SUMMARY REPORT

ENVIRONMENTAL & NUTRITIONAL IMPACT OF BEEF-LENTIL BLENDED BURGERS

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PULSE CANADA

Lentils.™

STUDY BACKGROUND

Numerous studies have shown that replacing a portion of beef with plant-based foods in daily diets can improve health, nutrition and environmental impacts (Willett et al. 2019; Chaudhary & Krishna, 2019; Clune et al. 2018).

Lentils are plant-based foods that have both environmental and nutritional benefits. The capacity of lentils to fix atmospheric nitrogen during their cultivation results in reduced nitrogen fertilizer requirement in crop production systems (Clune et al. 2017). Lentils also do not require irrigation and are well suited to semi-arid, water scarce regions (Angadi et al. 2008), and incorporating lentils into crop rotations can improve soils, yield and protein content of the following crop (MacWilliam et al. 2018; Lupwayi et al. 2007). Finally, lentils contain high amounts of protein, fiber, essential vitamins and minerals.

Beef-based burger patties can be made more sustainable, nutritious and cost-effective, while maintaining palatability, by reformulating with a portion of pulses such as whole cooked lentils. However, the nutritional and environmental benefits of lentil-reformulated beef burgers have not been quantified. This study compared the nutritional impact, environmental footprints (carbon, water and land use) and cost of lean US beef burgers compared to lean US beef burgers reformulated with 33% cooked lentil puree.

METHODOLOGY

The study utilized production and environmental data representing US beef production (Rotz et al. 2019) and data representing the lentil production region of Saskatchewan, Canada. A life cycle assessment (LCA) was conducted to assess the environmental impact of reformulating beef burgers to substitute 33% of the beef with cooked lentil puree.

Raw Ingredients in Burgers (1 serving = 4 oz/115 grams)

Patty Type	Raw Ground Beef	Whole Cooked Lentils	Water	Salt	Black Pepper
Lean Beef Burger	113.8 g			1 g	0.2 g
Lean Beef Burger with Lentil Puree	75.8 g	30.4 g	7.5 g	1 g	0.2 g

Nutritional Profile* of Ingredients and Burgers

	Calories (kcal)	Saturated Fat (g)	Total Fat (g)	Cholesterol (mg)	Protein (g)	Fibre (g)
Lean Ground Beef (100 g)	207	5.4	13.7	60	19.58	9.7
Cooked Lentils (100 g)	156	0.15	0.55	0	12.82	0
Lean Beef Burger (115 g)	234	6.19	15.5	68	22.19	0.06
Lean Beef Burger with Lentil Puree (1115 g)	205	4.19	10.6	46	18.77	3

Sustainability Profile* of Ingredients and Burgers

Ingredient	Greenhouse Gas Emissions (kg CO_2 eq)	Blue (Irrigation) Water Use (L)	Land Use (m^2)
Dry Lentils at Farm (1 kg)	-0.12	0.67	6.67
Lentils, Cooked (1 kg)	0.28	0.29	2.87
U.S. Boneless Beef at Packers End Gate (1 kg)	29.1	2220.9	86.5
Lean Beef Burger (115 g)	3.31	252.74	9.84
Lean Beef Burger with Lentil Puree (115 g)	2.22	168.45	6.65

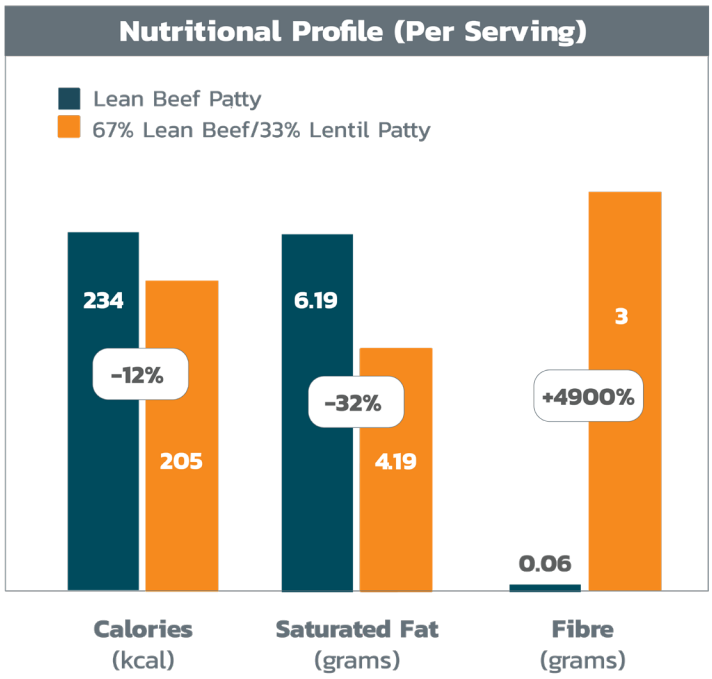
*See references for data sources and assumptions used

RESULTS

NUTRITION & COST

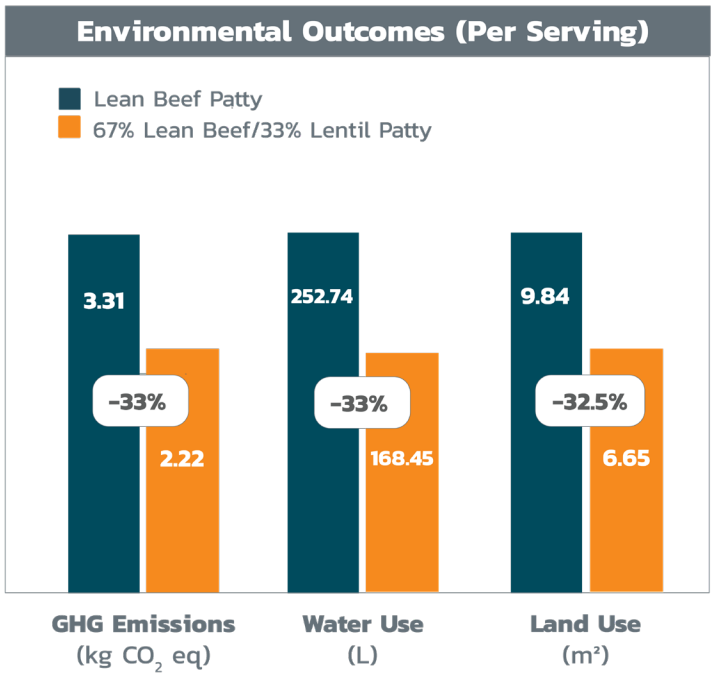
Nutritional data shows that partial replacement of lean ground beef with 33% cooked lentil puree results in a burger patty with 12% less calories, 32% less saturated fat, total fat and cholesterol per serving. The blended lean beef/lentil burger patty also contains 3 grams of fiber serving (compared to 0 grams in lean burger patty). Reformulation with lentil puree resulted in a 15% decrease in protein content.

At the time of the study (2020), there was also a cost savings of 26% achieved with the blended beef/lentil burger.



SUSTAINABILITY

The carbon footprint, water footprint and land use footprint of the blended beef/lentil burger were all substantially lowered with 33%, 33% and 32.5%, respectively, reductions when compared to the regular 100% beef burgers.



CONCLUSION

The results of this study demonstrate that reformulating burgers with whole cooked lentils is a strategy that can make a substantial impact on the nutritional profile and environmental impact of burgers, meeting emerging consumer interests while maintaining the familiarity of a traditional product.

ASSUMPTIONS AND DATA SOURCES

Sustainability Data

Product	Assumptions/Source for Greenhouse Gas Emissions	Assumptions/Source for Blue water use	Assumptions/Source for Land Use Footprint	Source link
Dry lentils, at farm (1 kg)	Canadian Roundtable for Sustainable Crops, Carbon Footprint for Canadian Lentils, 2017	Blue water footprint of lentils from Fig. 7 of Ding et al. (2018), % irrigation required = 24% of total water demand of lentils, full calculation of water footprint on 'Lentils - water footprint' worksheet	Yield is weighted average of 18 census divisions)	GHG: Pulse Canada has copy of report; Water footprint: https://www.mdpi.com/2073-4441/10/11/1609; Land use footprint: http://publications.saskatchewan.ca/#/products/89979
Lentils, cooked (1kg)	1 kg of dry lentils provide 2.326 kg of cooked lentils. Cooking stage gas use from Dettling et al. 2016. See Appendix M of report on Morningstar Farms website for cooking footprint of pulses	1 kg of dry lentils provide 2.326 kg of cooked lentils.	1 kg of dry lentils provide 2.326 kg of cooked lentils.	Pulse Canada; 33. Dettling, J., Tu, Q., Faist, M., DelDuce, A. and Mandlebaum, S., 2016. A comparative life cycle assessment of plant-based foods and meat foods. Quantis USA: Boston, MA, USA.; https://www.morningstarfarms.com/content/dam/morningstarfarms/pdf/MSFPlantBasedLCAReport_2016-04-10_Final.pdf
US boneless beef at packers end gate (1 kg)	Table 4 of Rotz et al. (2019) *Agricultural Systems* (23.3 kgCO2eq. till carcass weight and then 5.8 kg added from carcass to retail gate just like NBSA report does for Canada)	Table 5 of Rotz et al. (2019) Agricultural Systems (bluewater till carcass weight is 2095 Litres and then we add 125.9 litres from carcass to retail stage just like in NBSA Canadian report	Land use of US beef from Nijdam et al. 2012	https://www.sciencedirect.com/science/article/pii/S0308521X18305675#s0085; https://www.sciencedirect.com/science/article/abs/pii/S0306919212000942
One serving of regular ground beef burger (US beef)	Calculation using regular burger formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	Calculation using regular burger formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	Calculation using regular burger formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	
One serving of regular ground beef burger with lentil puree (US beef)	Calculation using beef burger with lentil puree formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	Calculation using beef burger with lentil puree formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	Calculation using beef burger with lentil puree formulation shown in worksheet 'Burger formulations', calculation does not include salt and pepper footprints	

Saskatchewan Census Division	Lentil production (tonnes)	Lentil acres (harvested)	Yield (tonnes/acre)	Irrigated/ Rain-fed	Bluewater footprint (litres/kg)	Production x Bluewater footprint
2	164200	383800	0.43	Rain fed	0	0
3	233400	475500	0.49	Rain fed	0	0
4	140800	326200	0.43	Rain fed	0	0
6	222500	369800	0.6	Rain fed	0	0
7	352485	600814	0.59	Rain fed	0	0
7	2515	4286	0.59	Irrigated	398	1000790
8	505800	813800	0.62	Rain fed	0	0
11	169590	246938	0.69	Rain fed	0	0
11	1210	1762	0.69	Irrigated	398	481507
12	220300	285700	0.77	Rain fed	0	0
13	198900	273700	0.73	Rain fed	0	0
	∑ = 2211700					∑ = 1482297
Weighted average Bluewater footprint for dry Saskatchewan lentils (liters/kg)						1482297 ÷ 2211700 = **0.67**

*Non-irrigated lentil production data taken from crop production statistics of Saskatchewan government: https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/market-and-trade-statistics/crops-statistics/crop-district-production

**Irrigated lentils production data from irrigation survey conducted by Irrigation Crop Divesification Corporation: https://irrigationsaskatchewan.com/icdc/irrigation-crop-survey).

Cost Analysis (as of March 27, 2020)

Beef Burger (1 serving = 4oz/115 g)

Ingredient Name	Quantity	Weight (g)	$USD/kg	Cost of Ingredient	Cost per kg	Cost per serving
Lean Ground Beef	1 lb	454.0	$5.79	$2.63		
Kosher Salt	1 tsp (5 mL)	1.4	n/a			
Black Pepper	1/2 tsp (2 mL)	1.4n/a				
TOTAL				$2.63	$5.69	**$0.65**

Beef/Lentil Burger (1 serving = 4 oz/115 g)

Ingredient Name	Quantity	Weight (g)	$USD/kg	Cost of Ingredient	Cost per kg	Cost per serving
Lean Ground Beef	1 lb	454.0	$5.79	$2.63		
Raw Lentils		78.2	$3.41	$0.27		
Water		45.0	n/a			
Kosher Salt	1 tsp (5 mL)	1.4	n/a			
Black Pepper	1/2 tsp (2 mL)	1.4n/a				
TOTAL				$2.89	$4.20	**$0.48**

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