PULSE INGREDIENTS FOR HEALTHY DIETS AND A SUSTAINABLE WORLD: GLUTEN-FREE APPLICATIONS

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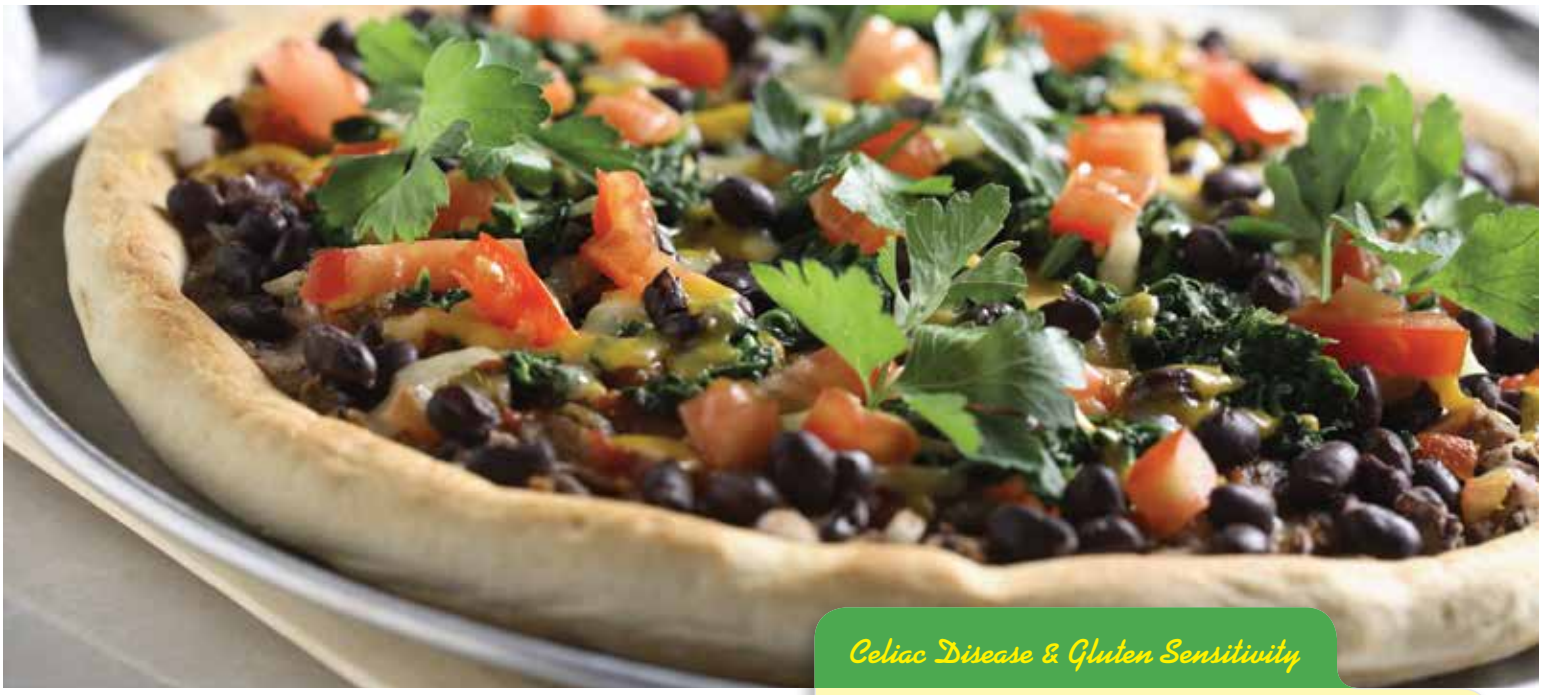


GLUTEN-FREE CONTINUES TO GROW

The global market for gluten-free foods and beverages shows continued growth. According to Packaged Facts (October 2012), the gluten-free market in the US reached $4.2 billion in 2012, with an annual growth of 28%. Gluten-free sales in the US are estimated to reach $6.6 billion by 2017.

A number of factors are driving this growth. The prevalence of celiac disease is rising, and so is awareness of gluten sensitivity. There is a widespread perception that gluten-free products are healthier. Finally, the growing presence of gluten-free products on store shelves has caught the eye of consumers and driven up sales.

Celiac Disease & Gluten Sensitivity

WHAT IS THE DIFFERENCE BETWEEN CELIAC DISEASE AND GLUTEN SENSITIVITY?

Celiac disease is an inherited, autoimmune condition triggered by the consumption of gluten, a protein found in wheat (including spelt and kamut), barley, rye and triticale. It affects nearly 1% of the population. When a person with celiac disease ingests gluten, his or her immune system responds inappropriately, creating inflammation and damage to the inner lining of the small intestine. This reduces the ability to absorb nutrients including iron, calcium, folate and vitamin D. The only treatment for celiac disease is a strict gluten-free diet (Health Canada, 2012).

Gluten sensitivity is not an autoimmune disorder, nor does it cause damage to the small intestine. Symptoms are highly variable, and are often similar to those of celiac disease, making diagnosis a challenge (Pulse Canada, 2011). Treatment is adherence to a gluten-free diet. The Centre for Celiac Research at the University of Maryland estimates that up to 8% of the population has some degree of sensitivity to gluten. This means that an additional 20 million Americans may benefit from gluten-free food products.

GLUTEN-FREE INGREDIENTS

Since gluten is the essential structure-building protein in wheat-based foods, its elimination presents a major challenge for formulators. Gluten-free options currently in use include (i) flours (rice, sorghum, quinoa, amaranth, teff, soy, buckwheat, pea, bean, chickpea, lentil); (ii) starches (tapioca, corn, potato, arrowroot); (iii) whey powder and egg; (iv) gums; and (v) emulsifiers and dough conditioners. Generally, blends of flours and starches are used (see panel).

Food manufacturers need to adapt their processes when formulating (see side panel) gluten-free products. Increased hydration and lower mixing speeds are often required. Higher levels of yeast and leavening agents are used, as well as pre-fermentation and carbonated liquids. Different-sized pans may be needed in order to accommodate the differing consistency of the dough. Baking temperatures may be lower, and steam is often used.

ADVANTAGES OF PULSES

Formulating healthy and appealing gluten-free products requires careful selection of ingredients. Flours and fibers made from pulses offer nutritional advantages over other gluten-free ingredients (Pulse Canada, 2012).

People with celiac disease and gluten sensitivity, as well as consumers who simply choose to eat gluten-free, face challenges in maintaining a healthy diet. Since they are unable to eat gluten, they must avoid wheat, barley, rye and triticale. However, wheat is not only a source of protein and carbohydrate, it is also an important source of essential minerals and vitamins, including iron, calcium, zinc, folate and niacin. Thus eliminating wheat from the diet has far-reaching nutritional consequences that need to be taken into account when formulating gluten-free products.

Pulses are high in protein and dietary fiber, both soluble and insoluble. Their fiber content is as much as 50% higher than that of wheat and oats, and four times more than that of brown rice. Pulses also have a higher protein content than most other plant foods. For example, they contain up to three times more protein than rice (Table 1).

TABLE 1 NUTRITIONAL PROFILE OF PULSES AND CEREAL GRAINS
(G/100G DRY WEIGHT BASIS)

	PROTEIN	FAT	CARBOHYDRATE	FIBER
Peas[1]	23	1	60	16
Beans[2,3]	23-26	1-2	67-71	17-28
Lentils[4]	26	1	60	14
Chickpeas[2]	22	7	69	19
White rice[2]	8	1	90	1
Brown rice[2]	9	3	85	4
Wheat[5]	15	3	83	13
Oats[2]	18	8	72	12

1. Wang and Daun (2004)
2. USDA National Nutrient Database for Standard Reference (2012)
3. Includes kidney, black, cranberry, pinto, and navy beans
4. Wang and Daun (2006)
5. Health Canada Canadian Nutrient File (2010)

EXAMPLES OF GLUTEN-FREE FLOUR BLENDS
(COPPEDGE, 2008 and 2013)

Low-protein flour (mostly carbohydrate)

- White rice flour
- Potato starch
- Tapioca starch

Medium-protein flour

- Brown rice flour
- White rice flour
- Potato starch
- Tapioca starch

High-protein flour

- White rice flour
- Tapioca starch
- Pulse flour (pea, bean, chickpea, lentil)

WHAT ARE PULSES?

The word 'pulse' comes from the Latin *puls*, meaning porridge or thick soup. Pulses are the edible seeds of the non-oilseed legumes, specifically peas, beans, chickpeas and lentils. Pulses do not include string beans, green peas, soy or peanuts. All pulse crops grown worldwide are non-GMO.

Pulses contain both resistant starch and oligosaccharides, which play a key role in gut health as prebiotics (Jones, 2011). In addition, their glycemic index is low when compared with other carbohydrate-rich foods.

Pulses are an excellent source of B vitamins and iron, and a good source of zinc, magnesium, calcium, selenium, potassium and phosphorus. They provide many of the nutrients that are often lacking from a gluten-free diet. Additionally, the seed coat or hull of pulses contains valuable antioxidants (Shum 2012).

Pulses can be combined with cereal grains to provide a balanced amino acid profile. Though they contain relatively low amounts of the essential sulfur amino acids, pulses are higher in lysine. In contrast, cereals are higher in sulfur amino acids and lower in lysine. Hence blending pulses with rice, for example provides higher levels of complete protein (House, 2013).

Specific nutrient, function and disease risk reduction claims can be made for products containing pulse ingredients. Suppliers of pulse ingredients need to be familiar with available permitted claims, and what is necessary to achieve them.

RECENT STUDIES

The USDA recommends that adults consume half a cup of pulses per day. This quantity has been shown to provide significant health benefits.

In a recent study involving hypercholesterolemic and overweight adults, it was demonstrated that if subjects were given half a cup of whole yellow pea flour or 12 grams of pea hull fiber per day, there were significant reductions in fasting insulin and insulin resistance, as well as reduced adiposity in women (Marinangeli and Jones, 2011).

A meta-analysis of 11 clinical trials found that consumption of pulses reduces the risk of cardiovascular disease, by lowering blood pressure and glucose levels. Similar benefits were demonstrated in diabetes and obesity (Anderson and Major, 2002).

In a study of almost 10,000 adults in the US, those who ate pulses four or more times a week had a 22% lower risk of coronary heart disease than those who ate pulses less than once a week (Bazzano et al, 2001).

THE PULSE ADVANTAGE

Besides their nutritional profile, pulses have other advantages as a gluten-free ingredient. Pulse seeds develop in a pod, which remains intact until harvest. This clean environment minimizes the risk of cross-contamination from other crops. Pulse ingredients made from well-cleaned raw materials, milled in a pulse-dedicated facility and with a negative ELISA test for gluten, may be labeled gluten-free. Additionally, pulses contain none of the potential allergens that are required by law to be labeled in the US and Canada.

Sustainability from the ground up

- Pulses use only half the non-renewable energy inputs (including nitrogen fertilizer) of other crops (Zentner et al, 2004). The result is a remarkably small carbon footprint.
- Pulses also play a vital role in crop rotation and improve the sustainability of cropping systems: Pulse plants extract nitrogen from the air into nodes on their roots, which are then left in the soil to provide nutrition for the following year's crop.
- Pulse crops produce compounds that nourish soil microbes and benefit soil health (Johnston et al, 2007). Crop yields are typically higher in soils that are 'alive' with a diverse population of soil organisms (Gan et al, 2002; Lupwayi et al, 1998). These organisms break down and cycle nutrients, feeding the crops as they grow (Pulse Canada). Naturally occurring soil organisms also 'crowd out' disease-causing bacteria and fungi (Lupwayi et al, 2007).
- Dry milling of pulse flours, as its name suggests, uses no water and creates no effluent. The entire seed is utilized, and no by-product is left behind.

In January 2014, Pulse Canada launched a 'Sustainable Business Guide' to help pulse companies understand sustainability and develop performance measures. See http://www.pulsecanada.com/environment/sustainable-business-guide

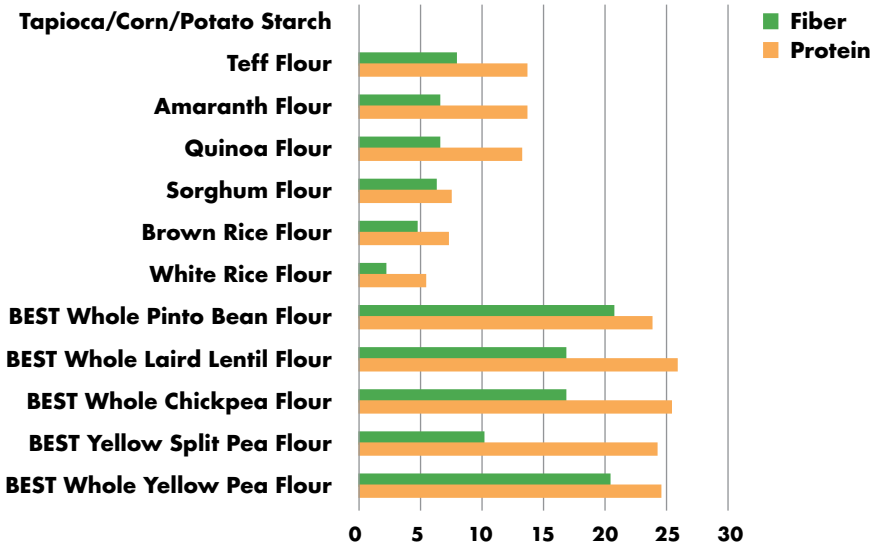
PULSE APPLICATIONS

Traditionally, gluten-free baked products have tended to be dry, bland, powdery and crumbly, with a limited shelf life (O'Neil, 2010). Many are made from refined flours and starches, with a poor nutritional profile. The addition of pulse flours and pea fiber can improve both nutritional content, moisture retention and shelf life.

Pulse Flours

Pulse flours have significantly more protein and fiber than other gluten-free flours and starches (Figure 1).

FIGURE 1. COMPARISON OF PROTEIN AND FIBRE LEVELS IN PULSE FLOURS AND OTHER GLUTEN-FREE FLOURS/STARCHES
(SOURCE: HEALTH CANADA, 2010 AND USDA, 2012)



They also have superior levels of minerals and B vitamins in comparison to other gluten-free flours and starches (Table 2).

THE WHOLE IS GREATER THAN THE SUM OF ITS PARTS

In terms of sustainability, the fractionation of pulses is much less ecologically efficient than milling whole pulse flours.

Dry fractionation of yellow peas creates protein-rich fractions (50-60% protein) and starch-rich fractions (60-80% starch). When a pea is fractionated, only 20-25% of the pea becomes a protein-rich fraction. The remaining starch-rich fraction, which still contains at least 10% protein, accounts for 75-80% of the pea. There is less demand for this by-product.

Whole pulse flours are more economical than pea protein. They contain all the protein of the pea in its natural form, as well as fiber and micronutrients, and they offer a wider range of functionality.

TABLE 2 MINERAL AND VITAMIN CONTENT OF WHEAT AND GLUTEN-FREE FLOURS AND STARCHES (PER 250 ML)

	GLUTEN-FREE FLOURS AND STARCHES					WHEAT FLOURS	
	BEST Whole chickpea flour[1]	BEST Whole yellow pea flour[1]	White rice flour[2]	Brown rice flour[2]	Tapioca starch[2]	Enriched white wheat flour[2]	Enriched whole wheat flour[2]
Iron (mg)	6.8	5.4	0.6	3.3	0	6.6	4.3
Calcium (mg)	92	90	16	18	0	18	34
Zinc (mg)	3.5	3.0	1.3	4.1	0	1.3	3.9
Magnesium (mg)	169	144	55	187	0	38	147
Thiamine (mg)	0.7	0.7	0.2	0.7	0	0.9	0.5
Riboflavin (mg)	0.16	0.15	0.03	0.13	0	0.53	0.14
Folate (mcg)	334	15	7	27	0	283	83

1. Best Cooking Pulses, Inc. 2. Health Canada Canadian Nutrient File (2010)

Pulse flours have excellent moisture retention, and water and fat-binding properties. They also provide emulsion stability and have good starch pasting properties. Pulse flours have been successfully used to formulate gluten-free crackers, batters and breading, extruded snacks, cookies, flat breads and pizza dough (Han et al, 2010; Sawyer, 2009; Hood-Neifer, 2013; Malcolmson et al, 2013). For any given application, careful thought needs to be given to the best choice of pulse flours. Experimenting with several different flours is recommended.

A particular flour may be a much better match for some applications than for others. For example, whole laird lentil flour works well in crackers and extruded products, while whole pinto bean flour is better suited for baked goods like cookies and brownies, as well as flat breads. Whole yellow pea flour works particularly well in batters and breading.

Pea Fiber

Two types of pea fiber are available: outer pea hull fiber, made from the seed coat of dried peas that have been split, and inner pea fiber, a fraction of the cotyledon which is a by-product of wet fractionation. They differ substantially in both composition and functionality. Only outer hull pea fiber which has been naturally processed without the use of enzymes or buffers is considered pre-GRAS.

Outer hull pea fiber is available from several manufacturers. Depending on the supplier, total dietary fiber levels can be anywhere from 82% to 95% on a dry weight basis. The ratio of insoluble to soluble fiber in pea hulls is similar to that recommended by dieticians (75% insoluble to 25% soluble). Outer pea hull fiber is light in colour with a low flavor profile, and, depending on the particle size, has a smooth mouthfeel.

The addition of pea hull fiber has been shown to improve baking yields and improve shelf-life in baked goods, by virtue of its moisture binding properties. Adding pea fiber to gluten-free formulations made from refined flours or starches is a useful means of boosting the fiber, iron and calcium content. Outer pea hull fiber can also act as a nucleation agent for improved starch expansion control in extruded snacks (Hood-Neifer, 2013).

In the United States, outer pea hull fiber with greater than 85% total dietary fiber may be labeled as 'pea fiber'. In Canada there are three approved commercial outer pea hull fibers which may be labelled as 'pea hull fiber' or 'pea fiber'.

A recent study conducted by the Manitoba Food Development Centre (Caspar and Meseyton, 2013) compared the antioxidant content of commercial outer pea hull fiber and cellulose. Only dry milled Best Cooking Pulses BEST Pea Fiber retained its antioxidant properties after milling, and continued to show antioxidant activity in pan bread stored for 7 days.

Blends

Specific blends of pulse flours and pea fiber have been formulated for use in batters and breading, extruded snacks, pan breads and breakfast cereals. This designer approach enables formulators to mask flavours, improve functionality, and reduce cost.

CHOOSING A PULSE FLOUR

Peas, beans, chickpeas and lentils can all be milled to produce flours. This choice of pulse flours used determines the flavour and functionality, as well as the colour of the end-product (Figure 2).

By incorporating the seed coat or hull in the flour, a higher content of fiber, iron and calcium can be achieved, as well as more antioxidants (Caspar and Meseyton,

Pulse flours have been successfully used to formulate gluten-free crackers, batters and breading, extruded snacks, cookies, flat breads and pizza dough.

FIGURE 2: Colour of pea fiber and whole pulse flours. Top row: whole chickpea flour, pea fiber. Middle row: whole laird lentil flour, whole yellow pea flour. Bottom row: whole pinto bean flour, whole green pea flour.

2013). Depending on the colour of the hull, there may be visible specks in the flour, much like those seen in wholewheat or whole grain flours.

Flours made from seeds with the hull removed (split flours) contain less fiber, calcium and antioxidants, but are still high in protein and other micronutrients.

When selecting pulse flours, consideration also needs to be given to the milling method and pre-treatment of the raw material (for example, pre-cooked, or micronized), since these can also have a major impact on the functional properties of the flour (Malcolmson et al, 2013). Ready-to-eat (RTE) or cold extrusion applications generally require a pre-cooked or micronized flour. However, also available are specialty-milled raw flours with an extended shelf-life, which are both economical and functional and can be successfully used in many applications. Gluten-free products currently on the market that use specialty-milled flours include crackers, cookies, pizza crusts, bread, baked nutrition bars, breakfast cereals and pasta.

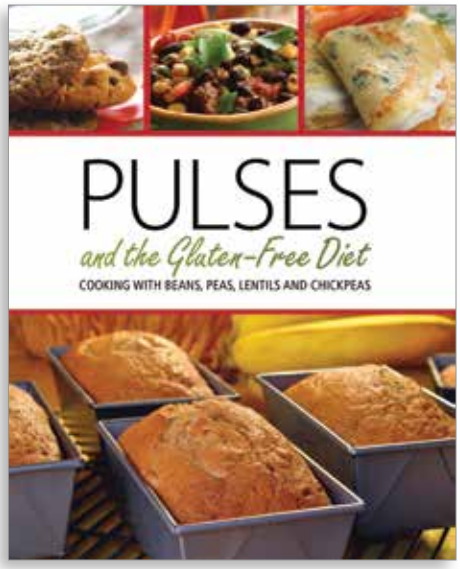
The particle size and uniformity of the pulse flour will also influence end-product quality. For example, flours with a coarser particle size have been shown to produce breads with improved quality compared to flours with a finer particle size (Borsuk et al, 2012).

SUMMARY

- Pulse flours, outer pea hull fiber and blends of flours and pea hull fiber are attractive options in the formulation of gluten-free products, with significant advantages in terms of nutrition, functionality and cost.
- As with other gluten-free ingredients, formulations typically require modification in order to achieve the desired end product.
- Successful inclusion lies in matching the unique functional properties and flavour attributes of the various pulse flours, pea fiber or blend with the desired end-product characteristics.

PULSES AND THE GLUTEN-FREE DIET

'Pulses and the Gluten-free Diet', commissioned by Pulse Canada and written by Shelley Case, RD and Carol Fenster, used BEST Whole Yellow Pea Flour and BEST Whole Chickpea Flour in developing the recipes. A free copy can be downloaded at www.pulsecanada.com.



Making the Case for Pulse Flours in Gluten-free Products

Pulse crops are a key component in the 'Foods for Health' program of the Manitoba Agri-Health Research Network (MAHRN). The mission of MAHRN is to research, develop and commercialize foods and ingredients that have health benefits beyond basic nutrition. In 2010, MAHRN launched an initiative to define and market health-promoting products, derived from Manitoba-grown and processed pinto beans.

Why pinto beans? Manitoba is the largest producer of pinto beans in Canada. Like all pulses, pinto beans are naturally gluten-free. High in protein, high in fiber and with unique functional properties, pinto beans provide a healthy alternative to many of the gluten-free ingredients currently in the market-place. The proprietary milling technology used by Best Cooking Pulses (BCP) at its Manitoba facility, uses the whole bean, maximizing the nutritional content of the flour.

Researchers at the Canadian Centre for Agri-Food Research in Health and Medicine (CCARM), the Food Development Centre (FDC) and the Richardson Centre for Functional Foods and Nutraceuticals (RCFFN) developed nine marketable prototypes based on pinto bean flour. Satiety trials are currently under way using a gluten-free pita bread made from whole pinto bean flour. Satiety – the feeling of being full – is a form of appetite control that could be employed to tackle obesity.

Building on the success of BCP's pinto bean flour, MAHRN is spearheading a concept called the Canadian Climate Advantage Diet – an initiative to explore genetics, growing conditions and novel processing in the context of chronic illnesses like diabetes and cardiovascular disease. Rather than studying single ingredients, the CCAD takes a 'portfolio' approach, designed to reflect how people eat (multi-ingredients at each meal, multiple food formats throughout the day). Early results indicate that pulse crops blended with other nutritious plant ingredients can play a key role in reducing blood sugar and cholesterol.

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PHOTO CREDITS

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CONTACT US

Best Cooking Pulses is a Canadian family owned agri-foods company active in the international pulse trade since 1936. We have strong relationships with our growers, and have worked with many farm families for several generations. BEST gluten-free (ELISA <5ppm), non-GMO products, sustainably milled on the Canadian prairies from North American pulses, include a range of whole pea, bean, chickpea and lentil flours, pea fiber, roasted yellow peas, split yellow and green peas, and whole pulses. All products are available as conventional, natural or certified organic (OPAM). Canadian Grain Commission, HACCP, Kosher Check, and WBEN certified. Partner with us to create nutritious, functional, tasty foods. *'Pulse ingredients for healthy diets and a sustainable world.'*

FOR MORE INFORMATION OR SAMPLES OF SPECIALTY MILLED GLUTEN-FREE BEST PULSE FLOURS AND PEA FIBER, CONTACT BEST COOKING PULSES AT 204.857.4451 OR EMAIL margaret@bestcookingpulses.com

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