Historical use of pulses and pulse ingredients in pet food industry: Past, Present and Future

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Introduction

- Pulse Crops
- Composition of Pulse Crops
- Nutritional Attributes of Pulses
- Pulse Processing and Overview of Pulse Ingredients
- Evolution of Whole Pulses & Pulse Ingredients in North America
  - Whole Pulses
  - Split Pulses
  - Pulse Flours
  - Fractionated Pulse Ingredients
- Pulses and pulse ingredients in pet food industry – Past, present & future
- Suggestions & Conclusions

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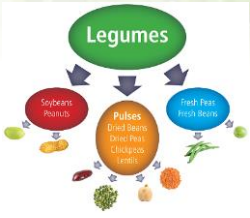
Pulse Crops

- Classified under legume <u>family Fabaceae spp. (or Leguminosae spp.)</u>
- Legumes refer to the plants with fruits/seeds enclosed in a pod.
- Include more than 600 genera and more than 13,000 species.
- Legumes fix nitrogen into the soil, which reduces the need for chemical fertilizers.
  - Alfalfa, clover, fresh peas, lupins, soybeans and peanuts



Pulse: from the Latin puls meaning thick soup or porridge, pulses are the edible seeds of plants in the legume family.

- *Starch, carbohydrate rich*
- *Gel formation*

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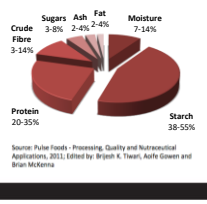
Pulse Crops

- FAO classifies pulses under 11 categories (dry beans, dry broad beans, dry peas, chickpeas, dry cowpeas, pigeon peas, lentils, Bambara ground nuts, vetch, lupins and minor pulses).
- Pulse crops include more than 50 market classes.
  - In Canada soybeans are classified under pulses.
- Pulses are non-GMO, gluten-free and low allergen crops which can provide major source of energy, carbohydrate, protein and fiber with high nutrient digestibility.

Composition of Pulses



Source: Pulse Foods - Processing, Quality and Nutraceutical Applications, 2011; Edited by: Brijesh K. Tiwari, Aoife Gowen and Brian McKenna

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Pulses & Sustainable Agriculture

Plant Fixing Nitrogen

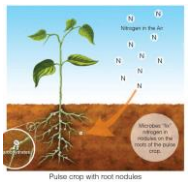
- Pulses produce their own fertilizer by fixing nitrogen

Lower Energy Requirement

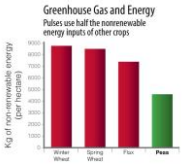
- Pulses Use Less Non-Renewable Energy Relative to Other Crops
- 70% of the non-renewable energy used in cropping systems in western Canada is attributable to fertilizers

Increased Water Use Efficiency

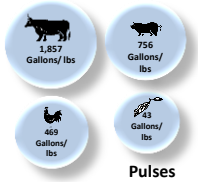
- ***43 gallons*** of water required to produce one pound of pulses
- ***1,857 gallons*** of water required to produce one pound of beef



Pulse crop with root nodules



Source: (Zentner et al. 2004)



Source: Hoekstra and Chapagain, *Globalization of Water*, U. of Twente, Waterfootprint.org National Geographic, April 2010

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Composition of Pulses vs. Wheat

Proximate Analysis

Parameters	Whole Peas	Lentils	Chickpeas	Pinto Beans	Black Beans	Wheat
Protein (%)	23.4	24.8	19.5	21.3	21.6	13.5
Fat (%)	1.2	1.1	6.5	1.3	1.2	1.3
Carbohydrate (%)	60.1	60.5	60.9	62.1	62.6	75.4
Total Dietary Fibre (%)	21.2	18.7	18.2	18.5	17.8	11.7
Sugars (%)	6.5	2.5	9.8	2.4	2.3	1.6
Starch (%)	49.0	47.0	41.0	40.0	41.0	67.0
Ash (%)	2.7	2.8	2.8	3.0	3.0	1.7

Data was compiled from USDA

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Composition of Pulses vs. Wheat

Mineral and Folate Composition

Parameters	Whole Peas	Lentils	Chickpeas	Pinto Beans	Black Beans	Wheat
Calcium (ppm)	850	800	1100	1250	1900	340
Magnesium (ppm)	1450	1350	1800	2200	2100	1380
Phosphorus (ppm)	5500	5000	5000	5500	5700	3500
Iron (ppm)	60	80	55	110	98	38
Zinc (ppm)	43	41	45	40	47	29
Copper (ppm)	7	10	10	9	15	4
Folate (µg/100g)	350	500	550	500	420	40

Data was compiled from USDA

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Composition of Pulses vs. Wheat

Essential Amino Acid Analysis

Parameters	Whole Peas	Lentils	Chickpeas	Pinto Beans	Black Beans	Wheat
Arginine	8.9	7.7	9.4	5.1	5.2	4.9
Histidine	3.1	2.8	2.8	2.6	2.8	2.7
Isoleucine	4.5	4.3	4.3	4.1	4.2	3.4
Leucine	7.3	7.3	7.1	7.3	7.4	6.8
Lysine	7.2	7.1	6.9	6.3	6.1	2.7
Methionine	1.0	0.9	1.3	1.2	1.1	1.7
Phenylalanine	5.1	4.9	5.4	5.1	5.0	5.2
Threonine	3.8	3.6	3.8	3.8	4.0	2.8
Valine	5.1	5.0	4.3	4.7	4.9	4.3

Data was compiled from USDA

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Composition of Pulses vs. Grains

Essential Amino Acid Analysis (mg/g protein)								
	Pea	Faba Bean	Lentil	Chickpea	Rice	Corn	Wheat	FAO recommend (2008)
Protein	24.1%	30.6%	24.8%	20.7%	5.95%	6.93%	10.33%	-
Histidine	25.7	24.8	23.0	27.5	25.0	30.4	22.3	18
Isoleucine	40.7	37.9	40.7	42.5	41.0	35.8	34.6	31
Leucine	67.2	64.4	67.7	72.9	82.0	122.7	68.7	63
Lysine	71.4	61.1	66.1	69.1	34.8	28.1	22.1	52
SAA	19.5	24.2	14.9	26.1	42.2	39.0	38.9	26
AAA	79.3	71.9	76.6	87.0	106.1	89.8	80.5	46
Threonine	38.2	34.6	38.3	42.0	35.3	37.7	27.2	34
Tryptophan	8.7	8.5	6.5	9.7	12.1	7.1	12.3	7.4
Valine	50.2	45.4	49.2	56.0	58.5	50.6	40.2	35

Cereal Data compiled from USDA studies.
SAA – Sulfur containing Amino Acids (Cystine and Methionine), AAA – Aromatic Amino Acids (Phenylalanine and Tyrosine)

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Pulses Help Improve Protein Quality

- 'Complete protein' involves having a balanced amino acid profile as recommended by the FAO
- Pulses are naturally high in lysine while low in sulfur containing amino acids (cysteine and methionine)
- Other cereals such as rice, corn and wheat have higher content of sulfur containing amino acids while a lower lysine content
- Combination of pulses with cereals help meet FAO recommended AA profile

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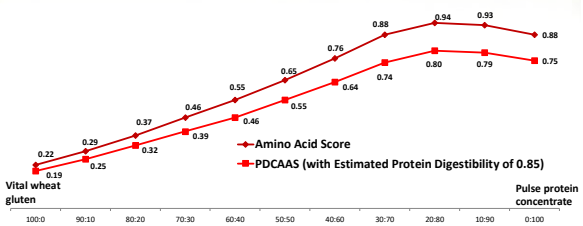
The Power of Blending

PDCAAS of Wheat and Pulse Proteins Blends (with Estimated Protein Digestibility of 0.85)



Cereal and Pulse Blend Ratio (Vital Wheat Gluten : Pulse Protein Concentrate)

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Antinutritional Properties of Pulses vs. Soybean

Antinutritional Compounds					
Crops	Faba Beans	Lentils	Chickpeas	Peas	Soybeans
Trypsin Inhibitor (TIU mg-1 d.w.)	6.7	8.4	7.5	6.6	50
Lectins (hemagluttinating activity mg-1 d.w.)	50	640	N/D	250	2400
Phytic acid	1.1	0.6	0.5	0.9	1.8
Polyphenols (tannic acid equivalents)	1.2	1.0	0.6	0.2	0.4
Tannins (catechin equivalents)	0.5	0.1	N/D	0.1	0.1
α-Galactosides (Raffinose, Stachyose, Verbascose)	2.9	5.6	3.8	5.9	4.0
Saponins	0.4	0.5	0.4	0.2	0.6

Data was compiled from Pulse Foods Processing, Quality and Nutraceutical Applications. 2011. Eds. Tiwari, B.K.; Gowen, A. and McKenna, B. Elsevier Academic Press.

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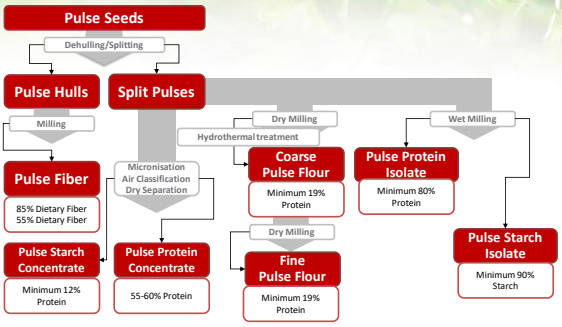
Pulse Ingredient Processing



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Evolution of Pulses & Pulse Ingredients in North America

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Whole Pulses

- Origin of edible beans is South America. Edible bean cultivation began ~300 years ago in North America.
  - i.e. black beans, black eye peas
- Pea and lentil production began in North America in early 20th century.
  - Pacific Northwest USA (peas, lentils)
  - Ontario, Canada
- Production expanded in mid 1980s in Western Canada and 1990s in Northern Plains (North Dakota, Montana)
- Currently there has been over ~8,000,000 MT of pea, lentil, chickpea and edible bean production in North America.

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Split Pulses

- Splitting is applied to remove the hulls of peas, lentils and chickpeas in order to enhance cooking process.
- Splitting process was introduced to North America from United Kingdom with the introduction of lentils in 1920s.
- Split pulse production significantly increased with the expansion of domestic and export markets as well as USDA Food Aid programs in 2000s.
- Splitting capacity of peas and lentils in North America is around ~500,000 MT.

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Pulse Flours

- Pulse flour production has been established early 20th century as the evolution of splitting process.
  - Pea flour
  - Pea hulls/pea fiber
- Industrial pulse flour (primarily edible bean flours) has been established by late 1970s due to development of Hispanic food/food service development.
- Pea, lentil and chickpea flour development has been established by 2010s.
- Pulse flour milling capacity in North America is at ~300,000 MT.

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Fractionated Pulse Ingredients

- Most recent segment of pulse processing industry
- First fractionation plant was established in Saskatoon, Canada in 1975.
- Currently several companies have been manufacturing pulse protein, starch, flour and fiber fractions with variable (dry and wet milling) technologies.
  - ~400,000 MT fractionated pulse ingredient capacity
- Based on the ongoing investments in North America in 2023 ~1,000,000 MT capacity will be reached.

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Pulse ingredients in pet food industry: Past, present & future

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Pulse ingredients in pet food industry

- Introduced as milled whole pulse flours in 1980s and late 1990s as an alternative to wheat, corn and soybeans.
- Developed by the industry due to the pet parent needs as allergen and gluten free formulation solutions. Pulses also served as functional and nutritional ingredients.
  - Protein supplement/alternatives
  - Binder and texturizer alternatives
  - Fiber supplement/alternatives
  - Low ash/low minerals
  - No mycotoxin with very low heavy metal levels
- High protein digestibility
  - Whole pulse flours over 85% true protein digestibility
  - Pulse proteins over 92% true protein digestibility

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Pulse ingredients in pet food industry

- Pea fiber used as an alternative to soybeans hulls, sugarbeet fiber and fruit/vegetable pomaces.
- In late 2000s whole pulse flours, split pulse flours, pea fiber and pulse ingredients became major ingredient solutions for the allergen free and grain free pet food industry.
  - Tubers – yam, tapioca, potato, starches & flours
  - Pulses – whole flours, split flours, proteins, fibers and starches
  - Fruits & vegetable pomace and fibers
- Pulse flours and pulse proteins provided solutions for the replacement of corn gluten meal, soybean meal and soy proteins as a protein source.
- Pulse flours and pulse starches provided as binder & texture solutions for the replacement of wheat flour and corn starch.

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Pulse ingredients in pet food industry

- In 2010s definitions of fractionated pulse ingredients were issued by AAFCO (process took ~3-4 years)
  - Detailed clinical trials, literature research as well as safety data provided as dossiers.
- FDA-CVM approved these ingredients
  - 60.115 Pulse protein (*Pisum sativum* and *Lens culinaris*)
  - 60.116 Pulse starch (*Pisum sativum* and *Lens culinaris*)
  - 60.113 Pulse fiber (*Pisum sativum* and *Lens culinaris*)
  - 60.114 Pulse flour (*Pisum sativum* and *Lens culinaris*)
- Adoption and use of pulse ingredients increased. Products were readily available for the market.
- Grain free pet food industry observed significant growth in dry, wet pet food and treat segments.

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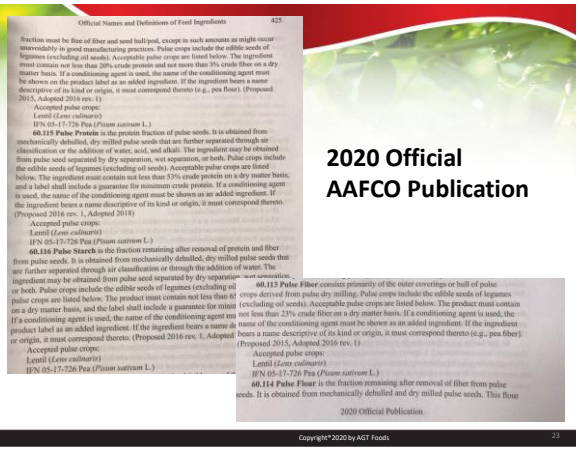
Official Names and Definitions of Feed Ingredients 425

fraction must be free of fiber and seed hull/pod, except in such amounts as might occur unavoidably in good manufacturing practices. Pulse crops include the edible seeds of legumes (excluding oil seeds). Acceptable pulse crops are listed below. The ingredient must contain not less than 20% crude protein and not more than 3% crude fiber on a dry matter basis. If a conditioning agent is used, the name of the conditioning agent must be shown on the product label as an added ingredient. If the ingredient bears a name descriptive of its kind or origin, it must correspond thereto (e.g., pea flour). (Proposed 2015, Adopted 2016 rev. 1)

Accepted pulse crops:
Lentil (*Lens culinaris*)
IFN 05-17-726 Pea (*Pisum sativum* L.)

60.115 Pulse Protein is the protein fraction of pulse seeds. It is obtained from mechanically dehulled, dry milled pulse seeds that are further separated through air classification or the addition of water, acid, and alkali. The ingredient may be obtained from pulse seed separated by dry separation, wet separation, or both. Pulse crops include the edible seeds of legumes (excluding oil seeds). Acceptable pulse crops are listed below. The ingredient must contain not less than 53% crude protein on a dry matter basis, and a label shall include a guarantee for minimum crude protein. If a conditioning agent is used, the name of the conditioning agent must be shown as an added ingredient. If the ingredient bears a name descriptive of its kind or origin, it must correspond thereto. (Proposed 2016 rev. 1, Adopted 2018)

Accepted pulse crops:
Lentil (*Lens culinaris*)
IFN 05-17-726 Pea (*Pisum sativum* L.)

60.116 Pulse Starch is the fraction remaining after removal of protein and fiber from pulse seeds. It is obtained from mechanically dehulled, dry milled pulse seeds that are further separated through air classification or through the addition of water. The ingredient may be obtained from pulse seed separated by dry separation, wet separation, or both. Pulse crops include the edible seeds of legumes (excluding oil seeds). Acceptable pulse crops are listed below. The product must contain not less than 60 on a dry matter basis, and the label shall include a guarantee for minin If a conditioning agent is used, the name of the conditioning agent mu product label as an added ingredient. If the ingredient bears a name d or origin, it must correspond thereto. (Proposed 2016 rev. 1, Adopted

Accepted pulse crops:
Lentil (*Lens culinaris*)
IFN 05-17-726 Pea (*Pisum sativum* L.)

60.113 Pulse Fiber consists primarily of the outer coverings or hull of pulse crops derived from pulse dry milling. Pulse crops include the edible seeds of legumes (excluding oil seeds). Acceptable pulse crops are listed below. The product must contain not less than 23% crude fiber on a dry matter basis. If a conditioning agent is used, the name of the conditioning agent must be shown as an added ingredient. If the ingredient bears a name descriptive of its kind or origin, it must correspond thereto (e.g., pea fiber). (Proposed 2015, Adopted 2016 rev. 1)

Accepted pulse crops:
Lentil (*Lens culinaris*)
IFN 05-17-726 Pea (*Pisum sativum* L.)

60.114 Pulse Flour is the fraction remaining after removal of fiber from pulse seeds. It is obtained from mechanically dehulled and dry milled pulse seeds. This flour

2020 Official Publication

2020 Official AAFCO Publication

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Pulse ingredients in pet food industry

- In September 2017 grain free pet food industry was no longer a niche market (Source: Petfood Industry September 2017).
  - In dry dog food, 44% of the recipes in the database did not contain grains.
  - 50.8% contained peas
  - 23.2% contained chickpeas
  - 14.3% contained lentils
- 78% of the brands producing dry dog food had at least one grain-free formula.

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Pulse ingredients in pet food industry

- In dry cat food, 47% of the recipes in the database did not contain grains (Source: Petfood Industry September 2017).
  - 45.9% contained peas
  - 19.1% contained chickpeas
  - 14.3% contained lentils
- 73% of the brands producing dry cat food had at least one grain-free formula.

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Pulse ingredients in pet food industry

- After the July 2018 FDA Notice the growth in the use of pulse ingredients were significantly reduced.
- Comprehensive and collaborative research were imperative however this was not coordinated and published.
  - **"Research camps"** with multiple views established
- Peer review research and review publications with different views were published from 2018-2020.
- We anticipate that without any conclusive evidence petfood industry may reduce the use of pulse ingredients in the future.

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Suggestions & Conclusions

- We expect rapid, reliable, conclusive science based data collection, evaluations and reports about DCM investigations periodically.
- We support and encourage further objective research and clinical studies to be conducted by universities, research groups and private companies.
- Coordination of joint collaborative objective research with multiple views are essential. We encourage and recommend joint research projects with several universities and programs working together.

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Questions?

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