Jurnal Ilmu Peternakan, Juni 2010, hal. 20 – 27 Vol. 5 No.1
ISSN 1907 – 2821

Puberty in Beef Heifers: A Review

(*Pubertas pada Sapi Potong Dara:suatu Review*)

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ABSTRAK

Performans reproduksi optimum dari ternak betina adalah faktor yang sangat penting dalam suatu usaha peternakan sapi potong, sebab sebuah perusahaan peternakan sapi potong hanya dapat berlangsung dengan baik jika ada cukup pedet yang dilahirkan, bertumbuh dengan baik sampai dipasarkan. Pubertas adalah salah satu kriteria reproduksi yang harus dipenuhi oleh ternak sebelum ternak itu dapat bereproduksi. Berbagai penelitian telah dilakukan dan telah diketahui bahwa umur dan bobot saat pubertas pada sapi betina sangat ditentukan oleh bangsa sapi, bobot badan, nutrisi dan musim. Oleh sebab itu, faktor-faktor tersebut perlu diketahui dan dipahami sehingga ternak sapi yang dipelihara dapat diatur untuk bereproduksi seperti yang diharapkan oleh peternak.

Kata kunci: pubertas, sapi dara, reproduksi

INTRODUCTION

Optimum reproductive performance of heifers and cows is of paramount importance. The financial viability of an operation depends primarily on numbers of calves born compared to cows mated and the percentage of calves weaned per year. Therefore, the reproductive performance of the female unit in the breeding herd is one of the major determining factors (Azzam and Nielsen, 1987; Bourdon and Brinks, 1987).

Heifers can only be bred when they reach sexual maturity (puberty); therefore factors that influence puberty must be known and understood.

PUBERTY

Puberty is the time when young animals are first capable of a fertile mating. Heifers are considered to have reached puberty when they experiences the spontaneous ovulation accompanied by obvious signs of oestrus (Hartigan, 1995). Kinder *et al.* (1978) defined puberty in heifers as the first standing heat followed by development of functional corpus luteum. Post and Reich (1980) defined puberty in *Bos indicus* heifers in Australia as the age at which plasma progesterone levels reach 1.0 ng/ml.

Age and Weight at Puberty

Age at puberty is an important trait because it determines lifetime reproductive performance. Ferrell (1982) stated that age at puberty has a significant effect on beef production, specifically when heifers are bred to calve as two years old in a restricted breeding season. Lesmeister *et al.* (1973) found that heifers that conceive early (2-year-olds) have greater lifetime productivity than those that conceive later (3-year-olds). For example, Meaker *et al.* (1980) showed that, Africander heifers calving first as 2 years old produced 0.6 more calves over their productive lifetime than those calving first as 3 year olds, while Pinney *et al.* (1962) estimated the increase to be 0.8 of a calf.

Young (1974) stated that first oestrus occurs when animals have grown to a certain minimum live weight rather than at a particular age. Puberty attainment usually occurs when animal live weight reaches 45-55% of the mature weight. Depending on breed, this will be between 320

and 600 days of age (Roy *et al.*,1975). For example, under similar management, 16% of Hereford heifers reached puberty at 360 days of age compared to 82% of Red Poll heifers (Dow *et al.*, 1982).

Short and Bellows (1971) found that there was a relationship between age at puberty and growth rates. Similarly Gardner *et al.* (1977) reported a correlation between weight gain and age at puberty, where increased growth rate of heifers reduced the age at puberty. During the pre and post-weaning period, growth rate in beef heifers was inversely correlated with the age at puberty (Arije and Wiltbank, 1971; 1974). Heifers which are weaned at heavier weights (204.3 kg) and grow faster (350 g/d) reach puberty earlier (348 days of age) compare to those that weaned at lighter weights (190.5 kg) which grew slower (310 g/d) and reached puberty at 392 days of age (Arije and Wiltbank, 1974).

These data suggest that the age and the weight at puberty is determined by breed, weight, environment, health and management.

Breed

The genetic influence on age at puberty is determined by heterosis, breed differences, and sire and dam effects within breed (Wiltbank *et al.,* 1969; Short *et al.*,1990). Koots *et al.* (1994) showed that the age at puberty is highly heritable (Table 1.). Therefore selecting a breed with younger age at puberty, or crossing them with a breed that has a similar or younger age at puberty will decrease age at puberty (Short *et al.,* 1990). For example Reynolds *et al.* (1963) estimated the average age at puberty in Brahman heifers in Louisiana, USA, to be 27.2 months, compared with 14.4 months for Angus heifers, and the estimate for Angus x Brahman crosses was 15.3 months.

The impact of breed differences on the age at puberty is very distinct (Table 2.). On average, the zebu reaches puberty 6 to 12 months later than *Bos taurus* cattle (Warnick, 1965; Wiltbank *et al.*, 1969). Temperate *Bos taurus* breeds of dairy cattle reach puberty at 30-40% of their adult body weight, compared with 45-55% for beef cattle (Hafez, 1980).

In addition, Laster *et al.* (1972) found that 100 % of Hereford-Angus crosses had reached puberty by 510 days of age compared to 92 % of Hereford and Angus straight-breed.The Hereford-Angus crosses also reached puberty 19.5 days earlier than the average for straight-breed. It is clear that heavier breeds and/or temperate *Bos taurus* breeds reach puberty earlier than lighter breeds and/or *Bos indicus* and *Bos sondaicus* breeds.

Table 1. Heritability of Female Reproduction Traits

Traits	Heritability
Heifer Age at Puberty	0,47
Age at First Calving	0,06
Heifer Conception Rate	0,05
Cow Conception Rate	0,17
Heifer Inter-calving Interval	0,06
Calving Date	0,08
Calving Rate	0,17
Cow Calving Ease	0,13
Heifer Calving Ease	0,10

Source: Koots *et al.* (1994)

Table 2. Female Age at Puberty in Different Breeds and Within Breed

Breed	Age at Puberty (day)	S o u r c e
Bali cattle	660	Copland, 1974
Bali cattle	730-912	Talib *et al.*, 2002
Angus	370	Laster *et al.*, 1972
Hereford	390	Laster *et al.*, 1972
Charolais x Hereford	366	Laster *et al.*, 1972
Jersey x Hereford	319	Laster *et al.*, 1972
South Devon x Hereford	371	Laster *et al.*, 1972
Simental x Hereford	369	Laster *et al.*, 1972
Limousin x Hereford	359	Laster *et al.*, 1972
Red Poll	355	Ferrell, 1982
Simmental	348	Ferrell, 1982
Romosinuano	427	Chase *et al.*, 1997
Senepol	481	Chase *et al.*, 1997
Hereford x Senepol	384	Chase *et al.*, 1997
Senepol x Hereford	427	Chase *et al.*, 1997
Senepol x Angus	475	Chase *et al.*, 1997
Tuli x Angus	466	Chase *et al.*, 1997
Brahman x Angus	478	Chase *et al.*, 1997
Hereford x *B. taurus*	358	Lammoglia *et al.*, 2000
Limousin x *B. taurus*	379	Lammoglia *et al.*, 2000
Piedmontese x *B. taurus*	338	Lammoglia *et al.*, 2000

Body Weight

Body weight and growth are the major factors controlling age at puberty (Joubert, 1963; Laster *et al.*,1972). Generally, non-pubertal heifers are lighter than pubertal heifers at the same age (Maueon, 1978). Heifers that reached puberty by 15 months of age were heavier (293.9 kg) than those that did not reach puberty (257.6 kg) (Laster *et al.*, 1972).

Negative correlations between gains in body weight and age at puberty indicates that increased growth rate of heifers results in reduce age at puberty (Smith *et al.*, 1976; Gardner *et al.*,1977; Oyedipe *et al.*, 1982). Pre-weaning growth has a greater influence on puberty in heifers than post-weaning growth (Joubert, 1954; Dufour, 1975; Swierstra *et al.*,1977; Little *et al.*, 1981; and Clanton *et al.*,1983). Heifers that experienced slower pre-weaning rates of growth (200 g/d) reached puberty at older ages and lighter weight than those that grew faster (400 g/d) (Wiltbank *et al.*, 1966). In contrast, Arije and Wiltbank (1971) found that rapid post-weaning growth rates (610g/d) were associated with delayed puberty attainment. This is supported by Grass *et al.* (1982) who stated that the faster growing heifers after weaning tend to be heavier but not necessary younger at puberty. Based on these phenomena it can be seen that, growth, as a result of nutrition availability and quality will determine the age heifers reach puberty rather than weight determining the age of puberty (Joubert, 1963).

It can be concluded that heifers can only attain puberty if significant weight gains are made, but fast post-weaning growth may in fact retard puberty attainment.

Nutrition

Pre-pubertal nutrition may have a lifetime impact on reproduction and production of a cow (Short *et al.*,1972; Reid, 1960; Day *et al.*, 1986). Studies by Lamond (1970) showed that under-

nutrition post-pubertal heifers may cause reproductive failure. In Zebu (Oyedipe *et al.*, 1982) as well as in *Bos taurus* (Short and Bellows, 1971), showed that poor nutrition significantly delays puberty. In Indonesia, poor growth rate pre and post-weaning, and the late maturity of Bali cattle is largely due to poor nutrition (Putra and Sukarini, 1998; Sutaryono *et al.*, 1998; Jelantik and Nikolaus, 1998). As in Papua Province where farmers rarely mostly on low nutritive value native pasture, the impact for the reproductive performance of the cow may be greater.

Studies by Corah *et al.* (1975) showed that the age at puberty of off-spring from heifers fed a low energy diet (47.70 MJ/d) was 19 days later than those off-spring from heifers fed high energy diets (73.64 MJ/d). Wiltbank *et al.* (1969) found that straight breed (Hereford and Angus) heifers that were fed 40% beet pulp, 60% ground shelled corn plus 1.3 to 1.8 kg crested or intermediate wheat grass hay (high nutritional level), reached puberty 191 days earlier than those fed and 200 g of 40% protein supplement plus 1.3 to 1.8 kg of crested or intermediate wheat grass hay per head per day (low nutritional level).

In addition, Wiltbank et al.(1969) found that straight breed heifers (Hereford and Angus) fed 1.3 to 1.8 kg of wheat grass hay and 0.2 kg of 40 % protein supplement per head per day (low level nutrient) were older at puberty (572 days) compared to their crosses (424 days of age).

These data suggest that although nutritional management of heifers is extremely important, the genetic impact on replacement heifers should not be over looked and will show an even greater role when nutritional resources are limited. The effect of nutritional level on the occurrence of first oestrus in heifers is shown in Table 3.

Heifers fed a high level of protein (150% of estimated requirements) grew faster and attained puberty at a younger age and heavier body weight, and had a higher fertility compared to those fed a low level of protein (41% of estimated requirements) (Oyedipe *et al.*, 1982). Moseley *et al.* (1977) found that dietary monensin carrying in 20% natural protein fed produced increased propionate levels that initiate an endocrine response that may speed up onset of puberty and improve conception rate. On the cotrary, Rhodes *et al.* (1978) found that metabolisable energy levels attained by protein protected feedstuffs from rumen fermentation processes are not effective in enhancing the onset of puberty.

In a study in Nebraska (USA), Arije and Wiltbank (1971) reported that Hereford heifers that run under grazing conditions with protein supplement reached puberty at 434 days of age in year 1 and 438 days of age in year 2 of the study. On the other hand, a study at Clay Center by Laster *et al.* (1972) found that Hereford heifers reach puberty at 390 days of age. These heifers were younger at puberty than those in the previous example most likely because of the differences in feeding management. In Indonesia,

Table 3. The Effect of Level of Energy on Occurrence of First Oestrus

Feed Level	Breed	Approx Gain (kg)	Age (mo)						
			11	12	13	14	15	16	17
Low	Angus	0,9	0	0	0	33	82	90	100
	Hereford	0,6	0	11	22	33	38	50	100
	Crossbred	1	0	0	12	68	85	100	100
High	Angus	1,6	8	33	58	100	100	100	100
	Hereford	1,3	0	12	50	100	100	100	100
	Crossbred	1,9	0	18	75	94	100	100	100

Adapted from Wiltbank *et al.*, 1969

Bali cattle that run under grazing conditions reach puberty at 540 to 660 days of age (Pane, 1990 and Darmadja, 1980).

Poor nutrition during the pre-pubertal period inhibits the development of a mature reproductive endocrine system (Day *et al.*, 1986), and hence delays puberty attainment. However, very high levels of feeding do not necessarily result in earlier puberty attainment. Maintaining feed availability and quality therefore is a major concern in a cow-calf program.

Season

Season contributes significantly to animal's lifetime reproductive performance since sexual development occurs over several seasons. Arije and Wiltbank (1971) found that in the Northern Hemisphere, heifers born in mid-February to May (later in the calving season) were lighter and younger at puberty. Animals exposed to winter conditions during the pre-pubertal period demonstrated delayed puberty (Grass *et al*., 1982). Hauser (1984) found that Heifers born in September were younger (307 vs 334 days) and lighter (287 vs 300 kg) at puberty compare to those that born in March. In other experiment, heifers which were born in September and March that expose to spring to fall environment chamber were 25 days younger and 38 kg lighter compared to those that exposed to fall to spring environment chamber (Hauser, 1984).

The mechanism of how season affect the puberty is not well understood. The effect may be through the direct effect such as the change in photoperiod, temperature, humidity or through the availability of feed.

CONCLUSION

1. Beef heifers Age and weight at puberty is determined by breed, body weight, nutrition and season.
2. Heavier breeds and/or temperate *Bos taurus* breeds reach puberty earlier than lighter breeds and/or *Bos indicus* and *Bos sondaicus* breeds.
3. Heifers can only attainment puberty if significant weight gains are made, but fast post weaning growth may in fact retard puberty attainment.
4. Poor nutrition during the pre-pubertal period delays puberty attainment. However, very high levels of feeding do not necessarily result in earlier puberty attainment. Maintaining feed availability and quality therefore is a major concern in a cow-calf program.
5. Even though the season affect on the puberty of heifers was not well documented and explained, it may affect heifers puberty through the direct effect such as the change in photoperiod, temperature, humidity or indirect effect through the availability of feed.

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