# DUAL ENERGY X-RAY ABSORPTIOMETRY AS A RAPID AND NON-DESTRUCTIVE METHOD FOR DETERMINATION OF PHYSIOLOGICAL MATURITY SCORES IN STEERS

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## I. INTRODUCTION

Bone ossification has been used as a physiological indicator of age and is also important in the determination of meat quality [1]. For this reason, maturity is considered a key factor in most of beef quality grading systems [2] and accurate assessments are desired. Previous studies have reported that production practices such as calf-fed (intensive) or yearling-fed (extensive) may alter the relationship between chronological age and physiological maturity [3]. Implanting strategies also advance skeletal maturity [4]. Dual energy X-ray absorptiometry (DXA) is a new technology that has been successfully used to measure carcass composition in livestock [5]. Interest in using DXA in the meat industry as an indirect method of estimating carcass composition has increased due to the relatively low cost per unit, speed of data collection, reliability and ease of use compared with other technologies. This technology also has the capability to measure bone mineral content (BMC) and bone mineral density (BMD). Hence, the objective of this study was to evaluate the potential of DXA technology to measure physiological maturity of beef carcasses produced under different production systems, calf-fed *vs.* yearling-fed, with and without growth implants.

## II. MATERIALS AND METHODS

A total of 411 crossbreed steers were assigned at weaning to a 2×2 factorial arrangement of treatments including production system (calf-fed harvested at 11-14 mo of age; yearling-fed harvested at 19-23 mo of age) and growth implant (non-implant and implant). Upon entering the feedlot, steers were finished on a commercial barley grain/barley silage based diet. All the animals were maintained and cared for according to the guidelines of the Canadian Council on Animal Care [6]. On a monthly basis, cattle were weighed and ultrasound backfat depths were recorded using an Aloka 500 V diagnostic real time ultrasound machine with a 17 cm 3.5 Mhz linear array transducer (Overseas Monitor Corporation Ltd., Richmond, BC). Steers were serially slaughtered from 300 to 800 kg live weight and ultrasound backfat depth end points from 2 to 20mm. Following splitting and conventional chilling at 2 °C for 24 h, carcasses were fabricated following normal commercial practices. Carcass break points were identified following Institutional Meat Purchase Specifications (IMPS) for Fresh Beef Products, Series 100 [7]. The primals collected from the left fabricated carcass side were the chuck (IMPS #113), rib (IMPS #103), brisket (IMPS #118), shank (IMPS #117), loin (IMPS #172A) and round (IMPS #158A) primal cuts. Each primal cut was scanned with a Lunar iDXA unit (GE Lunar, General Electric, Madison, WI, USA) using the whole body scan option on standard mode to estimate DXA BMC (g) a .nd BMD (g/cm$^2$) in each primal. Statistical analyses using the MIXED model procedure of SAS 9.4 [8] included production system and implant strategy as main effects and their interaction.

## III. RESULTS AND DISCUSSION

In all primals, both production system and implant strategy had a significant effect ($P$ < 0.001) on BMC and BMD values (Table 1). All calf-fed primals had lower BMC and BMD than yearling fed animals. This resulted in total carcass BMC values of 5,936.6 ± 56.57 *vs.* 6,948.3 ± 74.69 g and BMD values of 11.90 ± 0.07 *vs.* 12.80 ± 0.10 g/cm$^2$ for calf-fed *vs.* yearling-fed, respectively. Bone composition and densities differ with age [9], hence it was expected that DXA technology would show that younger animals (calf-fed) would have lower BMC and BMD than older (yearling-fed) animals. Primals from implanted animals had higher BMC and BMD than non-implanted, indicating DXA technology is capable of detecting changes in ossification associated with the use of growth promotants. Numerous studies have reported advanced physiological maturity associated with implant practices [5].

Table 1. Means ± SEM of the production system and implant strategy on the bone mineral composition (BMC) and bone mineral density (BMD) from dual-energy x-ray absorptiometry values for the different primals

| Variable | Calf-fed | Yearling-fed | Non-Implant | Implant | PS[a] | I[b] | PS×I |
|---|---|---|---|---|---|---|---|
| *BMC (g)* | | | | | | | |
| Brisket | 129.6±2.60 | 166.5±3.43 | 131.9b±2.91 | 164.1±3.17 | <0.0001 | <0.0001 | 0.8166 |
| Chuck | 1,561.4±16.02 | 1,834.3±21.15 | 1,577.2±17.94 | 1,818.5±19.54 | <0.0001 | <0.0001 | 0.7336 |
| Loin | 789.1±9.40 | 954.2±12.41 | 799.7b10.53 | 943.6±11.47 | <0.0001 | <0.0001 | 0.2332 |
| Round | 1,711.3±14.98 | 1,934.7±19.76 | 1,724.7±16.78 | 1,921.26±18.25 | <0.0001 | <0.0001 | 0.9388 |
| Shank | 714.2±6.64 | 801.6±8.75 | 719.7±7.42 | 796.15±8.10 | <0.0001 | <0.0001 | 0.8446 |
| Rib | 884.6±9.10 | 1033.9±12.02 | 896.7±10.20 | 1,021.9±11.11 | <0.0001 | <0.0001 | 0.4566 |
| Total | 5,936.6±56.57 | 6,948.3±74.69 | 6,015.8±63.37 | 6,869.1±69.02 | <0.0001 | <0.0001 | 0.6622 |
| *BMD (g/cm$^2$)* | | | | | | | |
| Brisket | 0.67±0.01 | 0.71±0.01 | 0.65±0.01 | 0.73±0.01 | <0.0001 | <0.0001 | 0.4476 |
| Chuck | 1.51±0.01 | 1.60±0.01 | 1.48±0.01 | 1.62±0.01 | <0.0001 | <0.0001 | 0.7769 |
| Loin | 1.21±0.01 | 1.32±0.01 | 1.20±0.01 | 1.33±0.01 | <0.0001 | <0.0001 | 0.4568 |
| Round | 2.50±0.01 | 2.63±0.02 | 2.47±0.01 | 2.67±0.01 | <0.0001 | <0.0001 | 0.7916 |
| Shank | 2.52±0.02 | 2.69±0.02 | 2.49±0.02 | 2.72±0.02 | <0.0001 | <0.0001 | 0.3464 |
| Rib | 2.43±0.03 | 2.74±0.03 | 2.51±0.03 | 2.67±0.03 | <0.0001 | 0.0002 | 0.0838 |
| Total | 11.90±0.07 | 12.80±0.10 | 11.83±0.08 | 12.87±0.09 | <0.0001 | <0.0001 | 0.2539 |

[a]PS: Production system effect. [b]I: Implant effect.

## IV. CONCLUSION

Present results suggest DXA technology might be used to perform ossification assessments on beef carcasses. Potentially, this technique could assist in further carcass segregations and categorizations based on physiological maturity and market eligibility in the absence of verifiable chronological age.


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