beef industry (Zhou, 1998). Because it is relatively new, much research needs to be done to improve its accuracy and enlarge the scope of its application.

Objectives

This study was designed to determine the relationship between the Chinese ossification maturity system and dentition-based maturity system, and the relationship between USDA ossification maturity system and dentition-based maturity system for Chinese yellow steers.

Methods

One thousand two hundred and four Chinese yellow steers, consisting of 403 Luxi steers, 417 Qinchuan steers and 384 crossbred steers were slaughtered after a 45-day-period finishing. Dentition-based maturity was determined by the number, height, and wear of permanent incisors by the method of Li et al. (2002). Chinese ossification maturity was determined by the characteristics of split vertebral processes, especially ossification of thoracic buttons according to the Chinese beef grading system. USDA ossification maturity was evaluated by the size, shape, and ossification of the bones and cartilages, and the color and texture of the lean according to the United States standards for grades of carcass beef (USDA, 1997). Data comparing the ossification maturity systems with the dentition-based system were arranged in tables according to breed and ossification maturity system. A ratio comparison for two independent samples was used to compare differences among crossbred steers, Luxi steers, and Qinchuan steers in the agreement between ossification maturity and dentition-based maturity. The kappa statistical analysis was applied to quantify the amount of agreement between ossification maturity and dentition-based maturity of the same individual, beyond what would be expected due to chance. McNemar's test for bias was used to evaluate the pattern of disagreement between ossification maturity system and dentition-based age system. All statistical analyses were performed using SAS8.2 (1999-2000, SAS Inst. Inc. Cary, NC).

Results and Discussion

Among the 1204 steers, Chinese ossification maturity agreed with dentition-based maturity for 664 steers and USDA ossification maturity agreed with dentition-based maturity for 732 steers. Ratio comparisons for two independent samples indicated that Chinese ossification maturity agreed with dentition-based maturity more ($P < 0.01$) for crossbred steers (60.4%) and Qinchuan steers (58.8%) than for Luxi steers (46.4%) with no difference between crossbred and Qinchuan steers($P>0.05$). USDA ossification maturity agreed with dentition-based maturity more ($P<0.01$) for crossbred steers (76.3%) than for Qinchuan steers (48.9%) with Luxi steers (58.3%) being intermediate (Table 1).

As shown in Table 2, among the 352 steers of up to 24 mo of age, the Chinese ossification maturity of 142 steers agreed with their dentition-based maturity. The relatively low agreement for Chinese maturity category A and dentition-based age of up to 24 mo is attributed to difficulties in distinguishing the Chinese ossification maturity category A from category B. Among 852 steers of greater than 24 mo of age, a higher agreement existed between Chinese ossification maturity and dentition-based maturity for 522 steers (61.3%).

As shown in Table 3, among 435 steers up to 30 mo of age, USDA ossification maturity agreed with dentition-based maturity for 384 (88.3%) steers. However, among the 769 steers of greater than 30 mo of age, USDA ossification maturity agreed with dentition-based maturity for 348 (45.3%) steers. For those steers of 30 to 72 mo of age, USDA ossification maturity tended to be younger than it should have been, whereas ossification maturity for steers of 72 to 96 mo of age tended to be older.

Overall kappa value between Chinese ossification maturity and dentition-based maturity was 0.42, and that between USDA ossification maturity and dentition-based maturity was 0.43. This indicates that there was a moderate agreement between the Chinese ossification maturity and dentition-based maturity systems, and so was between USDA ossification maturity and dentition-based maturity systems. The degrees of agreement between Chinese and USDA ossification maturity and dentition-based maturity differred greatly among different types of Chinese yellow steers. McNemar's test ($P < 0.001$) indicates that a significant difference existed between ossification maturity and dentition-based maturity. McNemar's test of bias of ossification maturity and dentition-based maturity ($P < 0.001$) for all steers indicated that Chinese ossification maturity for the misclassified steers, except those of 48- to 72-mo steers, tended to be more elderly than it should be (Table 2) and that USDA maturity had a tendency to be more youthful (Table 3).

Conclusions

Both Chinese ossification maturity and USDA ossification maturity agreed moderately with dentition-based maturity. Because of the bias breed on accuracy shown in the present study, more attention should be given to breed when determining ossification maturity.

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Table 1 Agreement between two ossification maturity systems with dentition-based maturity for different typess of Chinese yellow steers [a]

Breeds	Agreement between dentition-based maturity and	
	Chinese ossification maturity	USDA ossification maturity
Crossbred (n=384)	232(60.4%)[A]	293(76.3%)[A]
Luxi (n=403)	187(46.4%)[B]	235(58.3%)[B]
Qinchuan (n=417)	245(58.8%)[A]	204(48.9%)[C]

[a] Numbers with different letters in a column differ significantly (P < 0.01).

Table 2 Agreement between Chinese ossification maturity and dentition-based maturity for different types of Chinese steers

Age groups[a] (mo)	Chinese ossification maturity categories[b]														
	Crossbred steers (k=0.47, P<0.001)					Luxi steers (k=0.31, P<0.001)					Qinchuan steers (k=0.35, P<0.001)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
up to 24	102[c]	69	20	1	-	34[c]	60	33	13	-	6[c]	7	6	1	-
24 to 36	8	41[c]	8	3	-	1	52[c]	29	12	-	-	15[c]	4	1	-
36 to 48	4	8	34[c]	14	2	3	7	42[c]	24	-	-	14	55[c]	12	1
48 to 72	-	2	5	44[c]	7	2	12	20	52[c]	-	-	9	102	156[c]	7
>72	-	-	-	1	11[c]	-	-	-	-	7[c]	-	-	1	7	13[c]

[a] age groups on the basis of dentition; [b] maturity categories based on Chinese ossification maturity system with A, up to 24 mo; B, 24 to 36 mo; C, 36 to 48 mo; D, 48 to 72 mo; E, >72 mo; [c] the number of steers whose Chinese ossification maturity agreed with dentition-based maturity.

Table 3 Agreement between USDA ossification maturity and dentition-based maturity for different types of Chinese steers

Age groups[a] (mo)	USDA ossification maturity categories[b]														
	Crossbred steers (k=0.56, P<0.001)					Luxi steers (k=0.35, P<0.001)					Qinchuan steers (k=0.20, P<0.001)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
up to 30	219[c]	7	1	-	-	142[c]	25	15	1	-	23[c]	1	1	-	-
30 to 42	35	17[c]	5	-	-	39	32[c]	18	-	-	14	14[c]	1	-	-
42 to 72	11	12	52[c]	10	4	29	28	60[c]	7	-	60	106	156[c]	14	6
72 to 96	-	-	-	-	6	-	-	-	1[c]	6	-	1	5	9[c]	4
>96	-	-	-	-	5[c]	-	-	-	-	-	-	-	-	-	2[c]

[a] age groups on the basis of dentition; [b] maturity categories based on USDA ossification maturity system with A, 9 to 30 mo; B, 30 to 42 mo; C, 42 to 72 mo; D, 72 to 96 mo; E, >96 mo; [c] the number of steers whose USDA ossification maturity agreed with dentition-based maturity.