Effects of processing technologies combined with cell wall degrading enzymes on *in vitro* degradability of barley

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Effects of processing technologies and cell wall degrading enzymes on degradation of barley during *in vitro* digestion simulation were tested in a 5*2 factorial arrangement: 5 technologies (unprocessed, wet-milling, extrusion, autoclaving, and acid-autoclaving), with or without enzymes (xylanases and β-glucanases). Digestion in the upper gastrointestinal tract (adapted Boisen methodology) and subsequent, large intestinal fermentation (gas production) were simulated in duplicate. All technologies increased dry matter (DM) and starch disappearance of barley during Boisen incubation compared with the unprocessed control (Table 1). Wet-milling, extrusion, and acid-autoclaving increased protein disappearance, whereas autoclaving did not. Enzyme treatment increased DM, starch, and protein disappearance in unprocessed and autoclaved barley. Extent and maximum rate (R_{max}) of fermentation of Boisen residues, and time at which R_{max} occurred (T_{max}), were negatively correlated with starch disappearance during enzymatic digestion simulation (r=-0.93, -0.93, and -0.81, respectively; p<0.01). Wet-milling, extrusion, and acid-autoclaving, which reduced starch content of Boisen residues compared with the untreated control, reduced extent of fermentation by 50%, R_{max} by 60-75%, and T_{max} by 45-70% (P < 0.01). In conclusion, both processing and cell wall degrading enzymes might potentially untangle cell wall structure, thereby increasing accessibility of nutrients in barley. Processing technologies were generally more effective in improving nutrient digestion of barley compared with enzymes. The latter improved nutrient digestion only in barley that was unprocessed or little affected by processing.

Table 1. *In vitro* disappearance (%) of dry matter (DM), starch, and protein during enzymatic digestion simulation of unprocessed or processed barley, with or without addition of cell wall degrading enzymes.

	DM		Starch		Protein	
Enzyme	No	Yes	No	Yes	No	Yes
Unprocessed	40^{d}	59^{c}	49^{e}	73^{d}	58^{c}	71^{b}
Wet-milling	79^{a}	81^{a}	100^{a}	100^{a}	91^{a}	91^{a}
Extrusion	82^{a}	83^{a}	99^{ab}	100^{a}	87^{a}	89^{a}
Autoclaving	53^{c}	71^{b}	71^{d}	88^{c}	57^{c}	70^{b}
Acid-autoclaving	83^{a}	78^{ab}	97^{b}	97^{b}	88^{a}	85^{a}
SEM	2.3		1.8		2.3	
T	<0.01		<0.01		<0.01	
E	<0.01		<0.01		<0.01	
T*E	<0.01		<0.01		<0.01	