PREDICTING BEEF CARCASS COMPOSITION USING DUAL ENERGY X-RAY ABSORPTIOMETRY (DXA) SCANNING OF DIFFERENT CARCASS SECTIONS

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I. INTRODUCTION

The quantification of body composition is important to estimate animal nutritional requirements and saleable meat yield [1]. Dissection is a direct method to quantify tissue composition. However, it is not feasible to perform in an industrial environment due to its laborious and time-consuming nature. As a reliable indirect method, DXA scanning has been used to accurately predict lean, fat, and bone tissues [2,3,4]. We hypothesized that carcass physical composition can be precisely estimated using DXA data of different carcass sections. Therefore, this study aimed to develop equations to predict the half carcass composition of young Nellore males using DXA scanning of different carcass sections.

II. MATERIALS AND METHODS

The right half-carcasses from 18 young Nellore males (9 bulls and 9 steers), receiving maintenance (n = 6), high (n = 6), or low (n = 6) concentrate diets were evaluated in this study. The treatments were selected to maximize the range in hot carcass weight and fat score. After 24 h of chilling, carcasses were divided into five sections (Figure 1), and then scanned in a medical DXA unit (GE Healthcare, Lunar Prodigy Advance, USA). The Small Animal configuration mode of the GE Healthcare enCORE software, version 18, was selected. The DXA scanning provided data on fat, lean, and bone mineral content (BMC). Afterward, each section was dissected into fat, muscle, and bone content. DXA variables (fat, lean, and BMC) of carcass sections were used to predict carcass physical composition (fat, lean, and bone) using general linear regression models in SAS (Institute Inc., Cary, NC, USA). To develop prediction equations based on the input variables, a leave-one-out cross-validation method was performed. The precision of the predictions was assessed based on the coefficient of determination (R^2) and root mean square error (RMSE).

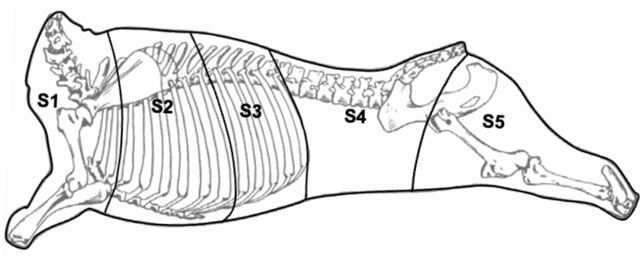

Figure 1. Representation of carcass sections used to predict half carcass composition. S1 - longitudinal cut after the second rib, S2 - longitudinal cut after the eighth rib, S3 - longitudinal cut after the thirteenth rib S4 - longitudinal cut after the sacrum, and S5 - the remaining section after the removal of S1 to S4

III. RESULTS AND DISCUSSION

The predictive equations for carcass physical composition, based on DXA measurements of different carcass sections, are shown in Table 1. Prediction of carcass muscle and bone using DXA data from section 1 exhibited lower RMSE and AICc values, coupled with high R^2 values, when compared to the equations based on the other evaluated sections. However, the equation for carcass fat prediction, using DXA fat content of section 5, showed the lowest RMSE and AICc values among the evaluated sections.

Table 1 – Prediction equations for carcass physical composition using dual energy X-ray absorptiometry (DXA) of carcass sections.

Tissue	Regression equation	R^2	RMSE	AICc
Muscle (kg)	Carcass muscle = 0.925 + 0.808 x total DXA lean[1]	0.92	5.56	85.36
	Carcass muscle = 5.275 + 2.386 x DXA lean S1	0.93	5.22	83.11
	Carcass muscle = 11.218 + 4.873 x DXA lean S2	0.70	11.05	110.08
	Carcass muscle = 11.069 + 7.658 x DXA lean S3	0.88	6.89	93.08
	Carcass muscle = 8.928 + 5.352 x DXA lean S4	0.79	9.18	103.42
	Carcass muscle = 2.878 + 2.424 x DXA lean S5	0.84	8.12	98.99
Fat (kg)	Carcass fat = 1.069 + 0.864 x total DXA fat[1]	0.96	1.89	46.58
	Carcass fat = 4.961 + 2.795 x DXA fat S1	0.83	4.18	75.09
	Carcass fat = 6.537 + 3.561 x DXA fat S2	0.75	4.99	81.53
	Carcass fat = 4.690 + 5.516 x DXA fat S3	0.88	3.56	69.28
	Carcass fat = 3.475 + 4.095 x DXA fat S4	0.82	4.24	75.64
	Carcass fat = -0.497 + 3.703 x DXA fat S5	0.92	2.86	61.41
Bone (kg)	Carcass bone = 6.446 + 2.478 x total DXA BMC[1]	0.88	1.33	33.83
	Carcass bone = 6.066 + 7.646 x DXA BMC S1	0.90	1.23	31.26
	Carcass bone = 8.233 + 15.583 x DXA BMC S2	0.71	2.09	50.19
	Carcass bone = 9.155 + 22.079 x DXA BMC S3	0.68	2.16	51.24
	Carcass bone = 11.295 + 12.732 x DXA BMC S4	0.67	2.24	52.63
	Carcass bone = 6.111 + 7.523 x DXA BMC S5	0.82	1.66	41.81

[1]Equation developed using pooled data from all carcass sections. S1 = section 1; S2 = section 2; S3 = section 3; S4 = section 4; BMC = bone mineral content; RMSE = root mean square error; AICc = corrected Akaike's information criterion.

Evaluating the developmental pattern of beef steers during fattening, Luitingh [5] demonstrated that shoulder and round represent the earliest-maturing parts of the carcass. This development pattern may explain the reason why sections 1 and 5 provided better estimates of carcass physical composition.

IV. CONCLUSION

Section 1 equation for muscle and bone and section 5 equation for fat content have shown the most precise estimates of half carcass tissue composition. However, more studies are necessary since our equations are based on Nellore bulls and steers and low sample size.

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REFERENCES

1. Barcelos, S. S.; Vargas, J. A. C.; Mezzomo, R.; Gionbelli, M. P.; Gomes, D. I.; Oliveira, L. R. S.; Luz, J. B.; Maciel, D.L.; Alves, K. S. (2021) Predicting the chemical composition of the body and the carcass of hair sheep using body parts and carcass measurements. Animal, 15(3): 100139.
2. Hunter, T. E.; Suster, D.; Dunshea, F. R.; Cummins, L. J.; Egan, A. R.; Leury, B. J. (2011) Dual energy X-ray absorptiometry (DXA) can be used to predict live animal and whole carcass composition of sheep. Small Ruminant Research, 100(2): 143-152.
3. Soladoye, O. P.; Campos, Ó. L.; Aalhus, J. L.; Gariépy, C.; Shand, P.; Juárez, M. (2016) Accuracy of dual energy X-ray absorptiometry (DXA) in assessing carcass composition from different pig populations. Meat Science, 121: 310-316.
4. Xavier, C.; Morel, I.; Dohme-Meier, F.; Siegenthaler, R.; Le Cozler, Y.; Lerch, S. (2023) Estimation of carcass chemical composition in beef-on-dairy cattle using dual-energy X-ray absorptiometry (DXA) scans of cold half-carcass or 11th rib cut. Journal of Animal Science, 101: 1-12.
5. Luitingh, H. C. (1962) Developmental changes in beef steers as influenced by fattening, age and type of ration. The Journal of Agricultural Science, 58(1): 1-47.