PULSE CANADA

Pulses in Meat Products

Binders are an integral component of comminuted meat products such as sausages, meatballs, beef patties, chicken fingers and deli meat. Binders can improve meat consistency and mouthfeel.

Auto-oxidation of binders can lead to off flavors and aromas in meat products. Micronization is an innovative thermal process that can be used to treat pulse flours to improve oxidative stability of pulse-based binders in meat.

For pulse flours, micronization can improve the protein efficiency ratio, protein chemical score and essential amino acid index[2] while decreasing tannins, phytic acid, trypsin inhibitor activity and oligosaccharides[3]. It also facilitates water absorption, reduces pulse cooking times[4] and can produce a toasted flavor in the flours[5].

Lentil and chickpea flours are prone to oxidation due to their linoleic and linolenic acid content. These fatty acids react with lipoxygenase (LOX) to form volatile organic compounds (VOCs) responsible for off flavors. Micronization can reduce LOX activity and VOCs in these pulse flours.

Effect of micronization on LOX activity and VOCs in chickpea and green lentil flours

Cleaned and dehulled lentils and chickpeas with no seed tempering were micronized at 130°C and 150°C and then ground into flours. The flours were analyzed for lipoxygenase activity, levels of volatile organic compounds and changes in pH and fatty acid profile.

In lentil flour, micronization at 130°C and 150°C resulted in a significant decrease in omega-3 fatty acids mainly from reductions in linolenic acid. Conversely, in chickpea flour, micronization at 150°C caused a significant increase in omega-3 fatty acids.

No changes were found for omega-6 linoleic acid between nonmicronized and micronized lentil and chickpea flours. The results confirm that linolenic acid with 3 double bonds is less stable and more susceptible to oxidation compared to linoleic and oleic acid. The results also suggest that the effect of micronization on fatty acids could be dependent on lipid and pulse type.

Micronization at 130°C significantly decreased lipoxygenase (LOX) activity for chickpea and green lentil flours (42.5% and 24%, respectively). The lentil flour micronized at 150°C showed a further decrease in LOX activity (65%). Lowering VOCs was possible with micronization at 130°C for chickpea flour and 150°C for lentil flour **(Table 1)**. A slight increase in pH was also found for the high micronization temperature (150°C) applied to both flours compared to the nonmicronized flours.

Key Findings

- *Pulse flours are innovative functional ingredients that can be added as binders to comminuted meat products to bind water, thus reducing cooking losses, increasing cooking yield and contributing to mouthfeel and other sensory attributes[1].*
- *In addition to providing nutrients, pulse flours can produce gluten-free meat products suitable for consumers with celiac disease or wheat allergies.*
- *Formulation of low-fat beef burgers containing 6% lentil and chickpea flour binders is possible based on favorable results for physicochemical and consumer acceptability.*

[1] Shariati-levari, S., Ryland, D. Edel, A et al., 2016. Sensory and physicochemical studies of thermally micronized chickpea (*Cicer arietinum*) and green lentil (*Lens culinaris*) flours as binders in low-fat beef burgers. J. Food Sci. 81: S1230-S1242.

[2] Khattab, R.Y. et al., 2009. Nutritional quality of legume seeds as affected by some physical treatments, part 1: protein quality evaluation. LWT-Food Sci. Technol. 42: 1107-1112.

[3] Khattab, R.Y. and Arntfield, S.D. 2009. Nutritional quality of legume seeds as affected by some physical treatments, part 2: antinutritional factors. LWT-Food Sci. Technol. 42: 1113-1118

[4] Arntfield, S.D., Scanlon, M.G. Malcolmson, L.J. et al. 2001. Reduction in lentil cooking time using micronization: comparison of 2 micronization temperatures. J. Food Sci. 66: 500-505.

[5] Sharma, G.K. 2009. Micronization. DRDO Science Spectrum. Defence Research and Development Organization, Ministry of Defence, Government of India, March 2009, p 169-171.

BURGERS

Low-fat burgers containing 6% nonmicronized or micronized lentil and chickpea flours were evaluated for physicochemical characteristics **(Table 2)**.

There was less cooking loss, drip loss and shrinkage in burgers containing pulse flours compared to the control burger with no significant difference between micronized and nonmicronized pulse flours. No difference was noted for the water holding capacity of raw burgers containing nonmicronized or micronized pulse flours compared to the control burger. The shear force significantly decreased with the addition of pulse flours, but no further change was found for burgers containing micronized pulse flours **(Table 2)**. These results indicate that micronization has no detrimental effect on the functionality of pulse flours and confirm the impact of pulse flours on the physicochemical properties of the burger.

CONSUMER ACCEPTABILITY

Sensory evaluation on all prepared burgers was conducted with 101 untrained participants. Appearance, aroma, flavor, texture and overall acceptability were rated using a 9-point hedonic scale. Consumer acceptability of appearance was highest with burgers made from chickpea flour micronized at 150°C and lentil flour micronized at 130°C. For aroma, burgers with lentil flour micronized at 130°C and with chickpea flour micronized at 150°C had the highest acceptability.

Overall acceptability was found to be higher for both micronized lentil flours than the non-micronized flours. Based on results of a partial least squares correlation map, burgers with green lentil flour micronized at 130°C and 150°C and chickpea flour micronized at 150°C were positively associated with overall acceptability as well as acceptability of flavor, aroma, texture and appearance. Burgers with micronized pulse flours had higher acceptability ratings than burgers with non-micronized flours and burgers with no pulse flours.

TABLE 1 Lipoxygenase (LOX) activity (µmole/min), concentration of selected volatile compounds (µg/100g pulse flour) and pH values of nonmicronized and micronized chickpea and green lentil flours[1]

COMPOUNDS		KABULI CHICKPEA FLOUR			GREEN LENTIL FLOUR		
	PROBABLE ORIGIN	RCP	MCP130	MCP150	RGL	MGL130	MGL150
LOX activity		0.4^{b}	0.23^{c}	0.21^{c}	0.59^{a}	0.45^{b}	0.21^{c}
Hexanal	13-Hydroperoxide	146.9^{a}	88.7^{b}	81.6^{b}	43.5^{c}	49.2^{c}	9.7^{d}
2-Hexenal	Linolenic acid	2.9^{a}	1.8^{b}	0.9^{b}	3.5^{a}	3.2^{a}	0.3^{b}
2-Octenal	Linolenic acid oxidation	9.3^{a}	7.2^{ab}	4.6^{b}	0.4^{c}	0.2^{c}	0.1^{c}
Furan-2-pentyl	Linoleic oxidation	116.3^{a}	68.2^{b}	59.2^{b}	16.5^{c}	17.5^{c}	7.9^{c}
Heptanal	Linoleic acid	5.1^{a}	3.2^{b}	3.2^{b}	0.6^{c}	0.6^{c}	0.4^{c}
Octanal	Oleate oxidation	3.9^{a}	2.6^{a}	2.6^{a}	0.6^{c}	0.6^{c}	0.5^{c}
Nonanal	Oleate oxidation	15.4^{a}	11.5^{a}	10.5^{ab}	2.8^{c}	3.3^{bc}	2.2^{c}
pH		6.12^{d}	6.14^{d}	6.23^{c}	6.33^{b}	6.34^{b}	6.39^{a}

RCP- nonmicronized chickpea flour, MCP130: micronized chickpea at 130°C, MCP150: micronized chickpea at 150°C, RGL: nonmicronized green lentil flour, MGL: micronized green lentil at 130°C, MGL150: micronized green lentil at 150°C. Mean values followed by the same letter in the same row are not significantly different at P<0.05.

TABLE 2 Physical characteristics of low-fat burgers containing nonmicronized and micronized chickpea and lentil flours[1]

PHYSICAL CHARACTERISTIC		BURGER with CHICKPEA FLOUR			BURGER with LENTIL FLOUR		
COOKED BURGER	CONTROL BURGER	RCP	MCP130	MCP150	RGL	MGL130	MGL150
% Cook Loss	22.2^{b}	22.2^{b}	22.55^{b}	22.16^{b}	21.51^{b}	22.21^{b}	21.01^{b}
% Drip Loss	1.89^{b}	1.89^{b}	2.42^{b}	2.07^{b}	2.12^{b}	2.50^{b}	1.66^{b}
% Shrinkage	16.94^{b}	16.94^{b}	17.03^{b}	15.79^{b}	16.15^{b}	15.48^{b}	15.43^{b}
Shear Force (N)	6.66^{b}	6.66^{b}	6.22^{b}	7.09^{b}	7.63^{b}	6.42^{b}	6.42^{b}
RAW BURGER							
WHC (g/100g)	1.35^{a}	1.35^{a}	1.42^{a}	0.85^{a}	1.20^{a}	0.73^{a}	1.07^{a}

Control: no pulse flour added; RCP-burgers with nonmicronized chickpea flour, MCP130: burgers with micronized chickpea at 130°C, MCP150: burgers with micronized chickpea at 150°C, RGL: burgers with nonmicronized green lentil flour, MGL: burgers with micronized green lentil at 130°C, MGL150: burgers with micronized green lentil at 150°C. WHC: water holding capacity. Mean values followed by the same letter in the same row are not significantly different at P<0.05.

Summary

- *LOX activity was significantly reduced for both flours when micronized at 130°C with significant further reduction achieved at 150°C for lentil flour.*
- *Micronization of chickpea flour at 130°C decreased VOCs compared to non-micronized flour whereas micronization at 150°C was required to reduce VOCs in lentil flour.*
- *Addition of 6% pulse flours with or without micronization to low-fat burgers resulted in lower cooking loss, drip loss, and shrinkage loss compared to the control burgers with no pulse flour ingredients.*
- *Consumer acceptability was highest for all attributes for burgers with chickpea flour micronized at 150°C and for lentils micronized at 130°C.*
- *Consumer acceptability was highest for burgers containing micronized flours compared to non-micronized flours and significantly higher than burgers with no pulse flours.*

This study was conducted by Dr. Michel Aliani's research group at the University of Manitoba.

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