PULSES 101

FABA BEANS

PULSE CANADA

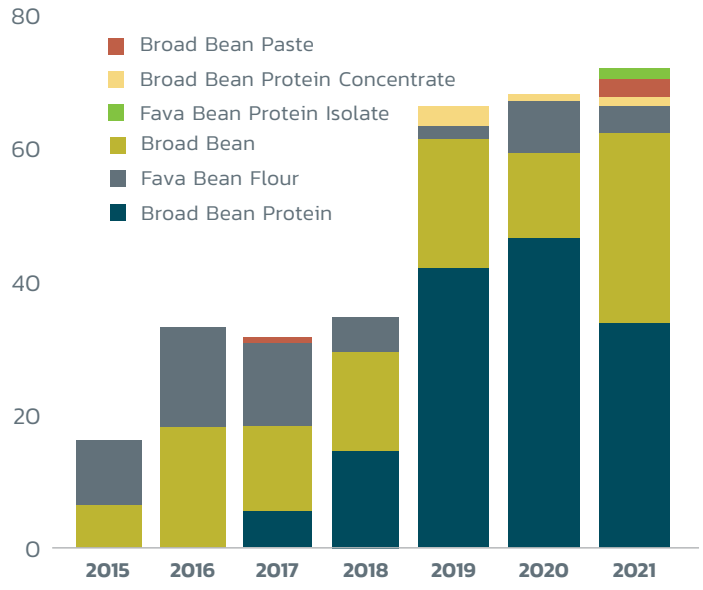
FABA BEANS

Faba bean (Vicia faba L.), (also known as fava bean, broad bean and horse bean) is one of the oldest legume crops cultivated globally and has been consumed in diets for over 5,000 years[1]. Faba beans are consumed as an ingredient in many traditional dishes in Africa and Asia including Falafel, Medammis (stewed beans), Blissara (poured pasta) and Nabet soup.[2,3] As consumers increasingly seek out high-protein, plant-based foods, faba bean ingredients are appearing on more product labels around the world.

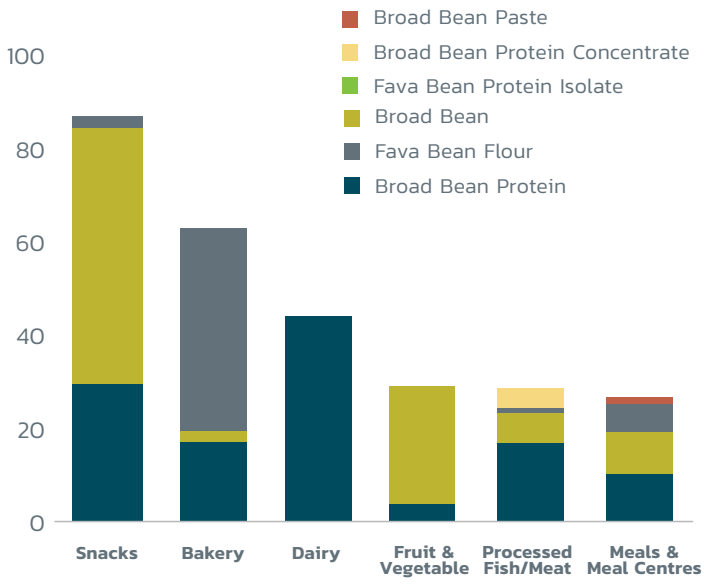
NEW PRODUCT INNOVATION

New product development using faba beans is a global trend with new launches having tripled over the last decade. While faba beans in their whole seed or paste format are most popular in Asia, the flour and protein ingredients have gained more traction in North America and Europe. Use of faba bean protein in the North American food industry started growing in 2017 and have continued to rise, making it the top ingredient format in over 50% of all faba bean based launches. Faba bean innovation is occurring across applications including snacks, bakery and dairy. Flours and pastes are emerging as functional ingredients in ready meals, sauces and pasta. Faba beans are set for continued expansion as ingredient processing technology and functional applications grow.

Total New Product Launches
(North America 2015 - 2021)



New Product Launches By Category
(North America 2015 - 2021)



Source: Mintel Global New Products Database

NUTRITION

Faba beans are a nutrient-rich food and ingredient with high amounts of protein, complex carbohydrates, dietary fiber, vitamins, minerals, and other bioactive phytonutrients.

Faba bean carbohydrate content ranges from 51–68%, the majority of which is starch (41–58%).[4] Dietary fiber content of whole faba beans ranges from 15–30%, with 82% of fiber present in the seed coat.[5] The main soluble sugars are the oligosaccharides raffinose, stachyose, and verabascose[4].

Nutrient Content of Whole Raw Faba Beans

	AMOUNT (PER 100 GRAMS)*
Protein	28.0 g
Total Fat	1.8 g
Total Carbohydrate	66.7 g
Total Sugars	2.1 g
Total Dietary Fibre	20.0 g
Sodium	18.6 mg
Potassium	1251.4 mg
Calcium	105.7 mg
Iron	5.9 mg
Phosphorus	422.6 mg
Magnesium	148.2 mg
Zinc	5.2 mg
Selenium	0.0 ppm
Folate	92.4 mcg
Vitamin A	7.7 RE
Vitamin C	<1 mg

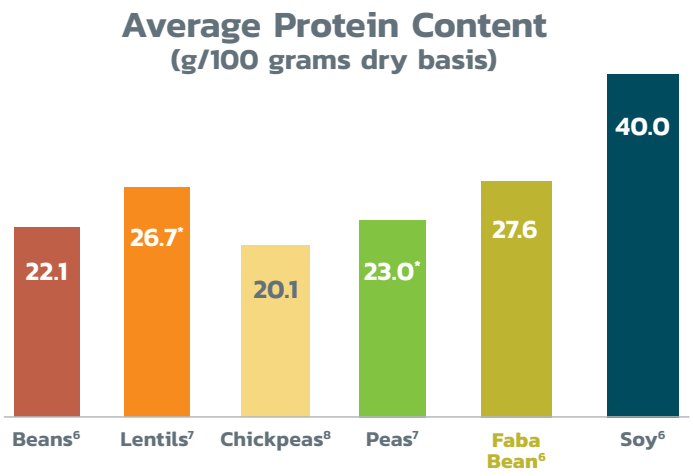
*Dry basis
Source: pulsecanada.com

PROTEIN

Faba beans have a higher protein content than most pulses.[6] However, the protein content is highly variable between varieties and growing conditions. Soil composition, nitrogen fixation efficiency and environmental stresses like drought can all affect protein content. Protein content reported for faba beans ranges from 22.7% – 34.7% (dry basis) based on data compiled from 13 different references representing 106 faba bean cultivars.[6]

Dehulling can significantly increase the protein concentration of faba beans, whereas other processing methods such as soaking, germination and extrusion have minimal effect on total protein content.[9]

The amino acid profile of faba bean is similar to pea and soy, containing high amounts of lysine, leucine, isoleucine, threonine, histidine, and aromatic amino acids but limited in sulfur-containing amino acids (methionine and cysteine). Faba beans also contain lower amounts of tryotophan than soy.[11,12]



*10 year mean

Flours and isolates produced from 3 different faba bean varieties were found to be more limited in sulfur-containing amino acids than those produced from pea and soy, resulting in a lower protein quality.[10] However, like other pulses, the amino acid profile of faba bean is complementary to cereals.[13] Blending faba with cereals can help to improve protein quality.

PHYTONUTRIENTS

Faba beans contain several bioactive phytonutrients including phytic acid, oxalates, saponins, lectins, condensed tannins as well as trypsin and protease inhibitors.[14,15] These phytonutrients can have beneficial as well as adverse effects.

Processing methods can be used to eliminate or minimize anti-nutrients. For example, extrusion has shown to be an efficient method to eliminate activity of trypsin, chymotrypsin and alpha -amylase inhibitors in faba beans.[9] Soaking, cooking, autoclaving, germination and extrusion can all reduce phytic acid in faba beans.[16] Fermentation has been shown to reduce trypsin inhibitor activity and condensed tannins.[17] Dehulling can reduce the concentration of tannins. Low tannin faba bean varieties are also available and widely produced in Canada.

FAVISM

Faba beans contain high concentrations (up to 2% in dry weight) of two beta- glycosides: vicine and convicine. When faba beans are consumed, vicine and convicine are hydrolyzed by glucosidase enzymes present both in the beans and in the gastrointestinal tract, releasing their respective aglycones: divicine and isouramil.

These are highly reactive redox compounds with antifungal and pesticide activity. While beneficial for the plant, these compounds are also capable of triggering a "favism attack".[18] Favism is a rare genetic condition caused by a deficiency of glucose-6-phosphate dehydrogenase (G6PD). When the level of this enzyme is too low, red blood cells break down prematurely (hemolysis), causing anemia. The deficiency of this enzyme on its own is not sufficient to cause hemolysis, additional factors are required to trigger the onset of symptoms. These triggers include certain infectious diseases, drugs and eating faba beans. Most cases of favism occurring with the consumption of raw faba beans that are consumed fresh, as a vegetable, and not with faba beans harvested dry.[19]

Processing is also effective for reducing vicine and convicine and de-activating the endogenous glycosidase enzymes in faba beans that convert vicine and convicine to their aglycone forms. Soaking and cooking reduced levels of vicine and convince in faba beans from 26-27% in whole Canadian faba beans and 32-38% in split faba beans.[20] Fermentation has also been shown to reduce vicine/convicine content.[17] Genetic improvements to faba bean varieties have successfully reduced the content of vicine and convicine.[21] The Canadian industry has committed to producing low vicine/covicine varieties.

Vicine and Convicine Content of Faba Bean Ingredients

	VARIETY FEATURES	VICINE (MG/G)	CONVICINE (MG/G)
FLOURS			
Fabelle	Low Vicine/Convicine	0.64 ± 0.10^{c}	0.23 ± 0.05^{b}
Malik		4.84 ± 0.67^{b}	3.41 ± 0.03^{a}
Snowbird	Low Tannin	8.56 ± 0.04^{a}	3.59 ± 0.61^{a}
PROTEIN ISOLATES			
Fabelle	Low Vicine/Convicine	0.19 ± 0.01^{c}	0.10 ± 0.00^{c}
Malik		2.40 ± 0.02^{b}	1.45 ± 0.02^{b}
Snowbird	Low Tannin	3.16 ± 0.06^{a}	1.57 ± 0.03^{a}

Data adapted form Shi et al. 2022[17]

FUNCTIONALITY

Flour and protein ingredients derived from faba beans have comparable functional performance to other legumes like soy and pea. The end-use applicability of faba bean ingredients will be significantly influenced by their processing history, making it important to discuss the specific functionality of any individual ingredient with suppliers.

Functionality of Faba Bean Flour Compared to Other Flours

WHOLE FLOURS	FABA BEAN	YELLOW PEA	SOYBEAN	DURUM WHEAT	CWRS WHEAT	HULL-LESS BARLEY	OAT
Albumins (% total protein)	47.3 ± 2.1	52.3 ± 2.3	51.8 ± 0.6	17.9 ± 1.0	18.7 ± 1.1	20.1 ± 0.9	23.4 ± 0.1
Globulins (% total protein)	47.0 ± 2.0	41.9 ± 0.7	45.6 ± 1.1	38.0 ± 3.3	33.8 ± 0.4	36.2 ± 2.1	43.5 ± 1.2
Prolamins (% total protein)	5.6 ± 0.1	5.8 ± 1.6	2.6 ± 0.5	44.0 ± 2.3	47.5 ± 0.7	43.7 ± 3.0	33.1 ± 1.3
Oil holding capacity (g/g)	1.93 ± 0.07	1.88 ± 0.20	1.92 ± 0.09	1.39 ± 0.04	1.50 ± 0.14	1.62 ± 0.22	1.51 ± 0.13
Water hydration capacity (%)	1.01 ± 0.01	1.13 ± 0.04	1.40 ± 0.07	1.13 ± 0.01	1.13 ± 0.05	1.42 ± 0.05	1.16 ± 0.09
Foaming capacity (%)	176 ± 1.2	166 ± 0.0	167 ± 0.0	146 ± 19.9	199 ± 9.2	149 ± 0.8	125 ± 4.8
Foaming stability (%)	75.8 ±0.5	72.9 ± 0.0	79.0 ± 2.8	16.3 ± 2.2	28.7 ± 2.2	20.2 ± 2.3	39.2 ± 3.1
Emulsion activity (%)	25.7 ± 2.9	21.5 ± 4.9	20.1 ± 1.0	16.3 ± 1.0	17.2 ± 2.6	5.0 ±0.5	6.9 ± 0.3
Emulsion stability (%)	89.1 ±1.2	90.6 ± 2.4	96.4 ± 5.1	97.7 ± 2.3	77.3 ± 3.6	83.1 ± 1.4	52.2 ± 5.0

Data adapted from Stone at al. 2019.[22]

Functionality of Faba Bean Protein Compared to Other Proteins

PROTEIN ISOLATES	FABA BEAN	YELLOW PEA	SOYBEAN	WHEY	EGG	WHEAT
Foaming capacity (%)	162 ± 5	150 ± 5	157 ± 5	228 ± 7	112 ± 2	223 ± 5
Foam stability (%)	65 ± 2	55 ± 1	57 ± 5	69 ± 1	188 ± 9	94 ± 0
Emulsion capacity (g/g)	184 ± 5	181 ± 0	175 ± 9	206 ± 0	188 ± 9	94 ± 0
Creaming stability (%)	94 ± 2	50 ±0	100 ± 0	89 ± 1	96 ± 0	62 ± 3
Oil holding capacity (g/g)	5.7 ± 0.2	1.1 ± 0.0	1.6 ± 0.3	1.8 ± 0.0	1.5 ± 0.0	2.3 ± 0.02
Emulsion activity index (m^2/g)	13 ± 0.7	1.7 ± 0	14.6 ± 1.7	14.5 ± 0.4	11.5 ± 0.1	1.2 ± 0.2
Emulsion stability index (min)	10.7 ± 0.2	11.9 ± 0.2	12.0 ± 0.6	13.0 ± 0.7	11.6 ± 0.1	13.1 ± 0.2

Data adapted from Singhal et al. 2016.[23]

PRODUCTION & SUSTAINABILITY

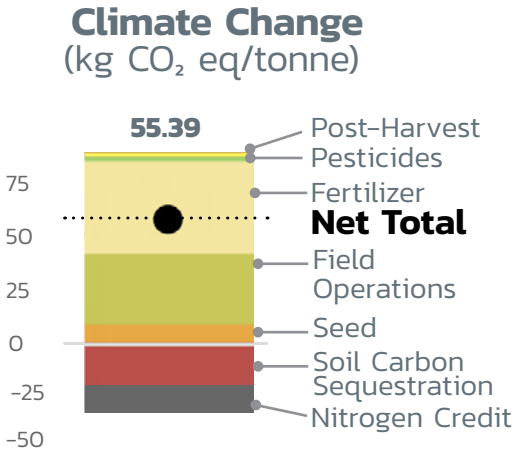
Worldwide production of faba beans (5.7 million tonnes) is currently modest when compared to soy (353 million tonnes) and pea (14.6 million tonnes).[1,6] However, global production of faba bean has been increasing at a steady rate over the past two decades, owing to the high protein content of the seeds and additional crop rotation advantages.[1,10]

CANADIAN PRODUCTION

In North America, Canada is emerging as a faba bean producer, particularly in the prairie provinces of Alberta, Manitoba and Saskatchewan, where the crop is well adapted. Canada produces a variety of faba beans differing in seed size, tannin, vicine and convicine contents. According to 2022 production data in the Canadian prairies, Snowbird, a low tannin variety, accounted for 67% of documented acres while Fabelle, a low vicine/convicine variety, accounted for 21% of acres.[24] The Canadian industry is focused on growing production of faba bean varieties that are best suited for human consumption and feed use. As of 2020, the Western Canada Faba Bean Co-op Trial (WCFBCT) will only test and recommend varieties with low vicine/convicine (LVC) content. Current varieties being tested in Canada include zero-tannin DL Rico, DL 18.7602 and 1310-5 as well as tannin-containing Fabelle.[25]

SUSTAINABILITY

Faba beans, like all pulses, benefit from symbiosis with nitrogen-fixing bacteria that grow on its roots. This allows farmers to grow faba beans without the addition of nitrogen fertilizers, which provides a key environmental advantage. Faba beans have the highest nitrogen fixation capacity of all other pulse crops grown in Canada and are very effective at transferring this fixed nitrogen to the seed.[26] The low environmental footprint of Canadian faba beans has been documented through the development of a life cycle assessment of Canadian faba beans. This study has shown that Canadian faba bean production produces very little greenhouse gas emissions compared to other non-pulse crops, and are well aligned with a world moving towards sustainable food systems.



Source: Faba Bean Life Cycle Assessment (Pulse Canada)

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