ASSESSMENT OF CATTLE CARCASS CHARACTERISTICS IN THREE MALAYSIAN ABATTOIRS

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ABSTRACT. The National Agro-Food Policy aims for 50% self-sufficiency in beef production by 2030. Recent declines in production and self-sufficiency highlight the need to update production factors last reviewed in 2006. Net carcass percentage, a key measure of beef cattle production efficiency, directly impacts breeder profitability. While the Food and Agriculture Organization (FAO) recommends a 50-55% net carcass percentage for Southeast Asia, Malaysia's current status remains unclear. This study assesses carcass characteristics of local crossbred and imported cattle breeds, comparing the current average carcass weight to the existing conversion factor. Data from 422 cattle were collected across three government-operated slaughterhouses in Selangor, Perak, and Negeri Sembilan using standardized digital scales and record forms. Statistical analysis with SPSS version 26.0 included descriptive statistics, Chi-Square tests, Spearman's rank correlation, and Kruskal-Wallis H tests. Results revealed averages of 430.53 ± 191.35 kg for live weight, 209.61 ± 88.70 kg for carcass weight, and 49.51 ± 5.66% for dressing percentage. New conversion factors of 0.1323 metric tons per head for the Kedah-Kelantan Cross and 0.2612 metric tons per head for imported breeds (Brahman, Charolais, and Limousin) are recommended to improve meat production estimates. Heavier breeds showed lower dressing percentages, suggesting that breed, nutrition, and slaughter age significantly affect net carcass yield. This study recommends revising conversion factors to enhance the accuracy of meat production estimates, supporting Malaysia's self-sufficiency goals.

***Keywords*:** slaughter, efficiency level, beef cattle, meat production

INTRODUCTION

The National Agro-Food Policy of Malaysia (DAN 2.0) aims to achieve 50% self-sufficiency in beef production by 2030. Data from the Department of Veterinary Services (DVS) indicate that from 2016 to 2021, an annual average of 110,353 cattle were slaughtered in Peninsular Malaysia, contributing 22.3% to local beef and buffalo production. However, a decline in production over the past six years necessitates a reassessment of the factors used to calculate beef production (DVS, 2022). The last review of these conversion factors was conducted in 2006, highlighting the urgent need for a new study to ensure that current data accurately reflects the state of the national livestock industry.

Conversion factors are essential for translating livestock variables into different measurement units, allowing for efficient calculations of total beef or buffalo meat production. These factors, derived from expert opinions, literature reviews, and regional practices, enable calculations based on the number of animals slaughtered and their average carcass weight without extensive data collection from individual producers (FAO, 2018). The accuracy of these factors directly influences calculated carcass weight and estimated meat production. Notably, the Food and Agriculture Organization (FAO) recommends a 50-55% net carcass percentage for Southeast Asia, providing a regional benchmark for these calculations.

Recent trends, particularly the increase in the live weight of imported cattle for slaughter in Malaysia, have significantly impacted these calculations. Imported cattle can weigh up to 500 kilograms per animal, compared to previous studies that reported an average live weight of 259.05 kilograms (DVS, 2022). The current conversion factor, established in a 2006 study (Tapsir *et al*., 2007), may no longer reflect contemporary livestock characteristics and production methods, potentially compromising the reliability of national livestock statistics. This discrepancy underscores the urgent need to review the carcass weight conversion factor for ruminant livestock.

The objective of this study is to assess the average carcass weight of cattle across crossbred, and imported breeds in Malaysia. Additionally, the study aims to compare the current average carcass weight of these cattle with the existing average carcass weight used as a conversion factor for cattle. Furthermore, it will evaluate the relevance of the current conversion factor in light of these new findings. By identifying significant discrepancies between the new data and existing standards, this research seeks to highlight the potential need for updated conversion factors. Such revisions would enhance accuracy in cattle weight estimation and production forecasting, thereby supporting Malaysia's efforts to achieve its self-sufficiency targets in the livestock sector.

MATERIALS AND METHOD

Data Collection

This research collected primary data from slaughtering activities at three Department of Veterinary Services abattoirs: Shah Alam, Senawang, and Ipoh Abattoir Complexes, all under the supervision of the Veterinary Regulatory Division. A total of 422 samples were gathered: 251 from Shah Alam, 137 from Senawang, and 34 from Ipoh. The 2021 report highlighted that the Shah Alam Abattoir Complex had the highest levels of cattle slaughtering activity.

The study employed precise digital scales for measurements: a platform-type scale for live weight and a portable digital scale for carcass weight. Data collection was conducted by slaughterhouse workers under the supervision of the slaughterhouse manager.

Data on livestock live weights prior to slaughter and carcass weights following slaughter were acquired through an extensive procedure. Standardised slaughter record forms were introduced to guarantee accuracy and uniformity across all locations.

The carcass weight data in this study adhered to FAO definition, which differs from the previous study (Tapsir *et al*., 2007) by excluding offal from the carcass weight calculation. This standardization ensures uniformity in data collection and allows for more accurate comparisons across different studies and time periods.

Sample Size

The sample size was calculated to ensure the minimum number of animals required for a representative sample in the study. This was determined using the Raosoft sample size calculator (Raosoft, 2015). With an indicator percentage of 0.50, a margin of error of 5%, and a confidence interval (CI) of 95%, the calculated sample size was 377. The actual sample size of 422 exceeded this minimum requirement, enhancing the study's statistical power.

DATA ANALYSIS AND CALCULATION

Data analysis was performed using SPSS version 26.0, utilizing both descriptive and inferential statistical methods. The descriptive analysis identified the average carcass weight at present. A chi-square test was applied to examine the relationship between breed and age group. To evaluate the correlation between live weight and carcass weight, Spearman's rank correlation analysis was employed. Furthermore, the study utilised the non-parametric Kruskal-Wallis H test alongside Duncan's pairwise post-hoc analysis to compare carcass weights among different cattle breeds. This analytical approach enabled an assessment of current carcass weights and underscored the potential need for revised conversion factors in livestock production estimates.

Dressing percentage is the ratio of dressed carcass weight to the weight of the live animal, expressed as a percentage. The conversion factor is determined by taking the average of the carcass weight in metric tonnes (FAO, 2018).

RESULTS AND DISCUSSION

Analysis of Cattle Breeds: Age, Weight Characteristic and Dressing Percentage

This study analysed data from 422 cattle samples collected over a six-month period, from April to October 2022, using a sample size determined to be statistically valid via the Raosoft sample size calculator (Raosoft, 2015). The breeds studied included Kedah-Kelantan Cross, Brahman, Charolais, and Limousin, with Brahman representing the largest proportion and Limousin the smallest. Table 1 presents an analysis of the age, weight, and dressing percentage of these breeds. Variations in live weight, carcass weight, and dressing percentage were observed across the breeds. These variations could be influenced by factors such as age, feeding regimes, and management practices (Kayar & İnal, 2022; Nogalski *et al.*, 2018).

Most cattle were slaughtered between 3 and 5 years of age, with the Kedah-Kelantan Cross being the youngest on average. Specifically, 50% of Kedah-Kelantan Cross cattle were slaughtered between 3 and 4 years, while the Brahman, Charolais, and Limousin breeds were predominantly slaughtered at ages exceeding 5 years. A chi-square test indicated a significant association between breed and age group ($\chi^2(6) = 83.933$, $p<0.05$), demonstrating notable age variations at slaughter among the breeds.

The dressing percentage, defined as the ratio of carcass weight to live weight, plays a crucial role in estimating meat yield and economic returns. In this study, the Kedah-Kelantan Cross had the highest dressing percentage, at 50.38%, followed by Brahman at 49.44%. In contrast, Charolais and Limousin, despite their higher live and carcass weights, exhibited lower dressing percentages of 47.69% and 47.72%, respectively. The higher dressing percentages of the Kedah-Kelantan Cross and Brahman breeds could suggest better efficiency in carcass yield relative to live weight, despite their lower absolute weights. Spearman's rank correlation analysis revealed a strong positive correlation between live weight and carcass weight ($r^s = 0.975$, $p<0.001$), but a weak negative correlation between live weight and dressing percentage ($r^s = -0.183$, $p<0.001$). These findings suggest that while live weight is a reliable predictor of carcass weight, its relationship with dressing percentage is influenced by factors like breed, diet, and management (Coyne *et al.*, 2019; Soulat *et al.*, 2023).

The results of this study are consistent with the findings of Abdullah and Meng (2024), who investigated the growth performance of Belgian Blue (BB) crossbred cattle in tropical conditions. Their study reported a substantial increase in live weight compared to the local Kedah-Kelantan and Brahman breeds, with BB crossbreds showing live weight gains of 50%–100% higher than these breeds. For example, male BB crossbreds reached a mature weight of 527.5 kg, and females reached 518.5 kg, indicating the significant benefits of heterosis and the double-muscled effect in these crossbred cattle. Such growth rates suggest that BB crossbreds may offer a more rapid and economically advantageous growth trajectory for tropical beef production.

Maulid *et al*. (2021) conducted a study examining the effects of slaughter age and sex (steer or bull) on the carcass characteristics of Red Brahman Crossbred cattle. Their findings indicated that both factors significantly influenced slaughter and carcass weights, with steers typically achieving higher weights than bulls. The research recorded the highest average carcass weights in cattle aged 2–2.5 years at 294.5 kg, followed by those aged 3 years at 281.1 kg, and those under 1.5 years at 268.2 kg. Consequently, the study recommended that the optimal slaughter age for maximizing meat yield while minimizing excess fat in Red Brahman Crossbred cattle is approximately 2–2.5 years.

Further studies on breed selection emphasize the importance of carcass yield and dressing percentages. Thirawong *et al.* (2024) found that Wagyu crossbred with Brahman (WBR) achieved the highest dressing yield of 60.95%, with a slaughter weight of 491.29 kg and a hot carcass weight of 299.70 kg. In comparison, Wagyu crossbred with Kamphaengsean (WKPS) achieved a dressing yield of 58.77%, with a slaughter weight of 482.14 kg and a hot carcass weight of 283.79 kg. These findings underscore the significant role that breed combinations can play in improving both live and carcass weights as well as dressing yield, which is an essential consideration for commercial beef production.

In Malaysia, the Kedah-Kelantan (KK) breed remains important for traditional farming and low-input systems, especially in light of the challenges posed by climate change. According to Islam *et al*. (2021), KK cattle are well-suited to local conditions, with the ability to thrive on low-quality feeds and produce one calf per year. While exotic and crossbred cattle are often seen as more productive, the KK breed is a sustainable and profitable option in certain regions due to its adaptability and resilience.

Table 1. Analysis of Cattle Breeds: Age, Weight, and Dressing Percentage

Breed	Age (Years)			Average (kg)		Dressing Percentage (%)
	< 3	3 – 4	≥ 5	Live Weight	Carcass Weight	
Kedah-Kelantan Cross, n = 169 (40.0%)	42 (25%)	98 (58%)	29 (17%)	265.92	132.36	50.38
Brahman, n = 179 (42.4%)	16 (8%)	71 (40%)	92 (52%)	480.17	233.75	49.44
Charolais, n = 41 (9.7%)	0	16 (39%)	25 (61%)	696.11	332.03	47.69
Limousin, n = 33 (7.8%)	0	10 (30%)	23 (70%)	674.27	322.16	47.72
Total, n = 422	**58 (14%)**	**195 (46%)**	**169 (40%)**	**430.53 ± 191.35**	**209.61 ± 88.70**	**49.51 ± 5.66**

A comparison of historical and recent data for the Kedah-Kelantan and Brahman breeds (Table 2) shows a trend of increased live weights over time. For instance, the average live weight of Kedah-Kelantan cattle increased from 200.9 kg in 1975 to 265.9 kg in the current study, although the dressing percentage has slightly declined from 53.3% in 1975 to 50.4% in 2024. Similarly, for Brahman cattle, the average live weight has varied from 424.3 kg to 513.6 kg in different studies, with the current study reporting an average live weight of 480.2 kg and a carcass weight of 233.8 kg. Notably, the dressing percentage for Brahman cattle has declined from 57.6% in previous studies to 49.4% in the present study, which may reflect changes in management practices, environmental factors, or breeding strategies over time.

When comparing Charolais and Limousin cattle across different studies (Table 3), our research found notably higher live weights, with Charolais averaging 696.11 kg and Limousin 674.27 kg, surpassing figures from previous studies by approximately 8.9%–16.2% (Alberti *et al*., 2008; Kayar & İnal, 2022). However, carcass weights were lower in our findings, with Charolais at 332.0 kg and Limousin at 322.2 kg, compared to the figures of 386.6 kg and 360.0 kg reported by Alberti *et al*. (2008) and Kayar and İnal (2022). Most notably, the dressing percentages for Charolais and Limousin were significantly lower in this study (47.7%) compared to those reported in previous research (>55%). These discrepancies may be due to a variety of factors, including differences in feeding regimes, environmental conditions, age at slaughter, and regional variations in cattle handling and processing methods.

Alberti *et al*. (2008) also discovered substantial variations across various European cattle breeds, including Charolais and Limousin. Their study evaluated 15 different breeds and found that Charolais was the heaviest breed at slaughter, with an average weight of 634 kg at 461 days of age, while Jersey was the lightest at 378 kg at 415 days. Carcass weights varied from 189.7 kg for Jersey to 386.6 kg for Charolais. These findings highlight significant variability in key beef production traits across different breeds, which can be instrumental for developing breeding strategies aimed at improving efficiency and meeting the demands of the beef industry.

The studies by Nogalski *et al*. (2017), Kuswati *et al.* (2014), and Oyan *et al.* (2024) further emphasised the critical role of breed selection, management practices, and age at slaughter in optimising beef production. For instance, Nogalski *et al.* (2017) found that Charolais x Holstein-Friesian bulls, at 18 months of age, had a slaughter weight of 539.5 kg, with a carcass weight averaging 316.7 kg and a dressing percentage of 58.8%. Similarly, Kuswati *et al.* (2014) reported that Brahman crossbred steers in an Indonesian feedlot had a carcass yield of 56.6%, with a slaughter weight of 450.2 kg and a hot carcass weight of 254.9 kg. These results align with our study's findings, confirming that while some breeds may produce heavier carcasses, the dressing percentage is often influenced by factors beyond just live weight, including diet, breed, and slaughter practices.

Analysis of Beef Carcass Weights by Breed

The initial analysis of carcass weight across different breeds revealed significant violations of the assumptions required for conducting a one-way ANOVA, particularly concerning non-normal data distribution and the homogeneity of variances. To address these issues, a Kruskal-Wallis H test was employed as a non-parametric alternative. The results revealed a statistically significant difference

Table 2. A comparative assessment of age, weight, and dressing percentage for Kedah-Kelantan and Brahman from the study's findings in comparison to previous research

Characteristics	Breed & References					
	Kedah-Kelantan (KK) & KK Cross			Brahman & Brahman Cross		
	Devendra and Choo (1975)	Dahlan *et al.* (1992)	Current Findings (2024)	Maulid *et al.* (2021)	Rafsanjani *et al.* (2023)	Current Findings (2024)
Slaughtering age (years)	3	3	3	2-2.5	1.5 - 2	4
Live weight (kg)	200.9	206.4	265.9	513.6	424.3	480.2
Carcass weight (kg)	106.8	145.4	132.4	294.5	231.8	233.8
Dressing percentage (%)	53.3	55.9	50.4	57.6	54.6	49.4

Table 3. A comparative assessment of age, weight, and dressing percentages for Charolais and Limousin from the study's findings in comparison to previous research

Characteristics	Breed & References					
	Charolais			Limousin		
	Alberti *et al.* (2008)	Kayar and İnal (2022)	Current Findings (2024)	Alberti *et al.* (2008)	Kayar and İnal (2022)	Current Findings (2024)
Slaughtering age (years)	1.3	1.5	5	1.3	1.5	5
Live weight (kg)	634.0	590.7	696.1	565.4	581.9	674.3
Carcass weight (kg)	386.6	346.9	332.0	360.0	348.3	322.2
Dressing percentage (%)	61.0	58.8	47.7	63.7	59.9	47.7

in the mean rank of carcass weights among the various breeds, with results showing H (3) =279.735 and p<0.05. The mean rank of carcass weight was 99.75 kg for KK cross, 253.85 kg for Brahman, 369.54 kg for Charolais, and 357.74 kg for Limousin. Another analysis was then conducted for further exploration of these differences.

Following the Kruskal-Wallis test, pairwise comparisons were conducted using Dunn's test with Bonferroni correction account for multiple comparisons. This subsequent analysis highlighted significant differences ($p < 0.05$) in carcass weights across all breed pairs, with the exception of the Limousin and Charolais breeds, which exhibited no significant difference ($p = 1.000$), as detailed in Table 4. These findings provide valuable insights into the weight characteristics of beef carcasses by breed, facilitating informed decisions in breeding and production practices.

Table 4. Pairwise Comparisons of Breed

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
KK cross-Brahman	-154.095	13.081	-11.780	0.000	0.000
KK cross-Limousin	-257.991	23.212	-11.115	0.000	0.000
KK cross-Charolais	-269.785	21.233	-12.706	0.000	0.000
Brahman-Limousin	-103.896	23.106	-4.497	0.000	0.000
Brahman-Charolais	-115.690	21.117	-5.479	0.000	0.000
Limousin-Charolais	11.794	28.523	0.413	0.679	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is 0.05.
[a]Significance values have been adjusted by the Bonferroni correction for multiple tests.

A corresponding box plot visually supports these findings (Figure 1), highlighting distinct variations in carcass weight distributions among most breeds, while Limousin and Charolais demonstrate notably similar profiles. Overall, these results indicate that breed significantly influences carcass weight, with some breeds exhibiting marked differences in characteristics, while others, particularly Limousin and Charolais, present comparable weight distributions.

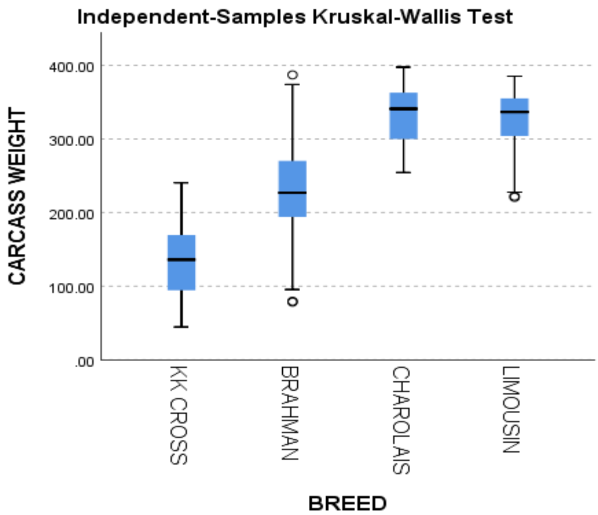

Figure 1. Box plot illustrating carcass weight versus breed

Comparative Analysis of Average Live and Carcass Weights in Cattle and Their Conversion Factor

All 422 data samples were compared with the findings of Tapsir *et al.* (2007) to assess changes in cattle characteristics over time. Table 5 presents a comparison of key parameters between the two studies. Statistical analysis using a t-test revealed significant differences in both average live weight and carcass weight between the studies ($p < 0.05$).

Currently, Malaysia calculates ruminant meat production using a carcass weight conversion factor of 0.1446 metric tons per head (cattle), as established by Tapsir *et al*. (2007). However, our study indicates a significant difference in carcass weight between the local Kedah-Kelantan crossbreed and imported breeds, specifically Brahman, Charolais, and Limousin. Notably, there is no significant difference in carcass weight between Charolais and Limousin as shown in Table 4. Ideally, separate conversion factors should be used for each category: Kedah-Kelantan cross breed, Brahman, and a combined Charolais-Limousin.

Due to challenges in obtaining precise breed-specific data in the field, we grouped carcass weights into two categories: Kedah-Kelantan cross breed, and imported breeds (Brahman, Charolais, and Limousin). The conversion factors derived from this grouping were 0.1323 metric tons per head for local Kedah-Kelantan crossbreed and 0.2612 metric tons per head for imported breeds.

Additionally, the current study provides a dressing percentage of 50.38 ± 6.90 for local Kedah-Kelantan crossbreeds and 48.93 ± 4.57 for imported breeds, a parameter not provided in the study by Tapsir *et al.* (2017). The dressing percentage for imported cattle breeds was lower than in previous studies, likely due to differences in slaughter age. The average slaughter age in the present study was over four years, compared to ≤ 2.5 years in earlier studies.

The marked rise in live and carcass weights, especially in imported breeds, underscores the importance of updating the conversion factors used in national livestock statistics. These factors are essential for translating livestock variables into units of measurement and for calculating total meat output from available data on cattle numbers and weights. Accurate conversion factors are crucial for reliable national livestock statistics, efficient market operations, and informed decision-making in the livestock industry (FAO, 2018).

It is proposed that these revised conversion factors be adopted for calculating ruminant meat production in Malaysia. This update is critical for more accurate estimation of national meat production and aligns with the objectives of National Agro-Food Policy of Malaysia, which targets a 50% self-sufficiency rate in beef meat by 2030 (DAN 2.0).

Table 5. Comparison of Current Study Findings with Tapsir *et al.* (2007)

Parameter	Tapsir *et al.* (2007) (n=1,362)	Current Findings (n = 422)					
		Local (KK Cross)	t	*p-val*	Import (B, CH, LI)	t	*p-val*
Average live weight, kg	259.05 (± 98.64)	265.92 (±89.07)	17.71	.000	540.48 (±159.92)	39.38	.000
Average carcass weight, kg	144.64 (± 59.83)	132.36 (±43.80)	-3.64	.000	261.21 (±72.03)	25.75	.000
Conversion factor	0.1446 metric tons per head	0.1323 metric tons per head			0.2612 metric tons per head		
Dressing percentage (%)	Not available	50.38 ± 6.90			48.93 ± 4.57		

KK Cross: Kedah-Kelantan cross, B: Brahman, CH: Charolais, and LI: Limousin

LIMITATION OF THE STUDY

This study encountered several key limitations that warrant consideration. Firstly, the sampling methodology lacked stratification across animal breeds and production systems, potentially affecting the representativeness of the study population. Additionally, technical constraints, particularly the absence of standardised digital weighing equipment, could have impacted measurement precision. Furthermore, the study's limited scope, coupled with resource constraints, restricted both the sample size and observation period, potentially limiting the generalisability of the findings.

RECOMMENDATION FOR FUTURE RESEARCH

Future research should address these limitations by incorporating methodological improvements. A stratified sampling approach should be adopted to ensure more representative coverage of various breeds, production systems, and geographical locations. Additionally, the use of calibrated digital weighing equipment and standardized measurement protocols would improve the accuracy of data collection. Expanding the scope of future studies to include longitudinal observations, environmental variables, and economic factors, while also increasing sample size, would enhance the robustness of the research and provide more comprehensive insights for practical applications in the field.

CONCLUSION

In conclusion, this study provides valuable updated data on cattle carcass characteristics in Malaysia, in cattle productivity over the past 15 years. There are increase in average of carcass and conversion factor significantly compared to previous study. A new conversion factor of 0.1323 metric tonnes per head for the Kedah-Kelantan cross and 0.2612 metric tonnes per head for imported breeds (Brahman, Charolais, and Limousin) is recommended to enhance the accuracy of meat production estimates. The findings emphasise the need for regular reassessment of conversion factors to ensure accurate national livestock statistics and informed policy decisions. Effective management of these variables is essential to improve net carcass percentages and support Malaysia's efforts to enhance meat production and food security.

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