

Lentils (*Lens culinaris* L.): a prebiotic rich whole food for reducing obesity and non-communicable diseases

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Abstract

Imbalanced energy intake, coupled with low concentrations of bioactive compounds in foods, has fueled the rising epidemic of obesity and related non-communicable diseases. In relation, chronic non-communicable diseases result in an estimated 36 million deaths globally each year. To combat these diet-related disorders, support health, and contribute to overall sustainability of health care and agriculture systems, it is important to develop foods that supply proper amounts of energy and nutrients. Lentil (*Lens culinaris* L.), a cool season food legume, is a good source of protein (20-30%), essential fatty acids, micronutrients, and complex carbohydrates, and has many desirable functional characteristics including a low glycemic index. Carbohydrate profiles of lentil that contribute to healthful effects include prebiotics: raffinose-family oligosaccharides, fructooligosaccharides, sugar alcohols, and resistant starch. Growing conditions and lentil genotype affect the concentration of prebiotic carbohydrates in lentil seeds. Moreover, dehulling, cooking, and cooling are associated with changes in their concentrations in lentil. In conclusion, it is clear that lentil contains nutritionally significant concentrations of prebiotics and warrants further investigation, especially animal and human trials to determine the impact lentil may have on health and well-being.

Mean concentration of prebiotic carbohydrates of 10 lentil varieties grown in North Dakota, USA, in 2010 and 2011.

Variety	Concentration (mg 100 g ⁻¹) ^a				
	Sorb	Mann	Raff + Stach ^b	Verb	Nys ^c
CDC Greenland	1109 c	211 c	2426	1770 b	57
CDC Lemay	1039 c	163 d	2497	1495 d	57
CDC Red Rider	1036 c	160 d	2419	1586 cd	52
CDC Redberry	1226 b	176 d	2349	1481 d	61
CDC Richlea	1295 ab	294 a	2319	1731 bc	62
CDC Rosetown	1325 ab	158 d	2586	922 e	62
CDC Rouleau	1304 ab	199 c	2793	1082 e	63
CDC Viceroy	1285 ab	215 c	2530	1800 b	79
Pennell	1231 b	204 c	2684	1968 a	57
Riveland	1349 a	249 b	2492	1784 b	68
Mean	1220	203	2509	1562	62
SE	12	2	17	18	1

^aMean concentration of varieties are not significantly different. ^bMeans within a column followed by different letters are significantly different at $p < 0.05$. ^cRaffinose and stachyose are reported as total raffinose and stachyose concentration due to similar elution times for the separation method. SE, standard error of combined data (n = 120). Sorb, sorbitol; Mann, mannitol; Raff, raffinose; Stach, stachyose; Verb, verbasco; Nys, nystose.

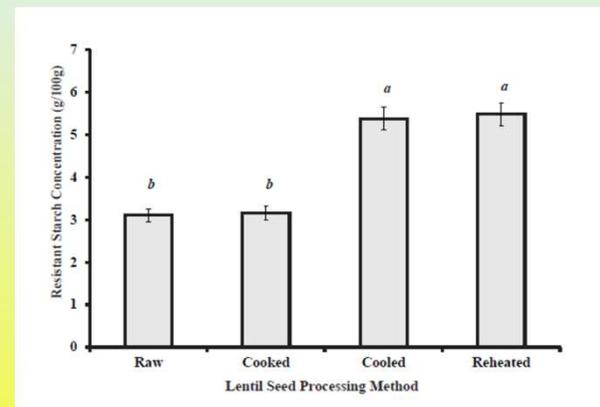
Mean concentrations of prebiotic carbohydrates and total starch by year and location.

Year	Location	mg 100 g ⁻¹ ^a					g 100 g ⁻¹	
		Sorb	Mann	Raff + Stach	Verb	Nys	RS	TS
2010	McLean	1373 x	246 x	2566 x	1710 x	61 x	9.3 x	48. x
	Ward	1161 y	188 y	2524 x	1255 y	57 x	5.5 y	49 x
	Mean	1267	217	2545	1482	59	7.4	48
	SE	19	4	27	26	1	0.2	1
2011	McLean	1255 x	198 x	2503 x	1656 x	67 x	7.1 y	44 y
	Ward	1089 y	178 y	2444 x	1627 y	61 y	8.3 x	47 x
	Mean	1172	188	2474	1641	64	7.7	45
	SE	14	3	18	24	1	0.2	1

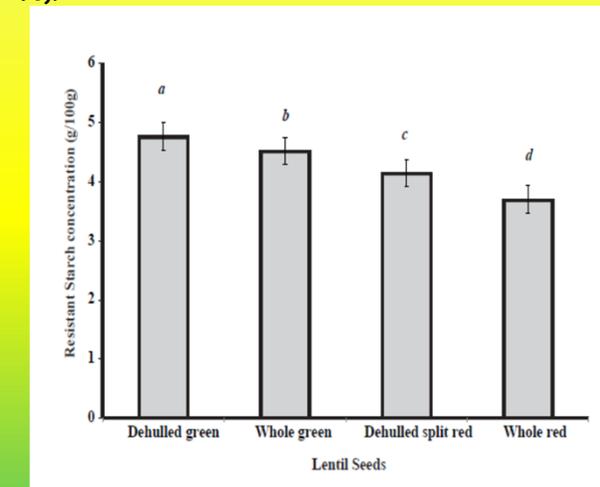
^aMeans within a column followed by different letters are significantly different at $p < 0.05$. Sorb, sorbitol; Mann, mannitol; Raff, raffinose; Stach, stachyose; Verb, verbasco; Nys, nystose; RS, resistant starch; TS, total starch. SE, standard error (n = 60).

Conclusions

- Prebiotics are an important component of healthy diet
- Significant variation was observed in prebiotic concentrations among lentil genotypes
- Environmental conditions impact prebiotic concentrations in lentil seeds
- Cooked lentils grown in North Dakota may contain 5 - 6 g of prebiotics in a 1-cup serving
- Cooking and processing procedures such as cooling influence prebiotic concentrations in lentil



Mean resistant starch concentration in raw, cooked, cooled, and reheated lentil products. Error bars are based on $p < 0.05$ (n = 96).



Mean resistant starch concentration in whole and dehulled lentil market classes. Error bars are based on $p < 0.05$ (n = 96).

Introduction

Obesity and related non-communicable diseases are affecting more than one in every ten adults (World Health Organization, 2012). Prebiotic carbohydrates are important in maintaining healthy gut microflora in the digestive system and contribute to reducing metabolic syndrome and obesity. Lentil (*Lens culinaris* L.), a widely grown pulse crop and dietary staple in many Middle Eastern, European, South American, African and Asian countries is a rich source of prebiotic carbohydrates. Biofortification of lentils with prebiotic carbohydrates may be an effective and sustainable means of improving human health.

The objectives of the present study were to (1) compare the concentrations of prebiotic carbohydrates [fructooligosaccharide (kestose and nystose), raffinose family sugars (raffinose, stachyose, and verbasco), sugar alcohols (sorbitol and mannitol), and resistant starch] in different lentil genotypes and growing locations in the US in 2010 and 2011; and (2) compare the concentrations of prebiotic carbohydrates in lentil under various processing and preparation procedures

Methods and Materials

- Total of 120 lentil samples were collected in 2010 and 2011 from two locations in North Dakota, USA.
- Soluble prebiotic carbohydrates were measured using an HPLC technique previously described (Feinberg et al. 2009).
- Resistant starch and total starch were measured using a method approved by AOAC International described by Megazyme International Ireland Ltd. (Megazyme, 2012).
- Soluble prebiotic carbohydrates and resistant starch in lentils were measure after dehulling, cooking and cooling.

References :

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