2013 U.S. Pulse Quality Survey

Northern Pulse Growers Association

USA Dry Pea & Lentil Council

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Contents

Author's Note:

Summary Points

1. Data from 140 samples received from major US pulse growing regions are reported in this 2013 report.
2. A range of physical and nutritional quality parameters were studied over a six-month period.
3. Pulse quality, especially in terms of protein, starch, and micronutrient content, was similar to the last three years.
4. Consumption of pulses is recommended given their superior nutritional quality profiles.
5. The NDSU Pulse Quality and Nutrition program is being dissolved as of June 30, 2014. This 2013 report represents the last report from the program.
6. Plans to produce future reports are under consideration.

The objectives of this report are to provide (1) proximate quality parameters (moisture, protein, total starch, water absorption, unsoaked seeds, test weight, 1000 seed weight, starch properties, and color) for dry pea, lentil, and chickpea varieties grown commercially in the USA, (2) data on total concentrations of micronutrients (iron, zinc, calcium, magnesium, potassium, manganese, copper, and selenium) in these same pulses, and (3) a technical summary of recent scientific publications on the nutritional quality of US-grown pulses as related to human health.

In 2013, a total of 140 pulse samples were collected from the major US pulse growing regions. Specifically, seeds representing 86 dry pea, 34 lentil, and 20 chickpea samples were acquired from industry representatives in pulse growing areas in North Dakota, South Dakota, Idaho, Montana, and Washington. The proximate quality parameters determined include moisture, protein, ash, total starch, water absorption, unsoaked seeds, test weight, 1000 seed weight, and starch parameters of peak viscosity, hotplate viscosity, breakdown, cold paste viscosity, setback, and peak time. In addition, average color quality (before and after soaking) was determined. The results of each quality parameter are provided for each pulse crop category. Physical quality parameters such as ash, water absorption, unsoaked seed percent, test weight, and 1000 seed weight of the 2013 samples were consistent with previous years, with the exception of low moisture and high starch levels.

Similar to results reported in 2011 and 2012, the pulses grown in 2013 are an excellent source of a wide range of micronutrients including iron (Fe), zinc (Zn), selenium (Se), and magnesium (Mg). In addition, concentrations of phytic acid—an antinutrient in the seeds of pulses that has the potential to bind mineral micronutrients in staple food crops and reduce their bioavailability—were low in US-grown pulses. This report includes the percent recommended dietary allowance (RDA) of minerals from a 50 g serving of pulses for adults aged 19 to 50 years. These data highlight the potential of US-grown pulses to be a whole food solution to mineral micronutrient malnutrition in particular and a contributor to better human nutrition in general; this is especially noted in some cases for selenium, iron, zinc, and magnesium.

Finally, this report includes two contributions from students involved in pulse quality research: (1) a letter from Casey R. Johnson, in which he shares his experience of nutritious pulses and (2) an article from the 2014 NDSU Innovation Challenge winners (Tyler Lewandowski, Dwight Anderson, and Lukshman Ekanayake) about their Healthy Hummus product.

The NDSU Pulse Quality and Nutrition Program was established in September 2010 to promote US-grown pulses as a whole food source to combat global micronutrient malnutrition. During the last three years, this program grew to be a leading research center, with the research conducted receiving substantial funding support as well as gaining attention from several countries in Asia, Africa, and South America. The program was equipped with a state-of-the-art laboratory complete with modern equipment, greenhouse facilities, and national/international collaborators. The program supported one PhD and three MS students, one technician, and two research assistants. More than 10 undergraduate students and several international visiting students (Australia and Serbia) were trained to conduct pulse nutritional quality research. More than 30 research publications are now available for the US pulse industry that document levels of minerals, anti-nutrients, prebiotic carbohydrates, and folates in various crops. The most recent Pulse Quality Survey results have been included in the United States Department of Agriculture (USDA) Nutrition database for wider user access. As the leader of the NDSU Pulse Quality and Nutrition Program, I would like to thank the USA pulse producers, global pulse consumers, and pulse industry for their continued support.

Sincerely,

Dil Thavarajah, Ph.D.
dthavarajah@gmail.com
dilrukshi.thavarajah@ndsu.edu

A list of scientific publications from the NDSU Pulse Quality and Nutrition Program is provided at the end of this report.

Pulse Production

Significant land area is allocated to pulse crops in the Pacific Northwest and rapidly expanding production is occurring in the Northern Plains region of the USA. US pulse production acreage in 2013 (1,444,859 acres) was substantially increased from 2012 (1,278,392 acres) but similar to 2010 (1,456,347). Total US pulse production was 1,273,269 MT in 2013 compared to 891,869 MT in 2012 (Table 1; Figure 1). US dry pea and chickpea production increased in 2010-2013 compared to lentil production.

Dry Pea: Total green pea acreage was 379,501 in 2013 compared to 282,960 in 2012, representing a 34% year-over-year increase. Total green pea production was 348,819 MT in 2013 and 229,328 MT in 2012. Similar to green peas, yellow pea acreage increased from 344,596 in 2012 to 477,000 in 2013. Corresponding production was 294,802 and 485,022 MT, respectively (USA Dry Pea and Lentil Council, 2013). Total US pea production including green, yellow, and Austrian winter pea was 869,708 MT in 2013. Most production came from Montana and North Dakota, followed by Washington State.

Lentil: Lentil acreage was 366,908 in 2013, 444,595 in 2012, and 425,893 acres in 2011. Lentil production was 284,332 MT in 2013, 229,171 MT in 2012, and 223,763 MT in 2011. Approximately 41% of the total lentil production was from North Dakota, 31% from Montana, 11% from Washington, and 4% from Idaho (USA Dry Pea Lentil Council, 2013)..

Chickpea: Chickpea acreage was 208,243 in 2013, 193,825 in 2012, and 117,050 in 2011. Production was approximately 145,636 MT in 2013, 127,339 MT in 2012, and 83,358 MT in 2011. More than 47% of the total chickpea production was from Washington, 29% from Idaho, 8% from Montana, 7% from California, and only 4% from North Dakota.

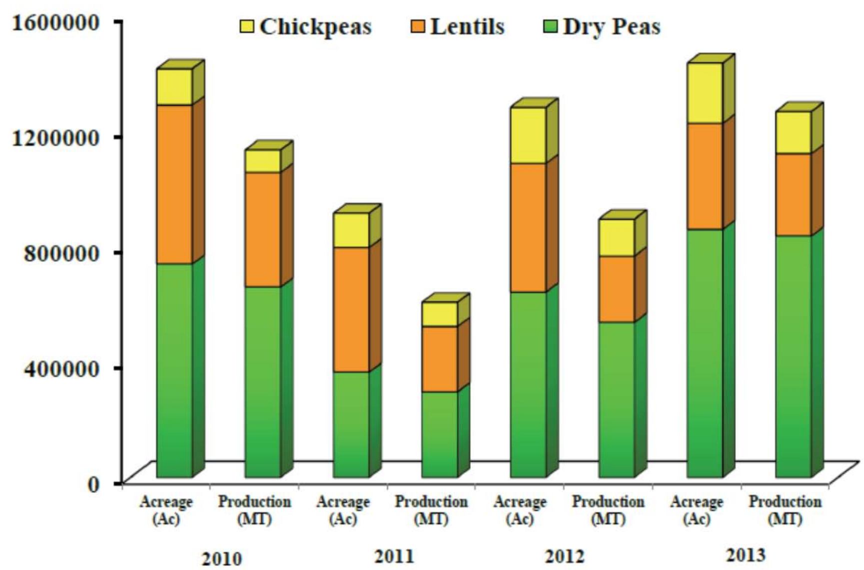


Figure 1: USA dry pea, lentil, and chickpea acreage and production (MT) in 2010, 2011, 2012, and 2013 (based on USA Dry Pea Lentil Council data).

Table1: U.S. pulse acreage, average yield, and production summary for 2010-2013.

Crop	2010 Acreage (Ac)	2010 Production (MT)	2011 Acreage (Ac)	2011 Production (MT)	2012 Acreage (Ac)	2012 Production (MT)	2013 Acreage (Ac)	2013 Production (MT)
Dry Pea	736,763	657,506	363,315	295,060	639,972	535,299	856,501	833,841
Lentil	549,425	396,086	430,840	226,031	444,595	229,171	366,908	284,332
Chickpea	125,159	77,669	118,390	83,616	193,825	127,399	208,243	145,636
Total	**1,456,347**	**1,131,261**	**917,548**	**604,707**	**1,278,392**	**891,869**	**1,444,859**	**1,273,269**

Data from USA Dry Pea and Lentil Council, 2013.

Laboratory Analysis

Similar to 2010-2012, standard methods were followed for the determination of each pulse quality attribute in 2013. Table 2 includes the references for each method.

- Moisture content is an important parameter for pulse seed handling and storage. Generally, pulse crops are recommended for harvest at 13-14% moisture. At lower moisture levels, the seeds are prone to mechanical damage during handling and storage. On the other hand, higher moisture levels are a risk with respect to food safety and microbial growth.
- Pulses are rich in protein, which ranges from 20 to 30% depending on the growing location, cultivar, and year. Pulses are low in sulfur-containing amino acids but high in lysine, an essential amino acids for human health. Most importantly, pulses are gluten free and rich in dietary fiber and a range of micronutrients.
- Ash content is an indicator of minerals. Higher ash content than cereals indicates pulses are particularly rich in minerals such as iron, zinc, and selenium.
- Pulse starch has a low glycemic index and is high in low digestible carbohydrates and dietary fiber. Pulse starch includes many prebiotic carbohydrates including resistant starch, sugar alcohols, fructooligosaccharide, and raffinose family sugars that serve to reduce obesity and other non-communicable diseases when included as part of the regular diet.
- Test weight and 1000 seed weight are indicators of seed size, shape, and milling yield. Each pulse crop has its own market preference based on color, seed size, and shape.
- Canning quality is determined by the percent water absorption and unsoaked seeds. Canning quality is an important indicator especially for the chickpea market. Canned chickpea is a popular item in the North American market for hummus, soups, and salads.

Table 2: Quality attribute, analytical method, and remarks for analyses conducted for the 2013 pulse quality survey.

Quality Attribute	Method	Remarks
1. Moisture (%)	AACC method 44-15A	Indicator of post-harvest handling, milling yield
2. Protein (%)	AACC method 46-30	Indicator of nutritional quality and processing
3. Ash (%)	AACC method 08-01	Indicator of total mineral content
4. Total starch (%)	Johnson et al., 2012	Indicator of nutritional quality and processing
5. Water absorption (%)	AACC method 56-35.01	Indicator of cooking quality/uniformity and canning
6. Unsoaked seed (%)	AACC method 56-35.01	Indicator of cooking quality/uniformity and canning
7. Test weight (lb/bu)	AACC method 55-10	Indicator of sample density, size, and shape
8. 1000 seed weight	100-kernel sample weight times 10	Indicator of grain size and milling yield
9. Starch properties	Rapid Visco Analyzer	Indicator of texture, firmness, and gelatinization of starch
10. Color	Konica Minolta CR-310 Chroma meter	Indicator of visual quality and processing
11. Micronutrients	Thavarajah et al., 2008, 2009a	Micronutrient analysis and malnutrition/cancer protection

Dry Pea Quality

Sample distribution

A total of 86 dry pea samples were collected from Montana, North Dakota, Idaho, and Washington State from September to February 2013. Growing location, number of samples, market class, and genotype details of these dry pea samples are described in Table 3. The majority of the dry pea samples were received from North Dakota followed by Montana, Washington, and Idaho.

Table 3: Description of dry pea samples used in the 2013 pulse quality survey.

State	No. of samples	Market class	Cultivars
Idaho	9	Green	Aragorn, Ariel, Banner, Ginny (Pro 7137), Greenwood (Pro 7040)
Montana	15	Green	Arcadia, Cruiser, CDC Striker
		Yellow	CDC Meadow, Delta, Korondo
		Winter pea	Graingen
North Dakota	48	Green	Arcadia, Cruiser, Dayton, Greenwood (Pro 7040), Shamrock, CDC Striker
		Yellow	DS Admiral, Agassiz, Bridger, CDC Meadow, Montec, Mystique, Nette, Torch
Washington	15	Green	Aragorn, Ariel, Banner, Ginny (Pro 7137), Greenwood (Pro 7040)
		Yellow	Universal, Rosalina
Total	86		

Proximate analysis of dry pea (Table 4)

Moisture

The moisture content of dry pea ranged from 1-13% in 2013. The average moisture content of the 86 samples was 6%, which is lower than the 4-year average of 11%. Dry peas grown in 2013 had a lower moisture content than samples from 2008-2012. The low moisture content would require careful handling of the 2013 crop to reduce seed damage during storage and handling.

Protein

Protein content of dry pea ranged from 17-29% with an average of 23%. Interestingly, the average protein content of dry peas grown in 2013 was slightly lower than the 5-year average of 24%. This is attributed to weather conditions and cultivar selection in 2013.

Ash

Ash content of dry pea ranged from 2.1-2.8% with an average of 2.5%. The average ash content of dry peas grown in 2013 was slightly lower than the 5-year average of 2.6%. Ash content is an indicator of minerals present.

Total starch

Total starch content of dry pea ranged from 36-75% with an average of 52%. The average total starch content of dry peas grown in 2013 was higher than the 5-year average of 46%.

Water absorption

Water absorption of dry pea ranged from 41-122% with an average of 98%. The 2013 average is similar to the 5-year average of 99%.

Unsoaked seed

Unsoaked seed percentage ranged from 0-54% with an average of 8%, which was considerably higher than the 5-year average of 1.6%. Higher levels of unsoaked seeds are probably due to the low moisture content during harvest.

Test weight

Test weight ranged from 60-67 lb/Bu with an average of 64 lb/Bu. This average value was higher than the 5-year average of 62 lb/Bu.

1000 seed weight

The average 1000 seed weight of dry peas grown in 2013 was 222 g, which was identical to the 5-year average of 222 g.

Proximate analysis of dry pea market classes (Tables 5 and 6)

For yellow peas, levels of moisture, protein, ash, and water absorption were lower in 2013 than values reported in 2012. Total starch, unsoaked seed percent, test weight, and 1000 seed weight were higher than 2012 values. Overall, 2013 yellow pea protein content was similar to 2011 but total starch content was considerably higher than 2010-2012 (Table 5). For green peas, all physical quality parameters except unsoaked seed percent, test weight, and 1000 seed weight were lower in 2013 than in 2012. Both yellow and green dry pea market classes showed similar proximate analysis for protein, total starch, and test weights. Overall, both dry pea classes have demonstrated significant moisture reduction over the past few years (Table 5).

In 2013, CDC Striker (26.1%) and Dayton (27%) had the highest protein content and Greenwood (60.7%) had the highest total starch content within the green market class. Aragorn (19.2%) and Ariel (18.9%) had the lowest protein content and Ginny had the lowest starch content (42.4%; Table 6). For the yellow market class, Agassi had the highest protein content (26%) and CDC Meadow had the highest total starch content (57.6%; Table 6).

Table 4: Proximate analysis of dry pea grown in the USA, 2008-2013.

	2013		Mean					5-year mean
Characteristics*	Range	Mean (SD)	2012	2011	2010	2009	2008	
1. Moisture (%)	1-13	6 (3)	9	7	13	12	13	11
2. Protein (%)	17-29	23 (3)	25	23	27	24	22	24
3. Ash (%)	2.1-2.8	2.5 (0.1)	2.6	2.6	2.5	2.6	2.6	2.6
4. Total starch (%)	36-75	52 (7)	52	41	45	43	51	46
5. Water absorption (%)	41-122	98 (13)	103	101	98	94	98	99
6. Unsoaked seed (%)	0-54	8 (9)	0.8	0.6	1.1	3.9	-	1.6
7. Test weight (lb/Bu)	60-67	64 (2)	61	61	63	63	63	62
8. 1000 seed weight (g)	139-304	222 (31)	206	203	241	225	235	222

* all measurements were done based on a sample arrival basis (dry basis).

Table 5: Summary of proximate analysis of dry pea market classes, 2010-2013.

	Mean (SD) of yellow pea				Mean (SD) of green pea			
Characteristics*	2013	2012	2011	2010	2013	2012	2011	2010
1. Moisture (%)	7 (3)	9 (0.6)	7 (0.1)	14 (2)	5 (3)	9 (0.7)	7 (0.4)	13 (2)
2. Protein (%)	23 (4)	25 (1.3)	23 (2)	27 (2)	23 (3)	25 (3)	22 (2)	27 (2)
3. Ash (%)	2.4 (0.1)	2.6 (0.2)	2.7 (0.2)	2.7 (0.5)	2.5 (0.1)	2.7 (0.2)	2.6 (0.2)	2.4 (0.5)
4. Total starch (%)	52 (6)	50 (8)	44 (4)	45 (3)	52 (7)	53 (6)	40 (6)	45 (3)
5. Water absorption (%)	94 (11)	102 (8)	99 (4)	99 (8)	102 (14)	104 (5)	101 (4)	99 (8)
6. Unsoaked seed (%)	8 (9)	2 (3)	0.8 (0.9)	1 (2)	8 (9)	0.5 (1)	0.5 (1.3)	1.1 (2)
7. Test weight (lb/Bu)	64 (2)	62 (2)	62 (1)	63 (1)	63 (2)	62 (1)	61 (1)	6 (1)
8. 1000 seed weight (g)	235 (29)	212 (23)	225 (22)	248 (27)	212 (29)	201 (31)	195 (22)	232 (36)

* all measurements were done based on a sample arrival basis (dry basis)

Table 6: Mean protein and starch content for different field pea cultivars grown in the USA in 2013.

Market Class	Cultivar	Protein (%)*	Total Starch (%)#
Green	Aragorn	19.2	55.4
	Arcadia	23.5	52.9
	Ariel	18.9	51.7
	Banner	19.6	54.6
	Cruiser	25.4	51.5
	Dayton	27.0	43.9
	Ginny	20.9	42.4
	Greenwood	21.9	60.7
	K-2	23.2	51.3
	Shamrock	24.5	49.0
	CDC Striker	26.1	52.7
	Unknown	24.6	55.5
Yellow	DS Admiral	23.1	57.4
	Agassiz	26.0	56.1
	Bridger	21.3	35.6
	CDC Meadow	21.7	57.6
	Delta	23.8	46.9
	Korondo	22.6	50.2
	Montec	24.5	51.9
	Mystique	22.3	51.4
	Nette	23.9	48.7
	Rosalina	19.4	50.6
	Torch	22.7	39.3
	Universal	23.3	52.8
Unknown	Graingen	22.9	51.2

Starch Properties
(Tables 7 and 8)

Starch properties were higher than 2012 values and within the range of the 5-year means. Starch properties of both dry pea market classes are more suited to the Asian noodle market, which prefers a medium to high peak viscosity flour product as it gives better textural characteristics. Flour from both dry market classes can be used as a thickening agent due to moderate peak viscosity values (Table 7). Average values of peak viscosity, hot plate viscosity, and breakdown in 2013 were significantly higher than values reported in 2012. Both green and yellow peas had similar starch properties and, for both market classes, average starch properties increased from 2012 (Table 8). The range of 5-year means for starch properties bracket the 2013 values, indicating consistently good quality starch for food processing.

Table 7: Starch properties of dry pea grown in the USA, 2008-2013.

	2013		Mean					
Characteristics	Range	mean (SD)	2012	2011	2010	2009	2008	5-year mean
1. Peak Viscosity (RVU)	92-173	141 (19)	123	215	126	117	118	140
2. Hot Paste Viscosity (RVU)	83-181	122 (14)	117	165	118	108	96	121
3. Break Down (RVU)	3-53	20 (13)	6.3	41	8	9	22	17
4. Cold Paste Viscosity (RVU)	131-318	212 (35)	213	355	204	184	180	227
5. Setback (RVU)	48-145	91 (24)	96	200	87	76	112	114
6. Peak time (min)	8-9	8 (0.4)	9	8	7	14	10	10

Table 8: Starch properties of pea market classes, 2010-2013.

	Mean (SD) of yellow pea				Mean (SD) of green pea			
Characteristics	2013	2012	2011	2010	2013	2012	2011	2010
1. Peak Viscosity (RVU)	136 (19)	126 (17)	192 (14)	127 (14)	146 (17)	120 (12)	223 (120)	124 (19)
2. Hot Paste Viscosity (RVU)	122 (19)	119 (11)	152 (12)	120 (13)	122 (9)	115 (10)	169 (62)	115 (16)
3. Breakdown (RVU)	17 (11)	8 (8)	41 (5)	7 (5)	24 (15)	5 (5)	41 (13)	9 (7)
4. Cold Paste Viscosity (RVU)	207 (42)	211 (38)	331 (33)	204 (29)	218 (27)	215 (31)	365 (72)	204 (35)
5. Setback (RVU)	85 (26)	93 (28)	179 (23)	85 (17)	96 (23)	100 (22)	209 (57)	89 (21)
6. Peak time (min)	8 (0)	9 (1)	8 (0.2)	9 (1)	8 (0.3)	9 (2)	8 (0)	9 (1)

Color quality of dry peas (Tables 9, 10, and 11)

Color is an important quality attribute for the dry pea food industry. Color quality was measured using an L, a, and b type scale as follows

- L (lightness) axis – 0 is black and 100 is white;
- a (red-green) axis – positive values are red, negative values are green, and zero is neutral; and
- b (yellow-blue) axis – positive values are yellow, negative values are blue, and zero is neutral.

Color quality for both market classes in 2013 was slightly higher (lighter in color) than results reported for 2010-2012. The more negative value for red-green (axis a) in 2013 indicates a greener color than 2012. For the yellow pea market class, lightness increased after soaking. In addition, soaking decreased red-green values but increased yellow-blue values. For the green pea market class, lightness and red-green value decreased after soaking but yellow-blue values increased (Tables 9 and 10).

Among the genotypes, Pro 7040, Banner, and Ariel had the most negative a axis value (greenest color) before soaking and Cruiser and Ariel had the most negative after soaking. Color quality effects on the final product are required by end users. Generally, a bright green color is more desirable in dry pea for many products. Green dry pea cultivars Pro 7040 and Banner had the greenest color compared to other cultivars (Table 11).

Table 9: Color quality of yellow pea before and after soaking, 2010-2013.

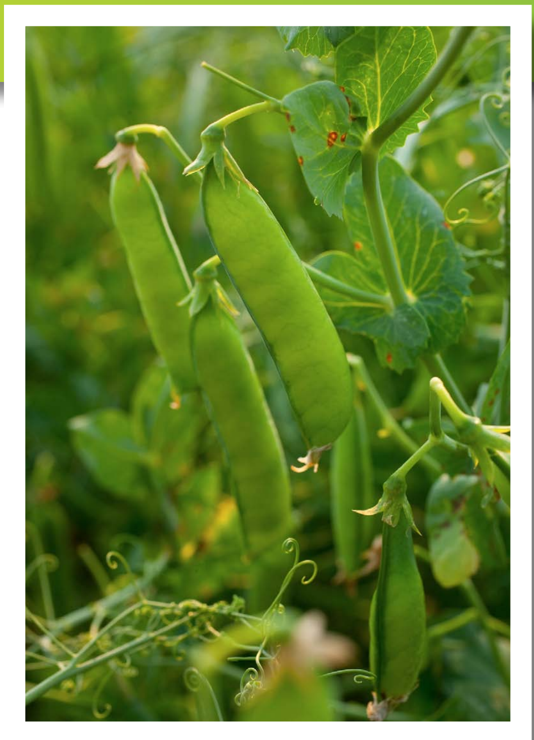
	Mean (SD) of yellow pea							
	Before soaking				After soaking			
Color Scale	2013	2012	2011	2010	2013	2012	2011	2010
† L (lightness)	71 (8)	65 (1)	65 (2)	63 (1)	77 (14)	65 (1)	66 (2)	67 (1)
± a (red-green)	7.0 (1)	4.7 (1)	4.7 (0.3)	5.6 (1)	6.3 (5)	5.4 (1)	5.6 (1)	5.5 (1)
* b (yellow-blue)	21 (2)	14 (1)	14 (0.4)	15 (1)	47 (6)	30 (1)	30 (0.4)	28 (2)

† Zero is black, 100 is white.
± Positive values are red; negative values are green and zero is neutral.
* Positive values are yellow; negative values are blue and zero is neutral.

Table 10: Color quality of green pea before and after soaking, 2010-2013.

	Mean (SD) of green pea							
	Before soaking				After soaking			
Color Scale	2013	2012	2011	2010	2013	2012	2011	2010
† L (lightness)	66 (8)	60 (2)	61 (2)	59 (4)	59 (9)	54 (2)	55 (2)	57 (2)
± a (red-green)	-3.8 (1)	-1.9 (1)	-0.9 (3)	-1.7 (1)	-15 (4)	-8.4 (1)	-8.7 (1)	-6.7 (1)
* b (yellow-blue)	14 (2)	9 (1)	10 (2)	9 (1)	34 (4)	18 (1)	18 (1)	17 (1)

† Zero is black, 100 is white.
± Positive values are red; negative values are green and zero is neutral.
* Positive values are yellow; negative values are blue and zero is neutral.



Dry Pea Micronutrients (Tables 12 and 13)

Mineral micronutrients are elements; some are required in large quantities while others, such as selenium (Se), iodine (I), copper (Cu), iron (Fe), and zinc (Zn), are required in smaller quantities Micronutrient malnutrition has a negative influence on the cognitive abilities of school-aged children, decreasing their educational achievements, increasing mortality and morbidity rates, and reducing the work force.

Pulses are naturally rich in minerals. For yellow peas, levels of calcium, copper, and magnesium were higher in 2013 compared to 2012 (Table 12). Dry pea cultivars vary with respect to seed mineral levels. Details with respect to different cultivars are given in Table 13.

Table 11: Mean color quality of green pea cultivars grown in the USA, 2013.

	a† (red-green) 2013		a† (red-green) 2012		a† (red-green) 2011	
Cultivar	Seed color Before soaking	Seed color After soaking	Seed color Before soaking	Seed color After soaking	Seed color Before soaking	Seed color After soaking
Aragorn	-3.3	-15.5	-1.6	-8.6	-2.4	-8.8
Arcadia	-3.3	-9	-0.4	-5.1	-	-
Ariel	-4.6	-17	-1.8	-9.1	-2.5	-9.1
Banner	-4.9	-14	-2.5	-8.9	-3.1	-9.1
CDC Striker	-3	-15	-1.6	-8.2	-1.5	-8
Columbian	-	-	-2.4	-9.2	-2.3	-9.5
Cooper	-	-	-0.2	-3.5	-	-
Cruiser	-2.6	-16	-1.8	-8.7	-1.5	-8.3
Dayton	-2	-13	-	-	-	-
K-2	-3.2	-13	-1.5	-7.1	-0.9	-7.5
Majorette	-	-	-0.9	-6.7	-	-
Orka	-	-	-1.3	-6.8	-	-
Pacifica	-	-	-2.9	-9.1	-	-
Pro 081-7116	-	-	-2.2	-9.1	-	-
Pro 091-7137	-2.7	-14	-2.1	-8.9	-	-
Pro 7040	-4.9	-15	-2.9	-9.5	-	-
SGPD	-	-	-2	-8.6	-	-
Shamrock	-4.7	-15	-3.1	-8.4	-	-
Unknown	-2.9	-15	-1.7	-8.3	-	-
Viper	-	-	-1.4	-8.3	-	-

† Positive values are red; negative values are green and zero is neutral

Table 12: Micronutrient concentrations in dry pea grown in the USA, 2011-2013.

Micronutrient	Mean (SD) of yellow pea 2013	Mean (SD) of yellow pea 2012	Mean (SD) of yellow pea 2011	Mean (SD) of green pea 2013	Mean (SD) of green pea 2012	Mean (SD) of green pea 2011
Calcium (mg/kg)	494 (173)	390 (99)	529 (68)	333 (169)	345 (167)	507 (114)
Copper (mg/kg)	5.0 (2)	3.8 (2)	7.8 (1)	5.5 (2)	*	*
Iron (mg/kg)	36 (13)	50 (10)	42 (7)	41 (14)	41 (9)	39 (6)
Magnesium (mg/kg)	728 (182)	579 (68)	821 (35)	689 (242)	440 (98)	769 (58)
Manganese (mg/kg)	11 (3)	10 (3)	12 (2)	11 (4)	*	*
Potassium (mg/kg)	6335 (1477)	7490 (743)	5830 (312)	7529 (1801)	9004 (601)	6000 (320)
Phosphorus (mg/kg)	2223 (869)	2860 (319)	*	2902 (1190)	3242 (283)	
Selenium (µg/kg)	500 (300)	500 (300)	700 (400)	300 (300)	600 (500)	326 (288)
Zinc (mg/kg)	29 (8)	35 (7)	22 (3)	38 (6)	25 (4)	8 (0)

* Not reported

Table 10. Mean mineral micronutrient of dry pea cultivars grown in the USA, 2012.

Market Class	Cultivar	Concentration (mg/kg) Ca	Cu	Fe	K	Mg	Mn	P	Zn	Se (µg/kg)
Artesian	Graingen	500	3.5	29	5306	625	11	2415	29	219
Green	Aragorn	294	7.1	60	9596	863	15	4198	34	318
	Arcadia	321	11	47	9980	521	17	3239	39	838
	Ariel	412	6.5	56	10080	916	13	3760	31	*
	Banner	363	7.9	59	9919	945	13	4191	39	365
	Cruiser	347	5.0	30	5720	525	9	2369	28	210
	Dayton	181	4.6	31	7226	620	9	2048	21	*
	Ginny	143	7.4	55	9501	966	15	4127	34	317
	Greenwood	377	7.2	49	9050	947	15	3984	36	702
	K-2	487	4.6	36	7420	-*	10	2577	24	23
	Shamrock	213	4.1	31	6254	382	8	1752	19	149
	CDC Striker	242	3.7	25	5307	436	7	1949	21	320
Yellow	Agassiz	*	3.0	28	5261	346	7	1643	18	*
	Bridger	861	5.0	40	7344	*	12	2445	25	580
	CDC Meadow	465	3.9	29	5833	768	11	2177	27	502
	Delta	468	3.9	22	5953	614	8	1984	35	219
	DS Admiral	554	3.5	22	6368	752	10	2844	22	460
	Korondo	*	3.2	24	5107	235	5	989	13	144
	Montec	134	3.9	27	6335	406	7	1582	14	355
	Mystique	284	3.0	24	6046	585	9	2088	21	417
	Nette	580	4.4	28	6139	718	11	2510	24	461
	Rosalina	99	6.5	61	9923	820	12	3903	32	414
	Torch	811	6.4	40	6846	-*	9	2327	30	75
	Universal	499	8.2	61	9108	873	14	4251	40	402

* Not reported

Lentil Quality

Sample Distribution

A total of 34 lentil samples were collected from Montana, North Dakota, Idaho, and Washington. Similar to dry peas, lentil samples were also collected from January to February in 2013. Growing location, number of samples, market class, and genotypes used in 2013 quality survey are described in Table 14.

Table 14: Description of lentil genotypes used in the 2013 pulse quality survey.

State	No. of Samples	Market class	Genotype
Idaho	4	Green	CDC Richlea
		Red	Red Chief
		Spanish Brown	Pardina
Montana	12	Green	CDC Richlea, CDC Impress
		Red	CDC Redberry
		Red	Red Chief
		Red	CDC Maxim
North Dakota	13	Green	CDC Meteor
		Green	CDC Richlea
		Green	CDC Viceroy
		Red	CDC Maxim
Washington	5	Green	CDC Richlea
		Spanish Brown	Pardina
		Red	Crimson
Total	34		

Proximate analysis of lentils (Table 15)

Moisture

Moisture content of lentils ranged from 1.2-12% in 2013. The average moisture content was 5%, which is lower than the 5-year average of 9%.

Protein

Protein content ranged from 20-29% with an average of 23%. The average protein content of 2013 grown lentils was lower than the 5-year average of 25%.

Ash

Ash content of lentils ranged from 1.8-3.3% with an average of 2.4%. The average ash content of lentils grown in 2013 was lower than the 5-year average of 2.7%.

Total starch

Total starch content ranged from 40-77% with an average of 54%. This average was considerably higher than the 5-year average of 47%.

Water absorption

The average water absorption of lentils ranged from 45-120% with an average of 90%. These values bracketed the 5-year average of 93%.

Unsoaked seed

The average unsoaked seed percentage was 7%, which was lower than the 5-year average of 5.0%.

Test weight

Test weight of lentils ranged from 59-66 lb/Bu with an average of 62 lb/Bu. These values were similar the 5-year average of 61 lb/Bu.

1000 seed weight

The average seed density of lentils grown in 2013 was 46 g, which was similar to the 5-year average of 47 g.

Table 15: Proximate analysis of lentils grown in the USA, 2008-2013.

Characteristics	2013 Range	2013 Mean (SD)	Mean 2012	Mean 2011	Mean 2010	Mean 2009	Mean 2008	5-year mean
1. Moisture (%)	1.2-12	5 (3)	8	7	12	11	10	9
2. Protein (%)	20-29	23 (2)	25	22	27	25	24	25
3. Ash (%)	1.8-3.3	2.4 (0.3)	2.8	2.7	2.8	2.6	2.6	2.7
4. Total Starch (%)	40-77	54 (6)	52	40	43	47	52	47
5. Water Absorption (%)	45-120	90 (20)	94	88	96	93	94	93
6. Unsoaked Seed (%)	0-28	7 (8)	7	6	2	3	*	5
7. Test Weight (lb/Bu)	59-66	62 (2)	61	60	61	62	62	61
8. 1000 Seed Weight (g)	30-60	46 (8)	45	49	46	49	-*	47

Proximate analysis of lentil market classes

(Tables 16 and 17)

Both red and green markets had low moisture contents compared to 2012 and 2011. The red market class had higher protein content than the green market class. The red market class also had higher ash, unsoaked seed percent, and test weights. However, total starch, water absorption, and 1000 seeds weights were higher for the green market class. Generally, the green market class is more preferred for soups and salads compared to the red market class, which is mostly used in Asian cuisine as dhal.

For the red market class, average moisture, ash, total starch, and water absorption decreased from 2012. Protein content was similar to 2012. Unsoaked seed levels and 1000 seed weights increased compared to 2012 values. For the green market class, moisture, protein, ash, and water absorption decreased from 2012 values (Table 16).

For the green market class, CDC Viceroy had the highest protein and CDC Impress had the highest starch content. For the red market class, CDC Redberry had the highest protein and Crimson had the highest starch content (Table 17).

Table 16: Summary of proximate analysis of red and green lentils grown in the USA, 2011-2013.

Characteristics	Mean (SD) of red lentil 2013	Mean (SD) of red lentil 2012	Mean (SD) of red lentil 2011	Mean (SD) of green lentil 2013	Mean (SD) of green lentil 2012	Mean (SD) of green lentil 2011
1. Moisture (%)	5 (3)	8 (0.3)	7 (1)	5 (1)	9 (1)	7 (0.1)
2. Protein (%)	25 (2)	25 (2)	22 (2)	23 (3)	25 (2)	22 (2)
3. Ash (%)	2.6 (0.4)	3.0 (0.2)	2.5 (3)	2.3 (0.2)	2.7 (0.2)	2.7 (0.2)
4. Total Starch (%)	52 (5)	53 (4)	41 (5)	55 (6)	52 (3)	40 (5)
5. Water Absorption (%)	82 (22)	85 (51)	86 (20)	89 (21)	98 (17)	91 (14)
6. Unsoaked Seed (%)	11 (7)	2 (3)	9 (8)	6 (8)	6 (7)	3 (4)
7. Test Weight (lb/Bu)	63 (2)	61 (1)	61 (2)	62 (1)	60 (2)	59 (2)
8. 1000 Seed Weight (g)	45 (6)	39 (11)	42 (11)	49 (7)	47 (11)	56 (9)

Table 17: Mean protein and starch content for different lentil cultivars grown in the USA in 2013.

Market Class	Cultivar	Protein (%)	Total Starch (%)
Green	CDC Impress	25	57
	CDC Meteor	24	55
	CDC Richlea	22	54
	CDC Viceroy	26	54
Red	CDC Maxim	26	53
	CDC Redberry	27	56
	CDC Redberry	27	56
	Crimson	22	57
Spanish Brown	Pardina	23	50

Color quality of lentils
(Tables 18 and 19)

Color quality for both market classes was improved compared to results reported in 2012 and 2011. For both market classes, color intensity increased after soaking.

Table 18. Color quality of red lentil before and after soaking, 2010-2013.

	Mean (SD) of red lentils							
	Before soaking				After soaking			
Color scale	2013	2012	2011	2010	2013	2012	2011	2010
L (lightness)	54 (8)	55 (2)	54 (1)	51 (7)	57 (8)	52 (3)	52 (2)	54 (1)
a (red-green)	5.4 (1)	3.9 (1)	4.3 (1)	3.9 (1)	10 (2)	7.7 (1)	7.3 (2)	6.9 (2)
b (yellow-blue)	15 (4)	9 (2)	8 (2)	8 (2)	28 (7)	19 (1)	18 (1)	16 (2)

† Zero is black, 100 is white.
± Positive values are red, negative values are green, and zero is neutral
* Positive values are yellow, negative values are blue, and zero is neutral

Table 19: Color quality of green lentil before and after soaking, 2010-2013.

	Mean (SD) of green lentils							
	Before soaking				After soaking			
Color scale	2013	2012	2011	2010	2013	2012	2011	2010
L (lightness)	60 (2)	60 (1)	60 (1)	60 (1)	67 (7)	59 (2)	60 (1)	62 (2)
a (red-green)	1.0 (2)	1.1 (1)	2.1 (0.4)	1.0 (0.6)	-0.2 (2)	-0.4 (1)	1.0 (0.6)	-0.2 (1.5)
b (yellow-blue)	23 (1)	15 (1)	24 (1)	23 (2)	35 (6)	23 (2)	24 (1)	22 (2)

† Zero is black, 100 is white.
± Positive values are red, negative values are green, and zero is neutral
* Positive values are yellow, negative values are blue, and zero is neutral

Lentil Micronutrients (Tables 20 and 21)

Levels of mineral micronutrients iron, zinc, calcium, magnesium, potassium, and selenium in red and green lentil market class are given in Table 20.

For the red market class, calcium, magnesium, potassium, and zinc increased from 2012. In addition, red lentil cultivar Red Chief had higher iron, zinc, magnesium, and potassium levels than both CDC Redberry and CDC Maxim (Table 21). As expected, CDC Redberry had a higher seed selenium level than either Red Chief or CDC Maxim.

For the green market class, calcium, magnesium, selenium, and zinc levels increased from 2012. Green lentil cultivar CDC Richlea had higher levels of iron, zinc, magnesium, and potassium than other cultivars grown in 2013.

For both market classes, levels of calcium, magnesium, and zinc increased from 2012.

Lentils have low levels of phytic acid, a mineral antinutrient for which low levels are a positive factor for increased mineral bioavailability. Lentils are also a good source of beta-carotene, a vitamin A precursor.

Mineral levels of lentils are known to vary with growing location and soil conditions.

Table 20: Micronutrient concentrations in lentils grown in the USA, 2011-2013.

	Market class					
	Mean (SD) of red lentil			Mean (SD) of green lentil		
Micronutrient	2013	2012	2011	2013	2012	2011
Calcium (mg/kg)	460 (56)	418 (85)	569 (99)	496 (81)	293 (79)	501 (62)
Copper (mg/kg)	7 (3)	*	*	7 (2)	*	*
Iron (mg/kg)	75 (28)	79 (18)	67 (6)	57 (18)	69 (39)	53 (6)
Magnesium (mg/kg)	677 (175)	482 (83)	720 (47)	597 (185)	367 (109)	761 (40)
Manganese (mg/kg)	20 (5)	*	*	15 (4)	*	*
Potassium (mg/kg)	7761 (2607)	7243 (896)	6108 (463)	6936 (1463)	6954 (709)	6255 (447)
Phosphorus (mg/kg)	3909 (1491)	*	*	2931 (829)	*	*
Selenium (µg/kg)	379 (143)	503 (174)	495 (158)	727 (382)	726 (403)	698 (273)
Zinc (mg/kg)	45 (16)	40 (4)	33 (6)	35 (10)	34 (8)	29 (4)

* mean values with standard deviation.

Table 21: Mean mineral micronutrients in lentil cultivars grown in the USA in 2013.

		Concentration (mg/kg)					
Market Class	Cultivar	Fe	Zn	Ca	Mg	K	Se (µg/kg)
Green	CDC Impress	36	31	523	456	5454	838
	CDC Meteor	40	23	510	294	6415	209
	CDC Richlea	63	39	497	664	7279	808
	CDC Viceroy	52	28	476	647	5982	802
Red	CDC Redberry	62	36	543	571	6160	558
	Red Chief	111	65	447	866	11060	380
	CDC Maxim	55	35	442	541	6095	318
Spanish Brown	Crimson	104	52	543	840	8878	430
	Pardina	127	51	453	748	9363	413

Chickpea Quality

Sample distribution

A total of 20 chickpea samples were collected from Idaho, Montana, North Dakota, and Washington. Samples of approximately 100-250 g were received by the NDSU Pulse Quality and Nutrition Laboratory from January to February 2013. Chickpea growing location, number of samples, market class, and genotypes used in 2013 quality survey are described in Table 22.

Table 22: Description of chickpea cultivars used in the 2013 pulse quality survey.

State	No of samples	Market class	Genotype
Idaho	6	Kabuli	Billy Bean, Bronic, Sawyers, Sierra, Troy
Montana	3	Kabuli	CDC Frontier, Sienna
North Dakota	5	Kabuli	CDC Frontier
Washington	6	Kabuli	Billy Bean, Dylan, Marvel, Sierra
Total	**20**		

Proximate analysis of chickpea (Tables 23 and 24)

Moisture

The moisture content of US-grown chickpea ranged from 1-7% in 2013. The average moisture content of chickpea was 2.8%. Extremely lower seed moisture levels were observed in 2013, with values much lower than for 2011 or 2012.

Protein

Protein content of chickpea ranged from 19-23% with an average of 21%. Bronic and CDC Frontier had the highest protein contents compared to the other cultivars (Table 24). Average protein content was similar to values from 2012 and 2011.

Ash

The ash content of chickpea ranged from 2.4-3.1% with an average of 2.8%. Average ash content was similar to values from the previous two years.

Total starch

Total starch content ranged from 44-65% with an average of 53%. Total starch values were higher than in 2012 and 2011. Marvel had the highest total starch content compared to the other cultivars (Table 24). Overall, the 2013 crop demonstrated a high starch content.

Table 23: Summary of proximate analysis of chickpea grown in USA, 2011-2013.

	2013		2012	2011	3-year
Characteristics*	Range	Mean (SD)	Mean (SD)	Mean (SD)	Mean
1. Moisture (%)	1.0-7.0	2.8 (2.6)	8.0 (1)	6.9 (1)	5.9
2. Protein (%)	19-23	21 (1.6)	21 (2)	21 (2)	21
3. Ash (%)	2.4-3.1	2.8 (0.2)	2.9 (0.2)	2.8 (0.1)	2.8
4. Total Starch (%)	44-65	53 (6)	50 (5)	41 (7)	48
5. Water Absorption (%)	93-121	108 (8)	113 (46)	103 (7)	108
6. Unsoaked Seed (%)	0	0 (0)	0	0	0
7. Test Weight (lb/Bu)	58-65	60 (2)	61 (2)	61 (20)	61
8. 1000 Seed Weight (g)	250-559	404 (90)	403 (99)	387 (82)	398

Water absorption

Water absorption of chickpea ranged from 93-123% with an average of 108%. The average value was slightly lower than 2012 values.

Unsoaked seed

All tested seeds were properly soaked. No unsoaked seed percentage was observed, which is similar to results from 2012.

Test weight

Test weight ranged from 58-65 lb/Bu with an average of 60 lb/Bu. These values are similar to data from 2012 and 2011.

1000 seed weight

The seed density of chickpea grown in 2013 ranged from 250-559 g with an average of 404 g. The mean value of the 1000 seed weight was slightly higher than 2012 and 2011 values.

Table 24: Mean protein and starch content for different chickpea cultivars grown in the USA in 2013.

Cultivar	Protein (%)	Total starch (%)
Billy Bean	21	46
Bronic	23	51
Dylan	20	52
CDC Frontier	22	56
Marvel	21	61
Sawyer	19	49
Sierra	20	52
Troy	18	50

Color quality of chickpea (Tables 25 and 26)

Color is an important quality attribute for the chickpea flour and hummus industry. Color quality was measured using an L, a, and b type scale as follows:

- L (lightness) axis – 0 is black and 100 is white;
- a (red-green) axis – positive values are red, negative values are green, and zero is neutral; and
- b (yellow-blue) axis – positive values are yellow, negative values are blue, and zero is neutral.

The lightness of chickpea did not change after soaking. CDC Frontier was the most suitable cultivar for canning.

Table 25: Color quality of chickpea before and after soaking, 2012-2013.

	Mean (SD) of Kabuli chickpea			
	Before Soaking		After Soaking	
Color scale	2013	2012	2013	2012
L (lightness)†	81 (12)	61 (2)	89 (11)	62 (1)
a (red-green)‡	11 (2)	6 (1)	13 (3)	7 (1)
b (yellow-blue)*	28 (4)	15 (1)	53 (7)	26 (2)

† Zero is black, 100 is white
‡ Positive values are red; negative values are green and zero is neutral
* Positive values are yellow; negative values are blue and zero is neutral

Table 26: Mean color quality of chickpea cultivars grown in the USA, 2012-2013.

	b* (yellow-blue) 2013		b* (yellow-blue) 2012	
Varieties	Before soaking	Seed after soaking	Before soaking	Seed after soaking
Billy Bean	34.3	50.4	14.6	27.9
Bronic	31.0	49.9	14.5	27.3
B-90	-	-	16.4	26.1
Dwelley	-	-	13.8	25.2
Dylan	28.3	53.8	12.6	21.3
CDC Frontier	24.5	59.0	15.4	26.8
Marvel	29.6	40.2	-	-
Sawyers	30.4	42.7	14.2	25.2
Sierra	28.7	51.8	13.8	23.3
Troy	21.2	50.2	12.5	22.6

Positive values are red; negative values are green and zero is neutral.

Chickpea micronutrients

US-grown chickpea are a good source of iron, zinc, calcium, magnesium, potassium, and selenium. Concentrations of each mineral micronutrient are given in Table 27.

Mineral nutrient levels of chickpea cultivars

(Table 28)

All genotypes had different levels of mineral micronutrients. CDC Frontier had higher selenium content compared to the other cultivars in 2013.

Table 27: Micronutrient concentrations in chickpea grown in the USA, 2011-2013.

	Mean (SD) of Kabuli chickpea		
Micronutrient	**2013**	**2012**	**2011**
Calcium (mg/kg)	499 (238)	503 (158)	645 (82)
Copper (mg/kg)	8 (2)	*	*
Iron (mg/kg)	51 (11)	43 (7)	43 (7)
Magnesium (mg/kg)	1148 (88)	693 (97)	906 (72)
Manganese (mg/kg)	44 (8)	*	*
Potassium (mg/kg)	9670 (1340)	7627 (1382)	6611 (406)
Phosphorus (mg/kg)	3992 (1050)	*	*
Selenium (µg/kg)	520 (264)	599 (504)	361 (280)
Zinc (mg/kg)	38 (9)	30 (7)	24 (2)

* Not reported

Table 28: Mean micronutrient concentrations in chickpea cultivars grown in the USA in 2013.

	Concentration (mg/kg)								
Cultivar	**Fe**	**Zn**	**Ca**	**Mg**	**K**	**P**	**Mn**	**Cu**	**Se (µg/kg)**
Billy Bean	55	37	221	1185	10318	4560	50	9	352
Bronic	55	49	589	1084	10277	4838	43	8	*
Dylan	64	49	989	1338	49	4701	56	9	359
CDC Frontier	38	26	558	*	7798	2538	41	5	681
Marvel	75	46	515	1051	11013	5095	41	8	*
Sawyer	43	36	162	1136	10453	4390	40	8	327
Sierra	57	43	520	1150	10444	4605	49	9	427
Troy	*	35	221	1115	*	*	*	*	*

* Not reported

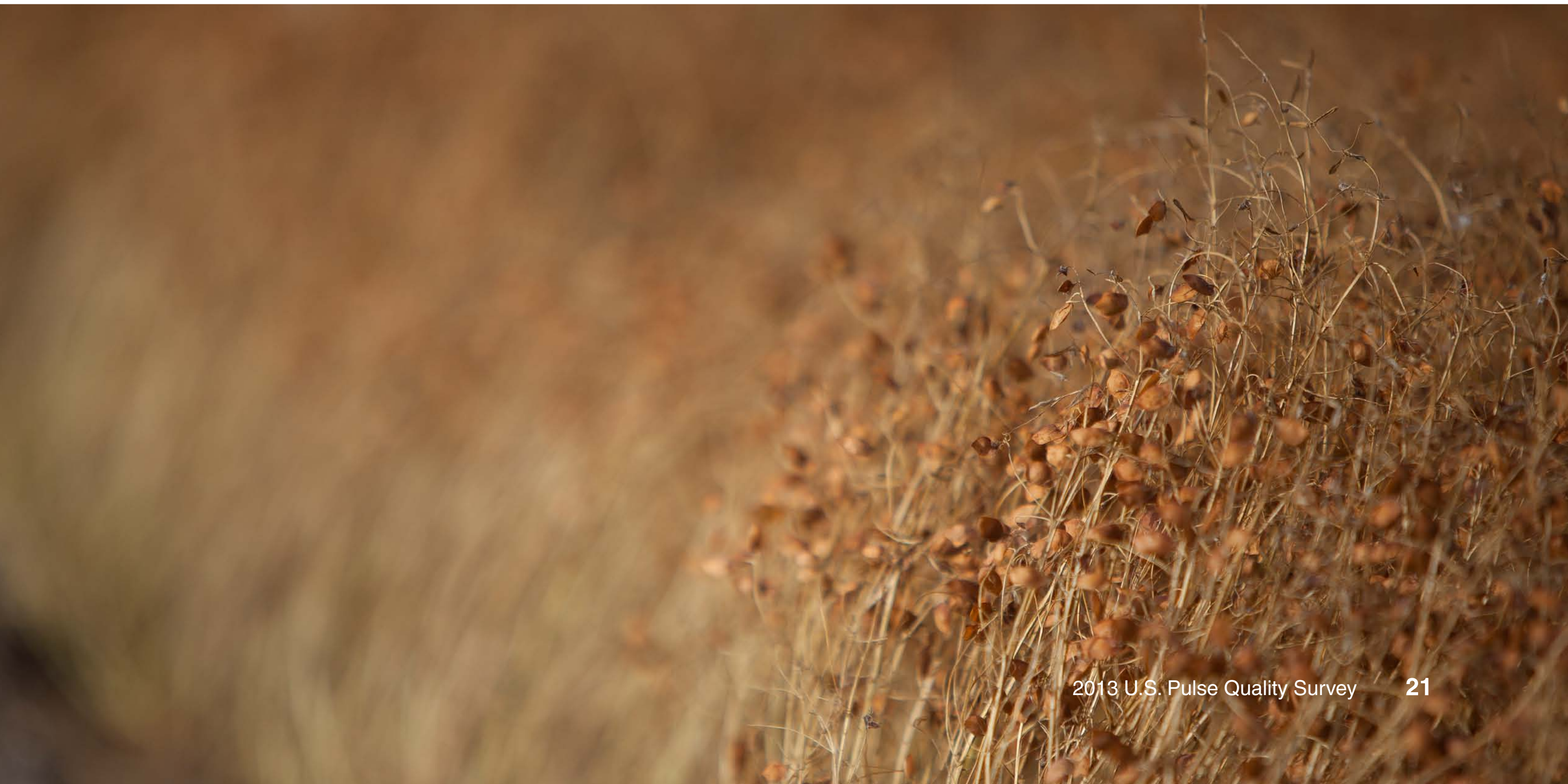
Percentage Recommended Daily Allowance

The percentage recommended daily allowance (%RDA) provides an indication of the nutrient concentration of a food item. Based on a 50 g serving for both adult males and females 19-50 years of age, US-grown field pea, lentil, and chickpea can be considered good sources of selenium, iron, zinc, potassium, and magnesium (Table 29).

Table 29. Percent recommended daily allowance (RDA) of minerals in a 50 g serving of pulses.

	%RDA in a 50 g of serving of pulses for adults (19-50 yrs)†								
	Se	Fe		Zn		Ca	Mg		K*
Crop	Male/ Female (55 µg)	Male (8 mg)	Female (18 mg)	Male (11 mg)	Female (8 mg)	Male/ Female (1000 mg)	Male (410 mg)	Female (310 mg)	Male/ Female (4.7 g)
Field pea	39	24	11	14	18	2	9	11	8
Lentil	57	44	19	18	24	2	8	10	8
Chickpea	47	32	14	17	24	2	18	18	10

†%RDA and AI were calculated based on www.nap.edu (Food and Nutrition Board, Institute of Medicine and National Academies; http://fnic.nal.usda.gov)
*Adequate Intake (AI)



Dear pulse consumers,

To you who have discovered the joy of eating pulses,

My name is Casey Johnson, research fellow at the Pulse Quality and Nutrition Program. I had never seen a lentil until I was a teenager. A canoe trip in the boundary waters of Northern Minnesota was the first time I ate lentils, brought along because they were lightweight and cooked fast. During college I had the chance to immerse myself in other cultures, and I noticed that these “strange” foods were in almost everything that they prepared. Since those days, I have become convinced of the benefits of growing and eating pulses. And so, if any doubt remains in your mind, any hesitation or uncertainty as to the importance of pulse crops in human health and agriculture, I hope to allay those fears and give you the same confidence that I have.

You may or may not be aware that a large percentage of the world eats a primarily vegetarian diet. Especially in many Asian and African countries where resources are scarce, pulse crops are an essential part of life; they conserve water and fertilizer during production and, being consumed at nearly every meal, are often the primary source of protein and some essential vitamins and minerals. Without pulses, millions of people would not be able to have a diet that nourishes and supports healthy lives. Many more people, especially children, would suffer from stunting, anemia, and a host of other deficiency diseases if it were not for lentils, peas, and chickpeas. Pulses are not just important, they are necessary for life.

While food has been intimately connected to human society ever since the first person walked the earth, much of our understanding about how foods interacts with our bodies to maintain health has developed fairly recently. The goal in human nutrition is this: don’t overload the body with energy all at once, but rather give it a constant supply throughout the day. This sustains mental and physical activity without the “crash”. At the same time, diet should supply all the necessary micronutrients to protect the body from damage over time. When our diet meets these essentials, we can grow and develop during youth and avoid many of the diseases which are characteristic of long-term poor-quality diet: obesity, cardiovascular diseases, diabetes, and cancer.

In terms of nutritional quality, pulses are in a class of their own. They are an excellent source of protein (20-30%), and their carbohydrate profile (60-75%) is uniquely composed to benefit health. One serving of pulses can meet about a third of the recommended daily fiber intake, and the starches and sugars, which are the main source of energy, are broken down slowly by our bodies to provide a constant energy supply after a meal. In addition, some of the carbohydrates are prebiotics, which interact with the microbes in our digestive system to protect us from infections, help us absorb minerals, and train our immune system to function more effectively. With my over two years of research experience at the Pulse Quality and Nutrition Laboratory, I was very happy to discover the link between prebiotic carbohydrates in lentils and combating obesity.

Wishing you well, and happy eating,

Casey R Johnson (MSc)

Hum-HealthyPlus

Discover Healthy Hummus

In the ever changing world around us there are people constantly questioning the things that are made available to the public. Without this, we would have a stagnant society and there would never be improvements made to the many things we use throughout our daily lives. Innovative thinkers like Benjamin Franklin and Thomas Edison were never satisfied with what was accepted throughout society at the time and made a huge impact on the world by thinking outside the box. This very thing is still happening today and a specific situation is currently taking place at Pulse Quality and Nutrition Laboratory at North Dakota State University.

Team Hum-HealthyPlus composed of Tyler Lewandowski (pre-medical student), Dwight Anderson (pre-dental student), and Lukshman Ekanayake (graduate student, Pulse quality and Nutrition) have developed an idea to combat one of the biggest issues facing America. This issue, obesity, is directly correlated to a person's diet and lifestyle choices and will only get worse if changes aren't made. Since people are constantly on the move and don't seem to make the time to prepare a nutritious home cooked meal anymore they have resorted to unhealthy alternatives. However, these quick and convenient dietary choices that people are using to fit their busy schedules are causing very detrimental effects to their long-term health. These students recognized this issue and felt this provided not only an opportunity to benefit society but also a way to turn a profit.

Through the help of their advisor, Dr. Dil Thavarajah, these students noticed that there was a growing popularity in a product that they could use in order to address the previously mentioned problems. This product, hummus, has really caught on in the American diet and only continues to gain popularity. However, these students felt that they could make adjustments to the ingredients to not only increase its nutritional value but also decrease the cost of raw ingredients.

Traditional hummus on the market today is produced using chickpea and tahini as its main ingredients. The problems that accompany these ingredients are unnecessary fats and elevated costs due to less availability. These students decided to replace these imported ingredients with the locally grown crops lentil, corn and flax. Not only are these ingredients cheaper to obtain but there is also an abundance of nutritional benefits. Lentil offers an increased source of protein, selenium, zinc, iron, folate and prebiotic while having almost no fat or sodium. Corn helps give the product a consistent texture and allows the humus to provide a complete protein to consumers by offering the two amino acids that are missing from lentil. Finally, the addition of flax provides omega 3 fatty acids which are under-represented in the American diet and can offer numerous health benefits.

This hummus that offers far more nutrition than the competitors and still produced at a reduced cost almost sounds too good to be true. It probably tastes horrible right? Well the judges at the 2014 NDSU Innovation Fair didn't appear to think so. Not only did the judges like the innovative idea proposed by these students, but also raved about how much they enjoyed taste testing the prototypes. At the end of innovation week the results were tallied and team Hum-HealthyPlus was awarded first prize in the corn category and a $5000 cash prize. This goes to show that innovation is happening everywhere around the world and by more than just renowned scientists and entrepreneurs. No one said it better than Albert Einstein himself, "If you always do what you always did, you will always get what you always got."

Why Pulses Are Good For You

A cup (100 g) of cooked lentils provides:

1. 19g of protein
2. 1g of fat
3. 13g of prebiotics
4. 0 g of cholesterol
5. 7.2 mg of iron
6. 5 mg of zinc
7. 40-70 mcg of selenium
8. 300-500 mcg of folate
9. 38-50 mg of calcium
10. < 4mg of sodium

Prebiotic carbohydrates

- Prebiotic carbohydrates support beneficial hindgut microflora to keep your body lean.
- A 100 g serving of US-grown lentils could provide 13 g of prebiotics

Proteins

- Pulses are high in protein (20-30%)

Lipids

- Lentil seeds contain <1% lipids, chickpea contains 6% and field pea contains about 0.4%.
- Linoleic acid is the major fatty acid forming 37% of total fatty acids.
- No cholesterols

Micronutrients

- Lentils: a 100 g serving of lentils provides 5.6-7.0 mg of iron, 4.4-5.4 mg of zinc, 42-70 μg of selenium, and 300-500 μg of folates
- Dry Peas: a 100 g serving of dry peas provides 4.6-5.4 mg of iron, 3.9-6.3 mg of zinc, 40-50 μg of selenium, and 300-500 μg of folates acid
- Chickpea: a 100 g serving of lentils provides 4.6-6.7 mg of iron, 3.7-7.4 mg of zinc, 15-56 μg of selenium, and 150-556 μg of folates
- Phytic acid: Pulses including lentils, dry peas, and chickpeas are low in phytic acid; Low phytic acid increases mineral bioavailability.

Preparation of pulses

Whole grain dry pulses are available in retail stores in plastic bags or in bulk. Pulses should be cooked before human consumption. Lentils and splits peas do not require soaking prior to cooking. However, dry bean and chickpea need at least 5 hours soaking prior to cooking. Pulses have been widely used in many parts of the world including South East Asia and Africa. Prepare hot spicy curry with lentils, split peas or chickpeas and serve over rice, or bread. Make a split pea soup/stew with or without added meat. Mashed chickpea with garlic, lemon, and tahini make "hummus" served with any type of bread or vegetables. Add chickpea, lentils or beans to a mixed green salad with carrots or cooked yams.

Authors

Dr. Dil Thavarajah, Assistant Professor, Pulse Quality and Nutrition, School of Food Systems, North Dakota State University, Dept. 7640, 223 Harris Hall, P.O. Box 6050, Fargo, ND, USA 58108-6050.

Dr. Pushparajah Thavarajah, Assistant Professor, Food Chemistry, School of Food Systems, North Dakota State University, Dept. 7640, 223 Harris Hall, P.O. Box 6050, Fargo, ND, USA 58108-6050.

Pulse Quality and Nutrition Team

Dil Thavarajah (PI)

Casey R. Johnson (Research Assistant)

Marry Gebhardt (Laboratory Management)

Lukshman Ekanayake (MSc student)

Debjyoti Sen Gupta (PhD student)

Dwight Anderson (Undergraduate student)

Lewandowski (Undergraduate student)

Ashley Kershaw (Undergraduate student)

Funding Support

USA Dry Pea Lentil Council

Northern Pulse Growers Association

North Dakota State University Agriculture Experimental Station

Acknowledgements

The 2013 U.S. Pulse Quality Report acknowledges support received from full and part time technical assistance from Pulse Quality and Nutrition technical team, Progene Plant Research, Othello, WA, USDA-ARS (Wheat Quality Group) Fargo, ND, and College of Agriculture, Food Systems and Natural Resources of North Dakota State University.

Please direct questions, comments, suggestions, or requests for copies of this report to Dr. Dil Thavarajah (dilrukshi.thavarajah@ndsu.edu; dthavarajah@gmail.com) at North Dakota State University, Ms. Shannon Berndt (berndt@northernpulse.com) at Northern Pulse Growers Association, and Ms. Todd Scholz (scholz@pea-lentil.com) at the USA Dry Pea and Lentil Council.

References

American Association of Cereal Chemists, 2000. Approved methods of the AACC 10th edition.

Katrangi et al., Journal of Lipid Research Volume 25, 1984.

Uebersax and Hosfield, 1985. Michigan State University, East Lansing.

National Pulse Quality Survey Report 2010, Northern Crop Institute, Fargo, ND

2011 U.S. Pulse Quality Survey, North Dakota State University, Fargo, ND

Northern Pulse Growers Association, http://www.northernpulse.com.

RVA-4 Series Operation Manual, Newport Scientific Pty. Ltd. 1995.

Thavarajah et al. 2008. Journal of Agricultural and Food Chemistry 56(22), 10747-10753.

Thavarajah et al. 2009a. Journal of Agricultural and Food Chemistry 57, 5413-5419.

Thavarajah et al., 2009b. Journal of Agricultural and Food Chemistry 57: 9044-9049.

Thavarajah et al., 2011. Euphytica, 180 (1): 123-128.

USA Dry Pea Lentil Council, 2012; http://www.pea-lentil.com/.

Casey R. Johnson and Thavarajah et al., 2012, Food Research International, In Press, Accepted Manuscript, Available online 29 November 2012.

Bhatty 1988. Canadian Institute of Food Science and Technology, 21(2), 144-160.

Jukanti, and Gaur et al., 2012. British Journal of Nutrition, 108, S11-S26.

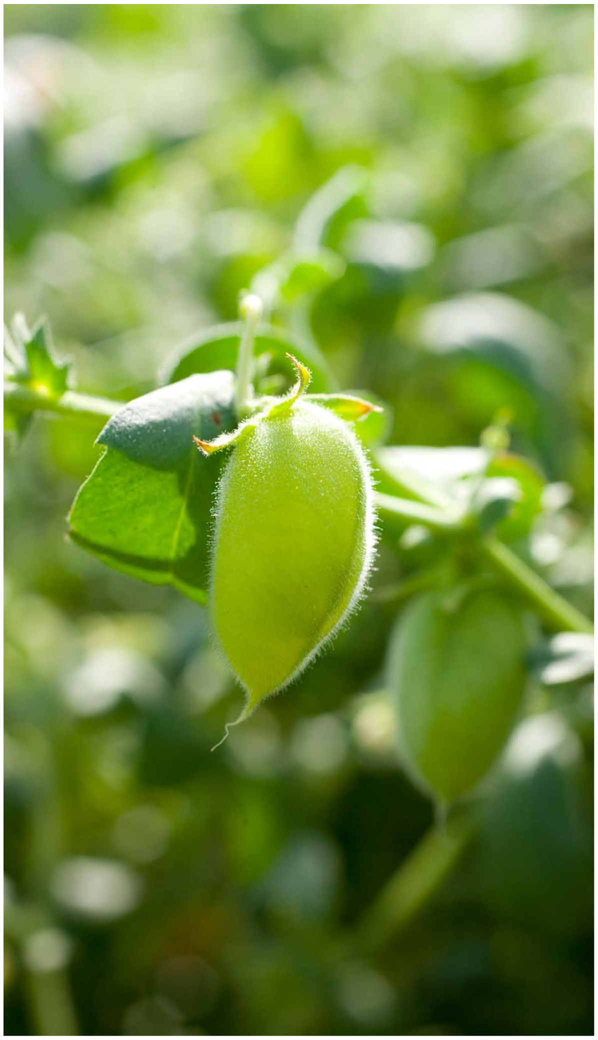
Amarakoon and Thavarajah et al., 2012. Journal of Food Composition and Analysis, 27 (1), 8-13.

Thavarajah and Thavarajah, 2012. Food Research International, 49, 99-104.

Recent Publications

1. Dil Thavarajah, Pushparajah Thavarajah, and Gerald F Combs Jr, 2013. "Selenium in lentils (*Lens culinaris* L.) and theoretical fortification strategies" In Handbook of Food Fortification and Health: From Concepts to Public Health Applications. Editor: Victor R. Preedy, King's College London, London, UK, Springer.
2. Dil Thavarajah, Pushparajah Thavarajah, and Debjyoti Sen Gupta 2013. "Pulse biofortification in genomic era: multidisciplinary opportunities and challengers" In Legumes in Omic Era, Editors: Sanjeev Gupta, Nagasamy Nadarajan, and Debjyoti Sen Gupta. Springer.
3. Dil Thavarajah, Casey R Johnson, Rebecca McGee, Pushparajah Thavarajah 2013. "Phenotyping nutritional and anti-nutritional traits of lentils (*Lens culinaris* L.). In Phenomics of crop plants: Trends, options, and limitations. Editor: Shiv Kumar Agrawal, Springer.
4. Dil Thavarajah, Pushparajah Thavarajah, and Shiv Kumar Agrawal 2013. Lentils (*Lens culinaris* L.): linking whole foods for better human health. In Legumes: Types, Nutritional Composition and Health Benefits, Nova Science Publishers, Inc., NY, USA.
5. Casey Johnson, Dil Thavarajah, Pushparajah Thavarajah, Shiv Kumar 2013. Lentil prebiotics: raffinose-family oligosaccharides, resistant starch, and health implications. In "Oligosaccharides: Food Sources, Biological Roles and Health Implications" Nova Science Publishers, Inc., NY, USA.
6. Dil Thavarajah and Pushparajah Thavarajah 2012. "Lentils (*Lens culinaris* L): a superior whole food solution to micronutrient malnutrition" In Micronutrients: Sources, Properties and Health Effects. Editors: Adan I Betancourt and Humerto F. Gaitan, Nova Science Publishers, Inc., NY, USA.
7. Casey R Johnson, Dil Thavarajah, Pushparajah Thavarajah, Scott Payne, Jayma Moore, Jae-Bom Ohm 2014. Processing, cooking, and cooling affect prebiotic concentrations in lentil (*Lens culinaris* L.). Journal of Food Composition and Analysis (JFCA-D-13-01190).
8. Darshika Amarakoon, Dil Thavarajah, Debjyoti Sen Gupta, Kevin McPhee, Tom Desutter, and Pushparajah Thavarajah, 2014. Iron Biofortification of North Dakota Grown Field Peas (*Pisum sativum* L.) Journal of Food Composition and Analysis, (JFCA-D-13-00692).
9. Nair, Ramakrishnan, Dil Thavarajah, Pushparajah Thavarajah, Rajkumar, Giri, Ledesma, Dolores, Yang, Ray-Yu, Hanson, Peter, Easdown, Warwick, d'A Hughes, Jackie, Dyno Keatinge, 2014. Mineral and phenolic concentrations of mungbean grown in semi-arid tropical India. Journal of Food Composition and Analysis (JFCA-D-13-01320).
10. Pushparajah Thavarajah and Dil Thavarajah 2014. Inaccuracies in Phytic Acid Measurement: Implications for Mineral Biofortification and Bioavailability. American Journal of Plant Sciences, 5(1).
11. Casey R Johnson, Dil Thavarajah, Gerald F. Combs, Jr., and Pushparajah Thavarajah 2013. Lentil (*Lens culinaris* L.): A prebiotic-rich whole food legume. Food Research International, 51(1), 107-113.
12. Debjyoti Sen Gupta, Dil Thavarajah, Pushparajah Thavarajah, Rebecca McGee, Clarice J. Coyne, Shiv Kumar 2013. Lentils (*Lens culinaris* L.), a rich source of folates. Journal of Agricultural and Food Chemistry, 61 (32), 7794–7799.
13. Dil Thavarajah, Pushparajah Thavarajah, Darshika Amarakoon, Abby Fenlason, Casey R Johnson, Phil Knutson, Tom Warkentin 2013. Changes in inositol phosphates in low phytic acid mutants and commercial cultivars of field pea (*Pisum sativum* L.) during germination and in response to fertilization. American Journal of Plant Sciences, 4, 251-256.
14. Ramakrishnan M. Nair, Ray-Yu Yang, Warwick J. Easdown, Dil Thavarajah, Pushparajah Thavarajah, Jacqueline d'A Hughes, and Dyno Keatinge 2013. Biofortification of mungbean (*Vigna radiata* (L.) R. Wilczek var. radiata) as a whole food to enhance human health. Journal of the Science of Food and Agriculture, 93(8), 1805–1813.
15. Casey R Johnson, Dil Thavarajah, and Pushparajah Thavarajah 2013. Phenolics and phytic acid affecting iron bioavailability in lentil (*Lens culinaris* L.). Journal of Food Composition and Analysis, 31(1), 82–86.

16. Mohammad M Rahman, William Erskine, Mohammad S Zaman, Pushparajah Thavarajah, Dil Thavarajah, Kadambot Siddique 2013. Selenium biofortification in lentil (Lens culinaris Medikus subsp. culinaris): Farmers' field survey and genotype x environment effect. Food Research International, 54 (2), 1596-1604.
17. Dil Thavarajah and Pushparajah Thavarajah 2012. Evaluation of chickpea (*Cicer arietinum* L.) micronutrient composition: Biofortification opportunities to combat global micronutrient malnutrition. Food Research International, 49 (1), 99-104.
18. Darshika Amarakoon, Dil Thavarajah, Kevin McPhee, and Pushparajah Thavarajah 2012. Naturally low phytic acid field peas (*Pisum sativum* L.) with high micronutrient concentrations: a food-based solution to global micronutrient malnutrition. Journal of Food Composition and Analysis, 27(1) 8-13.
19. Nadeesha K. Jayasinghe, Janak Vidanarachchi, K.F.S.T. Silva, Pushparajah Thavarajah, Dil Thavarajah and U. Mallikarachchi 2012. Incorporation of plant based gelling agents as the stabilizer to replace gelatine in set-yoghurt. Journal of Food Processing and Technology, 3: 10.



Northern Pulse Growers Association

info@northernpulse.com
www.northernpulse.com

USA Dry Pea & Lentil Council

USA Dry Pea & Lentil Council
2780 W Pullman Road, Moscow, ID 83843
208-882-3023 F-208-882-3023
pulse@pea-lentil.com
www.pea-lentil.com
www.cookingwithpulses.com

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Dr. Dil Thavarajah
dilrukshi.thavarajah@ndsu.edu