Steam-flaking conditions affect starch reactivity of barley grain

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Processing conditions for cereal grains can alter the site, rate, and extent of starch digestion. For barley grain, processing generally involves dry-rolling; however, due to variability in kernel size, attaining a consistently and optimally processed product is challenging. Steam-flaking can be used to increase the severity of processing without increasing risk for fine particles. As such, the objective of this study was to determine how steam flaking conditions affect starch availability. Five independent sources of barley were used in a 3 × 3 factorial arrangement. The main factors were the steam-conditioning duration (5, 20, or 35 min) and flaking density (targeting 0.43 (HIGH), 0.34 (MID) and 0.25 (LOW) kg/L). Five independent sources of barley were used and exposed to each of the treatments and an original unprocessed sample was retained. The flaked and unprocessed barley were analyzed for amyloglucosidase reactive soluble starch (AGR) and 6-h amylase reactive insoluble starch (ARS). Insoluble reactive starch (IRS), digestive insoluble starch (ISD), and predicted ruminal starch digestion (PRSD) were calculated. Data were analyzed to determine the effect of steam-conditioning duration, flaking density, and their interaction. Unprocessed samples were compared to the processed samples using a single polynomial contrast.

The achieved flaking densities were: 0.47 ± 0.03 for HIGH, 0.37 ± 0.02 for MID and 0.32 ± 0.01 kg/L for LOW. Conditioning duration did not affect any of the starch reactivity parameters ($P \geq 0.30$) and there were no interactions between conditioning duration and flaking density ($P \geq 0.41$). Flaking density did not influence IRS with a mean of 6.66% ($P = 0.75$). Enzymatic measurements of AGR ($P = 0.001$; 8.71, 13.8, 17.8% for HIGH, MID and LOW respectively) and ARS ($P = 0.001$; 48.0, 53.9, 58.4%), and the calculated PRSD ($P = 0.001$; 95.7, 97.6, 98.7%) were greater for lower flaking densities (barley that was more extensively processed), while flaking density had the opposite effect on ISD ($P = 0.001$; 90.6, 85.5, and 81.6%). Unprocessed barley had less AGR, ARS, IRS, and PRSD ($P \leq 0.001$) but greater ISD ($P = 0.001$) relative to processed samples.

Implications: Relative to unprocessed barley, steam-flaking increased starch reactivity. Conditioning durations longer than 5 min further improve starch reactivity, whereas, increasing the severity of processing by decreasing flaking density increased starch reactivity.