Effect of pre-treatments on roller milled green lentil flour quality and their use in bread and spaghetti applications

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Introduction

Pre-treatments of pulses prior to milling can modify end-product functionality and sensory profiles by altering the protein and starch, resulting in changes in flour quality and performance. Creating pulse flour ingredients with different quality attributes will allow for further ingredient customization for a variety of end-products. The objectives of this work were to evaluate the effect of pre-treatments (roasting, micronization, germination) on roller milled green lentil (GL) flour composition and functionality and their impact on bread and spaghetti end-product quality.

Materials and Methods

Pre-Treatments and Milling

- Whole GL (CDC Greenstar) 2019 crop year, sourced from McDougall Acres Ltd. (Moose Jaw, SK).
- Roasting (RST): GL were conditioned to 30% moisture overnight (16-18 h) and then roasted in a convection oven (160 °C, 30 min) on perforated trays.
- Germination (GER): GL were germinated (48 h, room temperature) according to Setia et al. (2019) at the Saskatchewan Food Industry Development Centre Inc.
- Micronization (MIC): GL were conditioned to 20% moisture and then micronized (140 °C) at InfraReady Products.
- Untreated (UNT) and pre-treated GL were milled using a Bühler laboratory roller mill (MLU 202) producing six flour streams (B1, B2, B3, 1M, 2M, 3M) and two by-product streams (hulls, shorts). All six flour streams were combined to create a straight grade flour.

Flour, Bread and Spaghetti Analysis

- Flour analysis: starch content (AACCI 76-13.01), colour (L*, a*, b*; AACCI 14-30.01 with modifications), pasting properties (AACCI 76.21.01; STD1, 13 min profile), starch damage (SD; AACCI 76-31.01), water hydration capacity (WHC; AACCI 56-37.01), protein (N x 6.25; Williams et al., 1998), and particle size distribution (Mastersizer 2000; internal method).
- Pan bread: 20% GL flour with 80% wheat flour (13.5% protein, 14% m.b.) was baked on a pilot scale using a no-time dough baking process and then evaluated for specific volume (SV; AACCI 10-14.01), crumb structure (AACCI 10-18.01) and crumb colour (L*, a*, b*; internal method).
- Spaghetti: 50% GL flour with 50% durum semolina (15.4% protein, 14% m.b.) was processed using a Namad Extruder and a Bühler batch dryer using a high temperature, short time drying cycle (max. temp. 81 °C; max. humidity 82%; 5.75 h). Dried spaghetti was evaluated for colour (L*, a*, b*; internal method). Cooked spaghetti was evaluated for firmness using a texture analyzer (TA.HDPlus with TA-47; internal method), cooking time (CT; absence of white core when spaghetti was compressed between two Plexiglas plates; internal method) and cooking loss (CL; percentage of solids lost by spaghetti during CT; internal method).
- Bread and spaghetti made from 100% wheat flour and semolina (milled at Cereals Canada), respectively, were included as reference samples.
- Data was analyzed using a one-way ANOVA and differences between means were determined by the Tukey-Kramer test ($p < 0.05$) using JMP software version 14 (SAS Institute Inc.).

Discussion

Flour Quality

- Less variability in the protein contents of individual MIC flour streams indicated MIC seeds fractured differently during roller milling (**Figure 1**).
- Flour quality results are shown in **Table 1**.
- MIC flour had significantly higher SD, while RST and GER flours had significantly lower SD compared to UNT.
- MIC flour had the highest WHC, followed by RST, GER and UNT.
- GER flour was brighter (higher L*) and less yellow (lower b*) than the flour produced from other pre-treatments.
- RST and MIC flours had higher peak viscosities, but MIC flour had a higher breakdown viscosity compared to flour from all other pre-treatments. This was likely due to higher starch damage.
- UNT and GER flours had similar particle size distributions with GER flour having a smaller span. MIC flour had the smallest span indicating it had the most consistent particle size. The differences in particle size distribution indicate the pre-treatments could impact the seed hardness affecting how the seed fractures during milling.

Bread Quality

- Images of the breads are shown in **Figure 2**.
- RST, MIC and GER flours produced bread with significantly lower SV than the UNT flour (**Figure 3**).
- GER and UNT flours produced bread with brighter (higher L*) and less yellow (lower b*) than RST and MIC flours.
- Crumb structure of breads made with UNT, RST and GER flours showed no significant difference in number of cells/slice area, cell contrast, cell wall thickness and cell diameter. Bread made with MIC flour had a poorer crumb structure with a lower number of cells/slice area and cell contrast, and higher cell wall thickness and cell diameter (**Figure 4**).

Spaghetti Quality

- Images of the dried spaghetti are shown in **Figure 2**.
- RST and GER flours produced spaghetti that was brighter (higher L*) and less red (lower a*) than spaghetti produced from UNT flour. Spaghetti made with MIC flour was significantly brighter, less red, and more yellow (higher b*) than the other flours.
- RST and GER flours produced spaghetti with longer CT than spaghetti produced from UNT flour, while spaghetti made with MIC flour had a shorter CT (**Figure 5**).
- Spaghetti made with MIC flour had a significantly higher CL and lower cooked firmness, likely due to high SD (**Figure 5**).

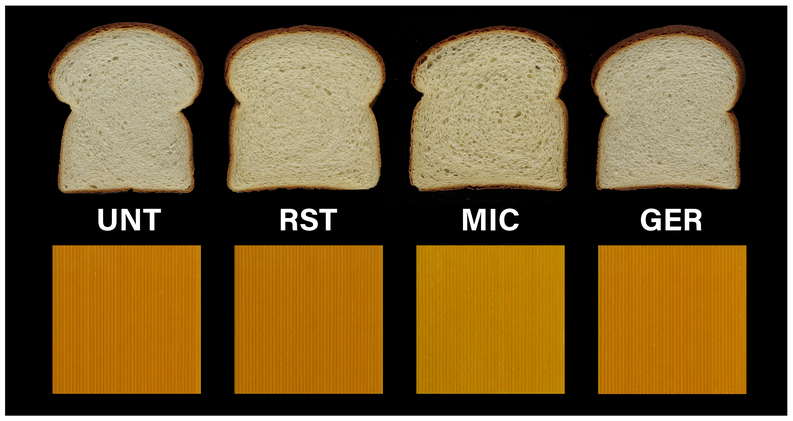

Figure 2. Top - Pan bread made with 20% pre-treated green lentil flours. Bottom - Dried spaghetti made with 50% pre-treated green lentil flours. (UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated)

Conclusions

- Applying pre-treatments to GL resulted in flours with different functionalities that impacted the end product quality.
  - GER flour performed the best in bread as it had good SV with good crumb structure and brightness.
  - MIC flour was not suitable for bread due to poor SV and crumb structure, nor in pasta due to low cooked firmness.
- High SD and changes in starch properties impacted the functionality of MIC flour when used for bread and spaghetti production.

References

AACC International. 2010. Approved Methods of Analysis (11th ed), St. Paul, MN: AACCI.

Setia et al. 2019. Impacts of short-term germination on the chemical compositions, technological characteristics and nutritional quality of yellow pea and faba bean flours. Food Res. Int., 122:263-272.

Williams et al. 1998. Protein testing methods at the Canadian Grain Commission. In: Wheat Protein, Production and Marketing, Proceedings of the Wheat Protein Symposium (pp. 37-47). Saskatoon, SK: University of Saskatchewan Press.

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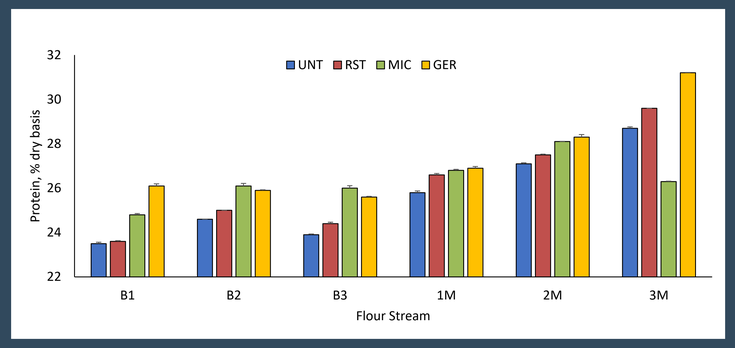

Figure 1. Protein contents of untreated and pre-treated green lentil roller milled flour streams. (UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated)

Table 1. Composition and functional properties of untreated and pre-treated green lentil flours

	UNT	RST	MIC	GER
Protein, % db	26.1 c	26.3 bc	26.6 b	26.9 a
Starch damage, % db	3.53 b	2.24 c	19.17 a	1.84 c
WHC, g/g db	0.75 d	1.05 b	1.77 a	0.82 c
Colour:				
L*	75.4 b	72.8 c	68.2 d	76.6 a
a*	0.20 c	1.28 a	1.09 b	0.27 c
b*	35.8 a	31.3 b	28.5 c	27.4 d
Starch pasting properties:				
Peak viscosity, cP	2207 c	2834 a	2851 a	2493 b
Hot paste viscosity, cP	1995 c	2558 a	2262 b	2236 b
Breakdown, cP	212 b	277 b	589 a	257 b
Final viscosity, cP	3464 c	4091 a	3435 c	3598 b
Setback, cP	1469 a	1534 a	1174 c	1362 b
Particle size distribution:				
d(0.1), µm	16 b	14 d	17 a	15 c
d(0.5), µm	64 c	56 d	73 a	67 b
d(0.9), µm	148 a	141 c	139 d	144 b
VWM, µm	74 b	68 c	77 a	74 b
Span	2.06 b	2.25 a	1.66 d	1.92 c

Values with different letters within same row are significantly different ($p < 0.05$)
UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated; WHC = water hydration capacity; d(0.1) = particle size at 10th percentile; d(0.5) = particle size at 50th percentile; d(0.9) = particle size at 90th percentile; VWM = volume weighted mean.

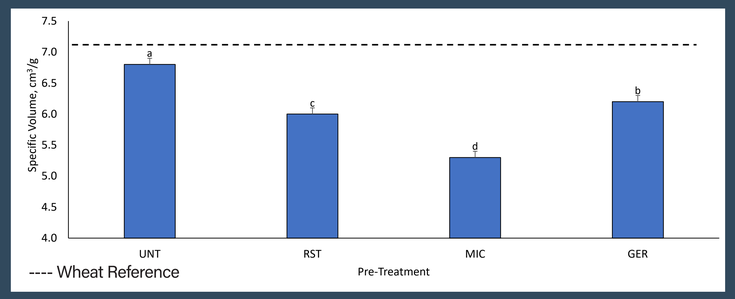

Figure 3. Specific volume of breads made with 20% pre-treated green lentil flours. Values with different letters are significantly different ($p < 0.05$). (UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated)

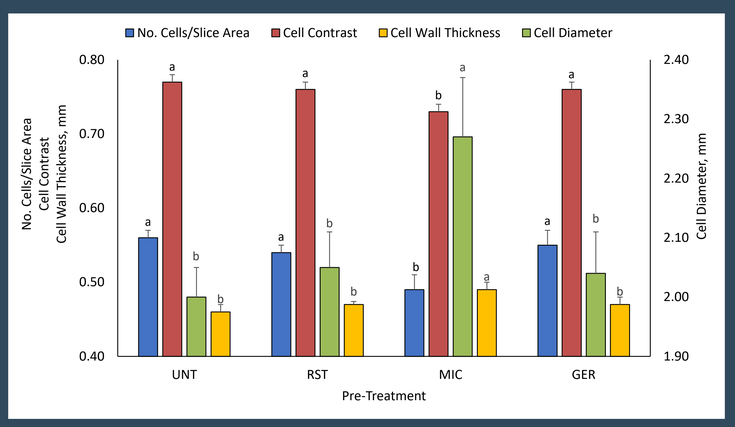

Figure 4. C-Cell characteristics of breads made with 20% pre-treated green lentil flours. Values with different letters within same parameter are significantly different ($p < 0.05$). (UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated)

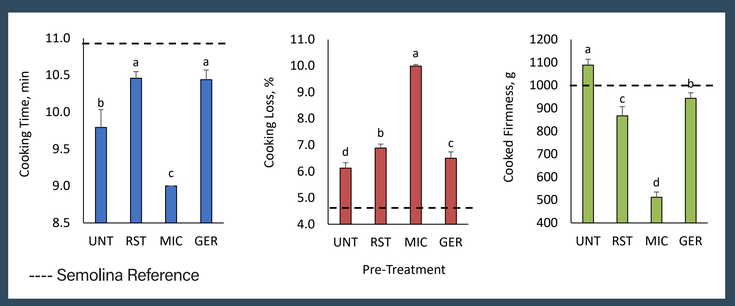

Figure 5. Quality attributes of spaghetti made with 50% pre-treated green lentil flours. Values with different letters are significantly different ($p < 0.05$). (UNT = Untreated, RST = Roasted, MIC = Micronized, GER = Germinated)