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Growth performance of Wagyu × (Angus × Brahman) and Wagyu × (Charolais × Brahman) crossbred calves from birth to 12 months

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ABSTRACT

This study aimed to evaluate the growth performance of crossbred calves produced by Wagyu bulls (frozen semen) with dams of Red Angus × Brahman (WAB) and Charolais × Brahman (WCB) from birth to 12 months at the Ruminant Research and Development Center, Binh Duong province, between March 2023 and April 2024. A total of 80 newborn calves were divided into two groups: 40 WAB and 40 WCB, monitored for 12 months. All calves were fed diets formulated according to NRC standards (2016) by energy and protein based on available feed sources at RRDC such as guinea grass (*Panicum maximum cv* Hamil; *Panicum maximum* Mombasa)), cassava residue, beer residue and concentrates. The birth weight of WAB calves (29.1 kg) was slightly lower than that of WCB calves (30.2 kg). From birth to 6 months, WCB calves had significantly higher average weights than WAB calves ($P < 0.05$). At 12 months, WAB calves weighed 288.6 kg, while WCB calves weighed 297.1 kg. Average daily weight gains from birth to 12 months were 710.7 g/head for WAB and 731.2 g/head for WCB. Overall, WCB crossbreds demonstrated superior growth performance compared to WAB.

Keywords: *Wagyu crossbred, growth performance.*

Introduction

In Vietnam, the beef cattle population experienced some fluctuation between 2020 and 2023. In 2020, there were 6.24 million cows. In 2021, the total herd reached 6.5 million heads. By 2022, the number slightly decreased to 6.339 million. In 2023, the population saw a slight increase, reaching 6.393 million.

In recent years, research on beef cattle breeds in Vietnam has focused on crossbreeding local Zebu cows with imported beef breeds like Charolais, Red Angus, BBB, Limousin, and Droughtmaster Master. These crossbreds show higher growth rates and improved carcass yields compared to pure Zebu crosses. Studies across various provinces report birth, 6-month, and 12-month weights for Charolais × Brahman and Red Angus × Brahman calves ranging from about 27 to 32 kg at birth and 240 to over 320 kg at 12 months, with some variation depending on location and breed combinations. Wagyu bulls have also been used for crossbreeding, producing calves with promising growth and higher fat content, which is important since current crossbreds still lack sufficient fat in meat to meet market demand.

Wagyu cattle are valued for high intramuscular fat and omega-3 and omega-6 fatty acid content, contributing to superior meat quality. With heritability of intramuscular fat ranging from 0.34 to 0.64, Wagyu genetics are key for improving beef quality worldwide.

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This study compares the growth of calves from Wagyu × Red Angus crossed with Brahman cows (WAB) and Wagyu × Charolais crossed with Brahman cows (WCB) from birth to 12 months, aiming to evaluate their potential for improved beef production in Vietnam.

Material and methods

Materials

Crossbred calves Wagyu × (Red Angus × Brahman crossbred) and WAB and Crossbred calves Wagyu × (Charolais × Brahman crossbred)-WCB. Number of crossbred calves were 40 (20 steer calves and 20 heifer calves) per group.

WAB and WCB are created from Wagyu bull semen with crossbred cows (Red Angus × Brahman crossbred) and (Charolais × Brahman crossbred) by artificial insemination. Crossbred cows (Red Angus × Brahman crossbred) and (Charolais × Brahman crossbred) are created from Red Angus bull semen and Charolais bull semen with Brahamn crossbred cows by artificial insemination.

Location and time

The experiment was conducted at the Ruminant Research and Development Center (RRDC), Lai Hung commune, Bau Bang district, Binh Duong province, from March 2023 to April 2024.

Experiment subject

Body weight of WAB and WCB crossbred calves were at birth, 6, 9 and 12 months of age and the weight gain of crossbred calves were birth - 3 months of age, 3 - 6, 6 - 9, 9 - 12, 0 - 6, 6 - 12 and 0 - 12 months of age of WAB and WCB.

Research methodology

Methods of raising WAB and WCB crossbred calves

WAB and WCB crossbred calves are breastfed freely, supplemented with concentrates and green grass. Calves were trained to eat early from the second week of age. Calves were weaned at 6 months of age and kept in barns according to the experimental.

Feed and rations

The diet of crossbred calves was mixed according to NRC standards (2016) by energy and protein based on available feed sources at RRDC such as guinea grass (*Panicum maximum cv Hamil; Panicum maximum Mombasa*), cassava residue, beer residue and concentrates. The nutritional composition of feeds and diets for calves are presented in Table 1, 2 and 3.

Table 1. Nutritional value of experimental foods

Ingredients	Dry matter (%)	Crude protein (%)	Crude fat (%)	Crude fibe (%)	Ca (g)	P (g)	ME (Kcal/kg)
Guinea grass	18.0	2.2	0.69	6.57	0.12	0.08	390
Cassava waste	24.0	0.7	0.17	0.08	-	-	640
Beer residue	28.0	8.0	1.56	3.26	1.02	0.07	750
Concentrate	89.0	13.0	-	8.50	1.20	0.70	2500

Table 2. Diet for calves from birth to 6 months of age

Months of age	Body weight (kg)	Guinea grass (kg)	Concentrate (kg)
Birth	26		
1	49	0.0	0.1
2	73	4.0	0.3
3	97	6.0	0.8
4	119	8.0	1.2
5	142	9.0	2.0
6	160	10.0	2.5

Note: Calves nurse freely

Table 3. Diet for calves from 7 to 12 months of age

Months of age	Body weight (kg)	Guinea grass (kg)	Concentrate (kg)	Beer residue (kg)	Cassava waste (kg)
7	185	12.0	2.0	2.0	2.0
8	205	14.0	2.0	2.0	2.0
9	224	16.0	2.0	3.0	2.0
10	244	18.0	2.0	3.0	2.5
11	262	22.0	2.0	3.0	3.0
12	280	24.0	2.0	3.0	4.0

In addition, experimental calves were provided with drinking water, mineral block in the barn and calves were vaccinated gainst pasteurellosis, foot-and-mouth disease, and lumpy dermatitis (twice/year). Calves were sprayed ticks periodically once a month and barns were disinfected weekly.

Targets and tracking methods

Body weight of crossbred WAB and WCB calves at birth, 3, 6, 9 and 12 months of age: weigh calves at 8.00 hours by an electronic scale with an error of 0.5 kg with Model 1200 weighing system from Ruddweigh Australia Pty Ltd.

Body weight gain 0 - 3, 3 - 6, 0 - 6, 6 - 9, 9 - 12, 0 - 6, 6-12 and 0-12 months of age is calculated according to the formula:

$$R = \frac{W2 - W1}{t2 - t1}$$

In there: *R: Body weight gain (kg/head/month; grams/head/day);*

W1, W2: Initial and final weight (kg);

t1, t2: Initial and ending time (months).

Data analysis

The obtained data were compiled and processed using Excel 2010 program and Minitab 16 software. Using Ttest to compare the average values according to the model:

$$Y_{ij} = \mu + \alpha_i + e_{ij},$$

In there: *Yij = Observation data (volume, volume gain);*

μ *= General average;*

α_i *= Experimental factor influence (pair of calves = 1, ..., 2);*

e_{ij} *= Experimental error; j = 1, ..., 20-40.*

Results and discussion

Body weight of crossbred calves from birth to 12 months of age

The results of body weight assessment of WAB and WCB crossbred calves are presented in Tables 4 and 5.

Tables 4. Body weight of crossbred calves from birth to 6 months of age

Items	WAB		WCB		P
	n	Body weight (kg) (Mean ± SE)	n	Body weight (kg) (Mean ± SE)	
Birth					
Heifer	20	$28.8^b \pm 0.2$	20	$29.7^a \pm 0.2$	0.002
Steer	20	$29.5^b \pm 0.3$	20	$30.7^a \pm 0.2$	0.004
Calf	40	$29.1^b \pm 0.2$	40	$30.2^a \pm 0.2$	0.001
3 months					
Heifer	20	94.6 ± 0.4	20	95.8 ± 0.5	0.090
Steer	20	100.4 ± 0.5	20	101.4 ± 0.4	0.145
Calf	40	97.5 ± 0.6	40	98.6 ± 0.6	0.176
6 months					
Heifer	20	$153.7^b \pm 0.7$	20	$159.5^a \pm 0.8$	0.001
Steer	20	$164.5^b \pm 0.8$	20	$169.9^a \pm 0.6$	0.001
Calf	40	$159.1^b \pm 1.0$	40	$164.7^a \pm 1.0$	0.001

Table 4 shows that birth weights and weights at 3 and 6 months for WAB and WCB crossbred steers tend to be higher than those for heifers of the same crossbreeds. At birth, WCB calves averaged 30.2 kg (29.7 kg for heifers and 30.7 kg for steers), while WAB calves averaged 29.1 kg (28.8 kg for heifers and 29.5 kg for steers). The birth weight of WCB was significantly higher than WAB ($P < 0.05$).

At 3 months, weights were similar between WAB (97.5 kg steers, 94.6 kg heifers) and WCB (98.6 kg steers, 95.7 kg heifers), suggesting early growth is influenced by maternal milk. By 6 months, WCB calves were significantly heavier than WAB ($P < 0.05$), with averages of 164.7 kg (169.9 kg steers, 159.5 kg heifers) versus 159.1 kg (164.5 kg steers, 153.7 kg heifers), indicating calf weight gain increasingly depends on feed intake and digestion after milk declines.

The weights for WAB and WCB calves are comparable to or exceed those reported in other studies involving Wagyu crossbreds. For instance, Duong *et al.* (2020) reported F_1 Wagyu × Zebu calves weighed 23.5 kg at birth, 94.4 kg at 3 months, and 149.7 kg at 6 months. Truong *et al.* (2021) found birth weights of 24.5-25.8 kg and 6-month weights of 136.4-152.6 kg for Wagyu × Zebu calves in Vinh Phuc. Vu *et al.* (2021) reported 26.4 kg at birth and 121.1 kg at 6 months in Ho Chi Minh City. Tan *et al.* (2022) recorded Wagyu × Holstein calves in Hanoi with birth weights of 29.5-33.0 kg, 3-month weights of 78.1-80.4 kg, and 6-month weights of 118.4-125.8 kg. Dung *et al.* (2022) reported Wagyu × Sind calves in Thai Binh with 23.8 kg at birth, 90.3 kg at 3 months, and 153.0 kg at 6 months; and Wagyu × Brahman calves with 25.4 kg, 94.6 kg, and 159.7 kg, respectively. Similarly, Ngan *et al.* (2023b) found Wagyu × Sind calves in Binh Thuan averaged 27.4 kg at birth, 92.2 kg at 3 months, and 156.1 kg at 6 months. These variations likely reflect differences in breeding stock and management.

Furthermore, Table 4 shows that birth and 6-month weights of WAB and WCB calves are comparable or higher than those of other crossbreds, such as Red Angus × Brahman and Charolais × Brahman, in various regions. For example, Khang *et al.* (2019) reported 23.8 kg birth weight for Red Angus × Sind calves in Tien Giang. Tuan *et al.* (2021) documented Charolais × Brahman calves weighing 31.1 kg at birth and 171.8 kg at 6 months in Hanoi, Hung Yen, and Thai Nguyen, while Red Angus × Brahman calves weighed 29.4 kg and 162.3 kg, respectively. Lap *et al.* (2021) found similar weights in Quang Ngai-Charolais × Brahman calves at 28.8 kg birth and 157.2 kg at 6 months; Red Angus × Brahman at 27.9 kg and 146.0 kg. Hung *et al.* (2022) reported from the Ruminant Research and Development Center that Red Angus × Brahman calves averaged 30.3 kg at birth and 175.9 kg at 6 months, while Charolais × Brahman averaged 31.4 kg and 194.6 kg.

Table 5. Body weight of crossbred calves from 9 to 12 months of age

Items	WAB		WCB		P
	n	Body weight (kg) (Mean ± SE)	n	Body weight (kg) (Mean ± SE)	
9 months					
Heifer	20	$210.5^{b} \pm 0.8$	20	$214.4^{a} \pm 1.0$	0.004
Steer	20	$238.5^{b} \pm 1.3$	20	$245.3^{a} \pm 0.8$	0.000
Calf	40	$224.5^{b} \pm 2.4$	40	$229.9^{a} \pm 2.6$	0.003
12 months					
Heifer	20	$265.1^{b} \pm 1.2$	20	$271.3^{a} \pm 1.4$	0.002
Steer	20	$312.1^{b} \pm 1.0$	20	$322.8^{a} \pm 1.0$	0.000
Calf	40	$288.6^{b} \pm 3.8$	40	$297.1^{a} \pm 4.2$	0.035

Table 5 shows that at 9 and 12 months, crossbred steers consistently weighed more than heifers. At 9 months, WAB calves averaged 224.5 kg (210.5 kg heifers, 238.5 kg steers), while WCB calves averaged 229.9 kg (214.4 kg heifers, 245.3 kg steers). At 12 months, WAB calves weighed 288.6 kg on average (265.1 kg heifers, 312.1 kg steers), and WCB calves weighed 297.1 kg (271.3 kg heifers, 322.8 kg steers). WCB calves were significantly heavier than WAB calves at both ages ($P < 0.05$).

These weights are comparable to or exceed those reported for Wagyu × Zebu crossbreds in various regions. Duong *et al.* (2020) reported F_1 WagyuxZebu calves weighing 199.9 kg and 248.1 kg at 9 and 12 months, respectively. In Vinh Phuc, Truong *et al.* (2021) found Wagyu × Zebu calves weighed between 185.3 - 206.2 kg at 9 months and 233.6 - 255.7 kg at 12 months. Vu *et al.* (2021) observed 201.7 kg at 12 months in Ho Chi Minh City; Tan *et al.* (2022) reported 229.2-261.9 kg for Wagyu × Holstein calves in Hanoi. In Thai Binh, Wagyu × Sind calves weighed 204.3 kg at 9 months and 238.1 kg at 12 months (Dung *et al.*, 2022), while Wagyu × Brahman crossbreds weighed 216.6 kg and 236.2 kg at respective ages. Ngan *et al.* (2023b) recorded 219.5 kg and 275.1 kg for Wagyu × Sind calves in Binh Thuan. Retana *et al.* (2018) reported Wagyu × Angus calves at 238.6 kg at 7 months and 335.7 kg at 12 months. Pure Wagyu calves reached 142.2 kg at 137 days and 541.3 kg at 485 days (Radunz *et al.*, 2009).

The superior weights of WAB and WCB calves may reflect differences in dam quality, rearing conditions, and selective breeding based on birth weight and health.

Moreover, WAB and WCB calves' weights at 9 and 12 months equal or surpass those of other crossbreds such as Red Angus × Brahman, Red Angus × Zebu, Charolais × Brahman, and Charolais × Zebu in various studies. Lap *et al.* (2021) reported 12-month weights of 262.1 kg for Charolais × Brahman and 249.6 kg for Red Angus × Brahman calves in Quang Ngai. Tuan *et al.* (2021) found Charolais × Brahman calves at 277.8 kg and Red Angus × Brahman calves at 264.0kg at 12 months in Hanoi, Hung Yen, and Thai Nguyen. Hung *et al.* (2022) reported 302.2 kg for Red Angus × Brahman and 322.3 kg for Charolais × Brahman calves at 12 months at the Ruminant Research and Development Center.

Overall, WAB and WCB calves demonstrate growth performance equal to or better than other popular crossbreds, highlighting their potential to improve beef productivity and quality in Vietnam.

Weight gain of crossbred calves from birth to 12 months of age

The absolute weight gain is closely related to the quality of breeding and the care and feeding practices. By monitoring weight gain, we can assess the growth potential, evaluate the effectiveness of feeding methods, and determine the meat production potential of the breed. Tables 6 and 7 present the growth rates of WAB and WCB crossbred calves.

Table 6. Weight gain of crossbred calves from birth to 6 months of age

Items	WAB		WCB		P
	n	grams/head/day (Mean ± SE)	n	grams/head/day (Mean ± SE)	
Birth - 3 months					
Heifer	20	731.1 ± 4.7	20	733.9 ± 4.1	0.659
Steer	20	787.8 ± 3.2	20	785.6 ± 2.4	0.585
Calf	40	759.4 ± 5.3	40	759.7 ± 4.8	0.969
3 - 6 months					
Heifer	20	657.2^{b} ± 5.1	20	708.3^{a} ± 6.1	0.001
Steer	20	711.7^{b} ± 3.7	20	761.1^{a} ± 6.0	0.001
Calf	40	684.4^{b} ± 5.4	40	734.7^{a} ± 6.0	0,001
Birth - 6 months					
Heifer	20	694.2^{b} ± 3.6	20	721.1^{a} ± 3.8	0.001
Steer	20	749.7^{b} ± 2.9	20	773.3^{a} ± 3.2	0.001
Calf	40	721.9^{b} ± 5.0	40	747.2^{a} ± 4.9	0.001

Results in Table 6 indicate that from birth to 6 months, heifers generally exhibit higher weight gain than steers. From birth to 3 months, both WAB and WCB crossbred calves showed similar weight gains - 759.4 g/head/day for WAB and 759.7 g/head/day for WCB. However, between 3 and 6 months, WCB calves demonstrated significantly higher weight gain (734.7 g/head/day) compared to WAB calves (684.4 g/head/day) ($P < 0.05$). Across the entire birth-to-6-month period, WCB calves gained 721.1 g/head/day (heifers) and 773.3 g/head/day (steers), while WAB calves gained 694.2 g/head/day (heifers) and 749.7 g/head/day (steers), with these differences also statistically significant ($P < 0.05$). These findings reveal distinct patterns of weight gain by sex and growth stage between the two crossbreds.

Overall, the weight gains of WAB and WCB calves are comparable to or exceed those reported in studies of Wagyu bulls crossed with local beef breeds. Duong *et al.* (2020) reported that F_1 Wagyu × Zebu calves in Ba Vi, Hanoi, peaked at 788.0 g/head/day from birth to 3 months. Similarly, Vu *et al.* (2021) found Wagyu × Zebu calves in Ho Chi Minh City achieved 525.3 g/head/day from birth to 6 months.

Dung *et al.* (2022) observed in Thai Binh that Wagyu × Brahman and Wagyu × Sind calves gained 769.6 g/head/day and 736.6 g/head/day, respectively, from birth to 3 months, with gains higher at this younger age compared to later stages. Ngan *et al.* (2023a) reported a weight gain of 697.6 g/head/day from birth to 6 months for Wagyu × Brahman calves at the Ruminant Research and Development Center. In Binh Thuan, Wagyu × Sind crossbreds gained 714.8 g/head/day during the same period (Ngan *et al.*, 2023b).

Table 7. Weight gain of crossbred calves from 6 to 12 months of age

Items	WAB		WCB		P
	n	grams/head/day (Mean ± SE)	n	grams/head/day (Mean ± SE)	
6-9 months					
Heifer	20	631.1± 6.6	20	610.0 ± 5.6	0.060
Steer	20	822.8 ± 10.9	20	837.8 ± 5.9	0.236
Calf	40	726.9 ± 16.6	40	723.9 ± 18.7	0.903
9-12 months					
Heifer	20	606.1^{b} ± 7.7	20	632.2^{a} ± 11.7	0.070
Steer	20	817.8^{b} ± 14.6	20	861.1^{a} ± 7.2	0.011
Calf	40	711.9^{b} ± 18.8	40	746.7^{a} ± 19.5	0.022
6-12 months					
Heifer	20	618.6 ± 5.4	20	621.1 ± 7.0	0.778
Steer	20	820.3^{b} ± 3.9	20	849.4^{a} ± 4.8	0.001
Calf	40	719.4^{b} ± 16.5	40	735.3^{a} ± 18.8	0.038
0-12 months					
Heifer	20	647.4^{b} ± 3.2	20	661.9^{a} ± 3.8	0.006
Steer	20	774.3^{b} ± 2.2	20	800.3^{a} ± 2.5	0.001
Calf	40	710.8^{b} ± 10.3	40	731.1^{a} ± 11.3	0.003

Results from Table 7 show that between 6 and 9 months of age, WAB and WCB crossbred calves exhibit similar weight gains-726.9 g/head/day for WAB and 723.9 g/head/day for WCB-comparable to their gains from birth to 6 months. This indicates that post-weaning, calves adapt well to feeding conditions, with sufficient feed intake and balanced nutrition.

From 9 to 12 months, WCB calves achieve a significantly higher average weight gain of 746.7 g/head/day (632.2 g for heifers, 861.1 g for steers) compared to WAB calves at 711.9 g/head/day (606.1 g for heifers, 817.8 g for steers) ($P < 0.05$). Over the 6 to 12-month period, WCB calves continue to outperform WAB, gaining 735.3 g/head/day versus 719.4 g/head/day, also significant ($P < 0.05$).

Overall, weight gain from 6 to 12 months matches gains from birth to 6 months. Across the entire birth-to-12-month period, WCB calves gained 731.3 g/head/day - significantly more than WAB calves with 710.8 g/head/day ($P < 0.05$).

These weight gains are on par with or higher than those recorded for Wagyu bulls crossed with local beef breeds. Duong *et al.* (2020) noted that F_1 Wagyu × Zebu calves in Ba Vi, Hanoi, had lower gains during 9 - 12 months at 535.0 g/head/day. Vu *et al.* (2021) observed 458.1 g/head/day in Ho Chi Minh City from 6 to 12 months. Ngan *et al.* (2023a) reported 627.8 g/head/day gain for Wagyu × Brahman calves from 7 to 12 months, while in Binh Thuan, Wagyu × Sind calves gained 661.5 g/head/day (Ngan *et al.*, 2023b).

WAB and WCB gains also exceed those of Charolais × Brahman and Red Angus × Brahman crossbreds. In Quang Ngai, Lap *et al.* (2021) found 7-12-month gains of 582.8 g/head/day (Charolais × Brahman) and 575.3 g/head/day (Red Angus × Brahman). Tuan *et al.* (2021) reported gains of 558.9 and 618.3 g/head/day for Charolais × Brahman calves at 7-9 and 10-12 months, respectively, while Red Angus × Brahman calves gained 543.3 and 586.1 g/head/day. Hung *et al.* (2022) documented gains at the Ruminant Research and Development Center of 701.7 g/head/day (Red Angus × Brahman) and 709.2 g/head/day (Charolais × Brahman) from 7 to 12 months.

Globally, weight gains reported for Wagyu-based crosses are higher. Retana *et al.* (2018) recorded 798.69 g/head/day for Wagyu × Anguscalves from 7 to 12 months, and Vazquez-Mossquera *et al.* (2022) found 1,046 g/head/day from 5 to 12 months. The lower gains of WAB and WCB calves compared to these studies may result from differences in breeding stock, management, and feed quality.

Conclusions

WCB crossbred calves generally weigh more than WAB calves, with body weights of 164.7 kg and 297.1 kg at 6 and 12 months, compared to 159.1 kg and 288.6 kg for WAB calves. WCB calves also exhibit higher weight gains from birth to 6 months, 6 to 12 months, and birth to 1.2 months. Both crossbreds show the highest weight gain between birth and 3 months, averaging around 759 g/head/day. Further research is needed to assess their growth, reproductive performance, productivity, meat quality after fattening, and economic efficiency.

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