Computer vision systems (CVS) to predict composition of primal and retail cuts of youthful beef carcasses

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Introduction: Beef grading systems provide the language for trade, facilitate marketing and production decisions, and ensure a predictable and consistent product. Their objectivity is a fundamental pillar of beef carcass classification. Computer vision systems (CVS) are a computerized, non-destructive, non-invasive, objective, cost-effective, and automatable technology, based on image analysis, that provide measurements of the beef carcass or rib-eye proportions [1]. The objective of this study was to evaluate the potential of the whole-side (HCC) and the rib-eye (CCC) camera systems to predict yields of primal and retail cuts of youthful beef carcasses.

Material and methods: A total of 535 animals (steers/heifers) were slaughtered at AAFC-Lacombe Research and Development Centre federally inspected abattoir. Pictures of each carcass side were taken using a HCC (VBS 2000, e+v® Technology GmbH, Germany). Following 72 h of chilling at 2°C, carcass sides were weighed and knife-ribbed between the 12th-13th ribs. After 20 min of atmospheric exposure, CCC (VGB 2000 e+v® Technology GmbH, Germany) pictures were taken at the grade site of left rib-eyes. Primal cuts were fabricated and weighed, with carcass breakpoints identified following the Institutional Meat Purchase Specifications for Fresh Beef Products, Series 100 [2]: chuck (#113, #113C, #115-1, #130-4), rib (#103, #109B, #109E PS03, #107], brisket (#118), flank (#193), foreshank (#117), loin (#172A, #104, #181, #180 PS02, round (#158A, #168, #171), and plate (#121). Partial least square regression (PLSR) procedures were used to predict cut weights using the CVS data as independent variables. PLSR models were fit using an internal full leave-one-out cross-validation. The accuracies were assessed by the coefficient of determination (R^2) and root mean square error of cross-validation.

Results: Overall, weight predictions in all primals showed higher R^2 values using CCC than HCC variables. Chuck, loin, round and foreshank showed a difference lower than 2%, and brisket and flank lower than 3% and 6%, respectively. Rib and plate differences were higher than 16%. R^2 values lower than 0.75 were found for brisket, foreshank and plate for both CCC and HCC, and rib estimation only for HCC. In turn, higher R^2 values (>0.88) were found for the chuck retail cuts. When rib, loin and round retail cuts were considered, the difference between CCC and HCC ranged from 4% for inside round (#168) to 26% for steak style rib (#109E PS03), with the R^2 values for CCC always being higher than HCC. Nevertheless, R^2 values lower than 0.75 were only found in HCC estimations of blade meat (#109B) and steak-style rib (#109E PS03) cuts.

Conclusion: This study demonstrates the feasibility of using CVS variables to estimate the weight of primal and retail cuts of youthful beef carcasses.

In this study CVS weight estimations have been studied with limited retail cuts, hence, further studies with alternate cut-out specifications are needed to confirm the CVS ability for different retail specifications. Furthermore, the accuracy and precision of the prediction models might be improved by using a wider carcass population.

Acknowledgements and Financial support statement: The authors gratefully acknowledge funding support from Beef Cattle Research Council (project number ASC-01; Activity number: BQU.08.17) and the in-kind contribution of animals, facilities and people received from Agriculture and Agri-Food Canada (AAFC), Lacombe Research and Development Centre, AB, Canada. Dr. Jose Segura Plaza gratefully acknowledges the support from Canada's Sustainable Beef and Forage Science Cluster, through funding provided by the Canadian Cattlemen's Association and Agriculture and Agri-Food Canada. The authors express their gratitude to the AAFC-Lacombe Beef Unit and Meat Centre staff for animal care and management, animal slaughter and carcass fabrication, and technical collection and compilation of the research data.

Literature:

[1] López-Campos, Ó., N. Prieto, M. Juárez, and J. L. Aalhus. 2019. New technologies available for livestock carcass classification and grading. CAB Reviews 14(018):1-10. doi: 10.1079/PAVSNNR201914018

[2] USDA (2014). Institutional meat purchasing specifications for fresh beef. Retrieved from ams.usda.gov/grades-standards/imps, Accessed date: 25 March 2021.