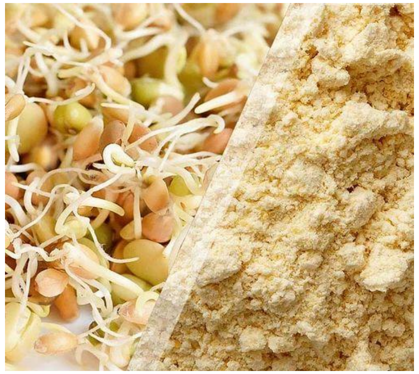
Optimalisasi Leguminosa untuk Industri Pangan Berkelanjutan



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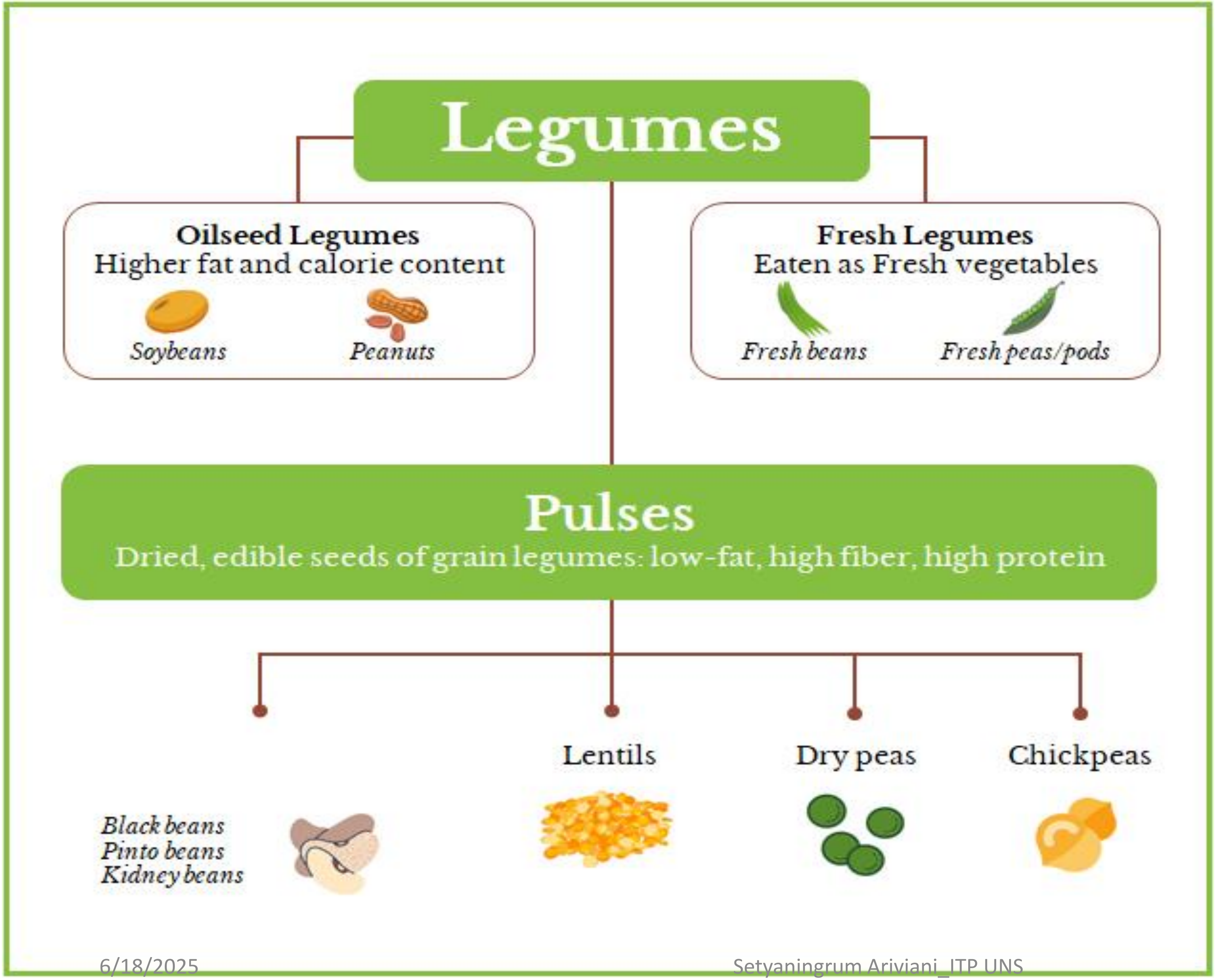
DISAMPAIKAN DALAM SEMINAR NASIONAL

“MEMBANGUN EKOSISTEM KEDAULATAN PANGAN NASIONAL: SINERGI PERTANIAN, TEKNOLOGI, DAN INDUSTRI PANGAN

18 JULI 2025

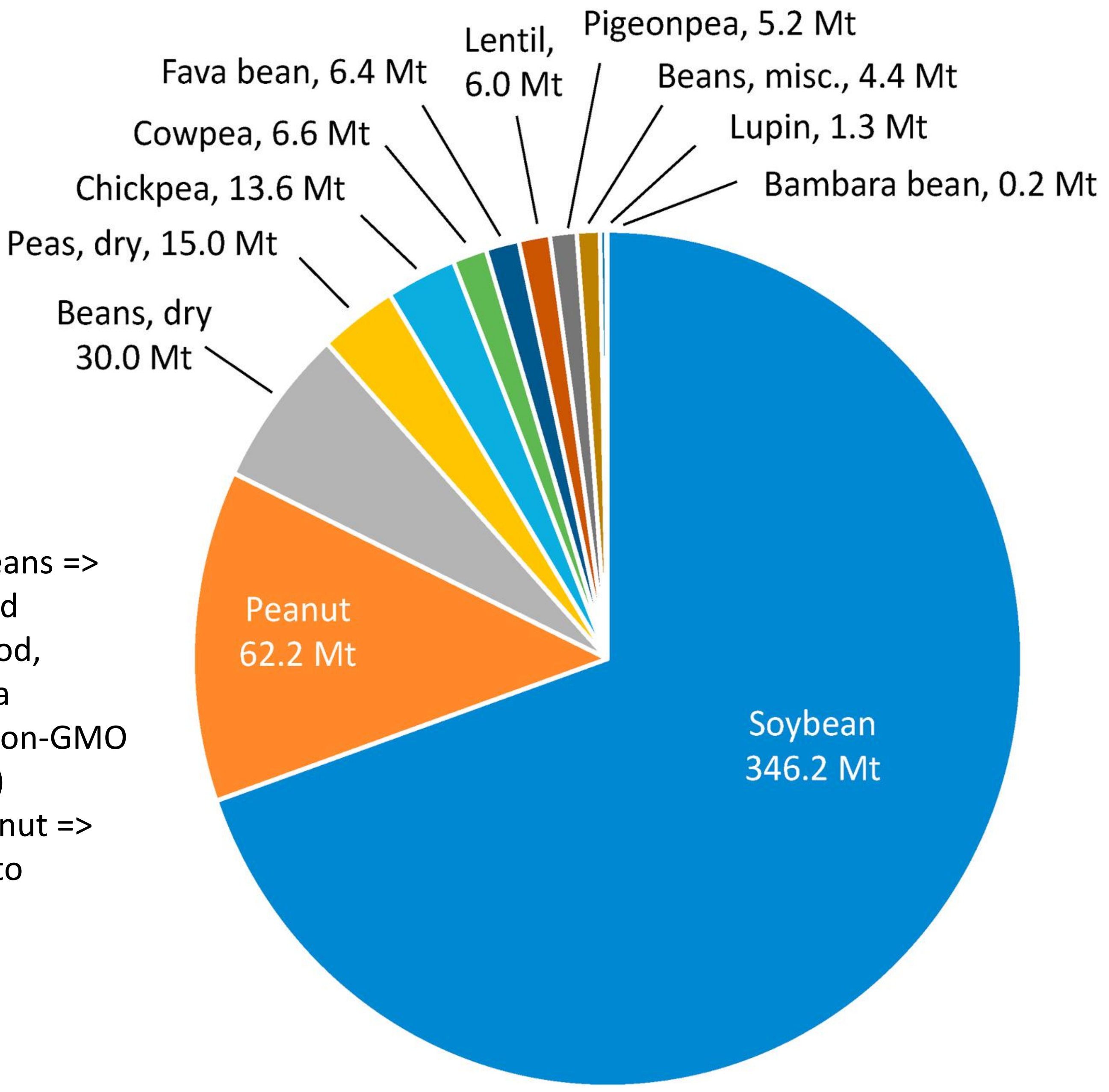
Outline

- Introduction
- The potentials, limitations, and applications
- Strategy
- Related research



Introduction

Introduction

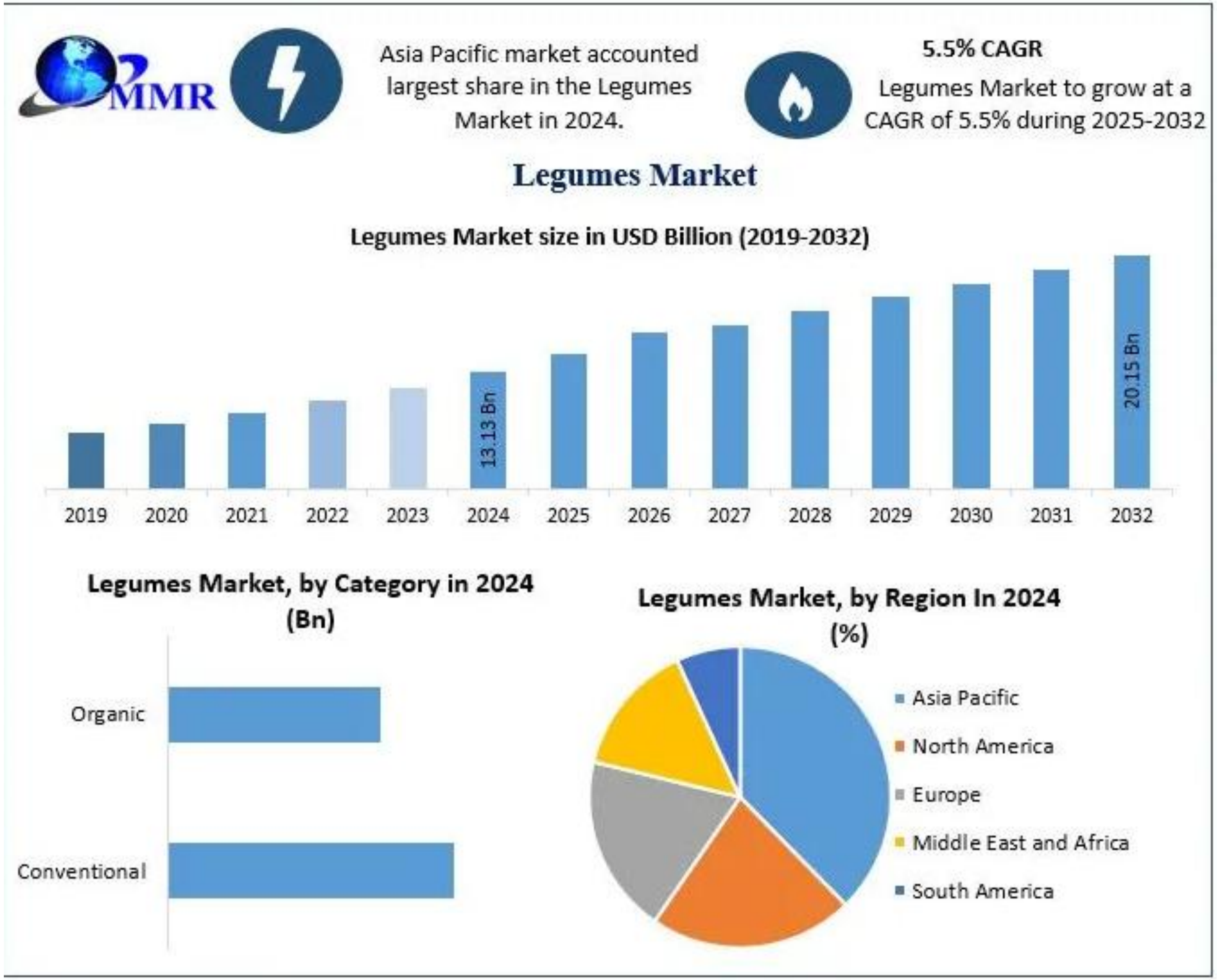


Relative contribution of different legume groups in the global production of legumes (Mt), 2014–2019, (FAOSTAT, 2020)

~6% of soybeans => currently used directly as food, mostly in Asia (Organic & Non-GMO Forum, 2020)
~50% of peanut => processed into cooking oil

- Legumes production in Indonesia?
- Common and major legumes cultivated in Indonesia?

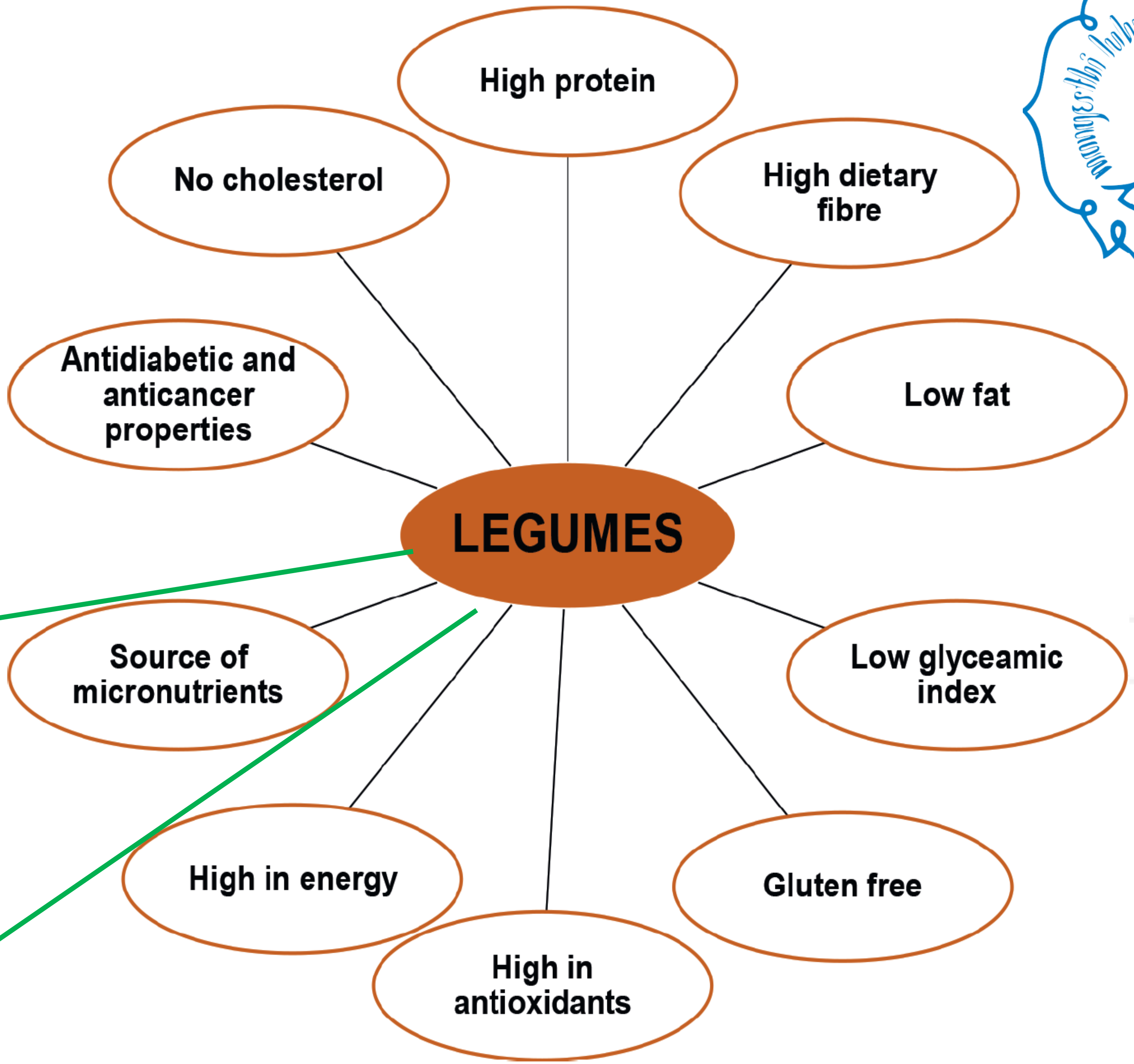
Introduction



Global Legumes Market

Introduction….

Desirable attributes of legumes



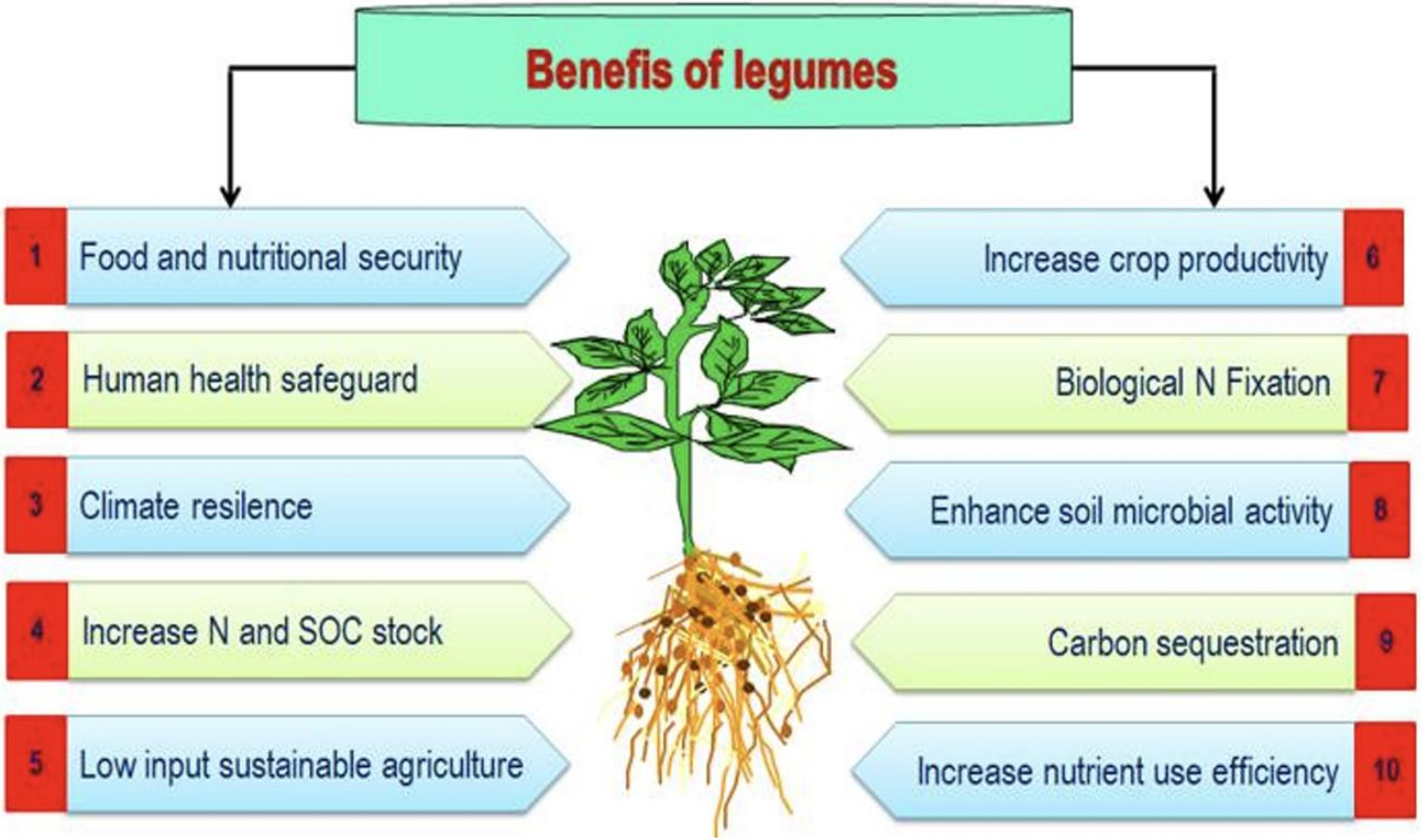
Agriculture

Fix atmospheric Nitrogen
Resist pest and pathogen
Improve soil fertility
Resist abiotic conditions

Environmental sustainability

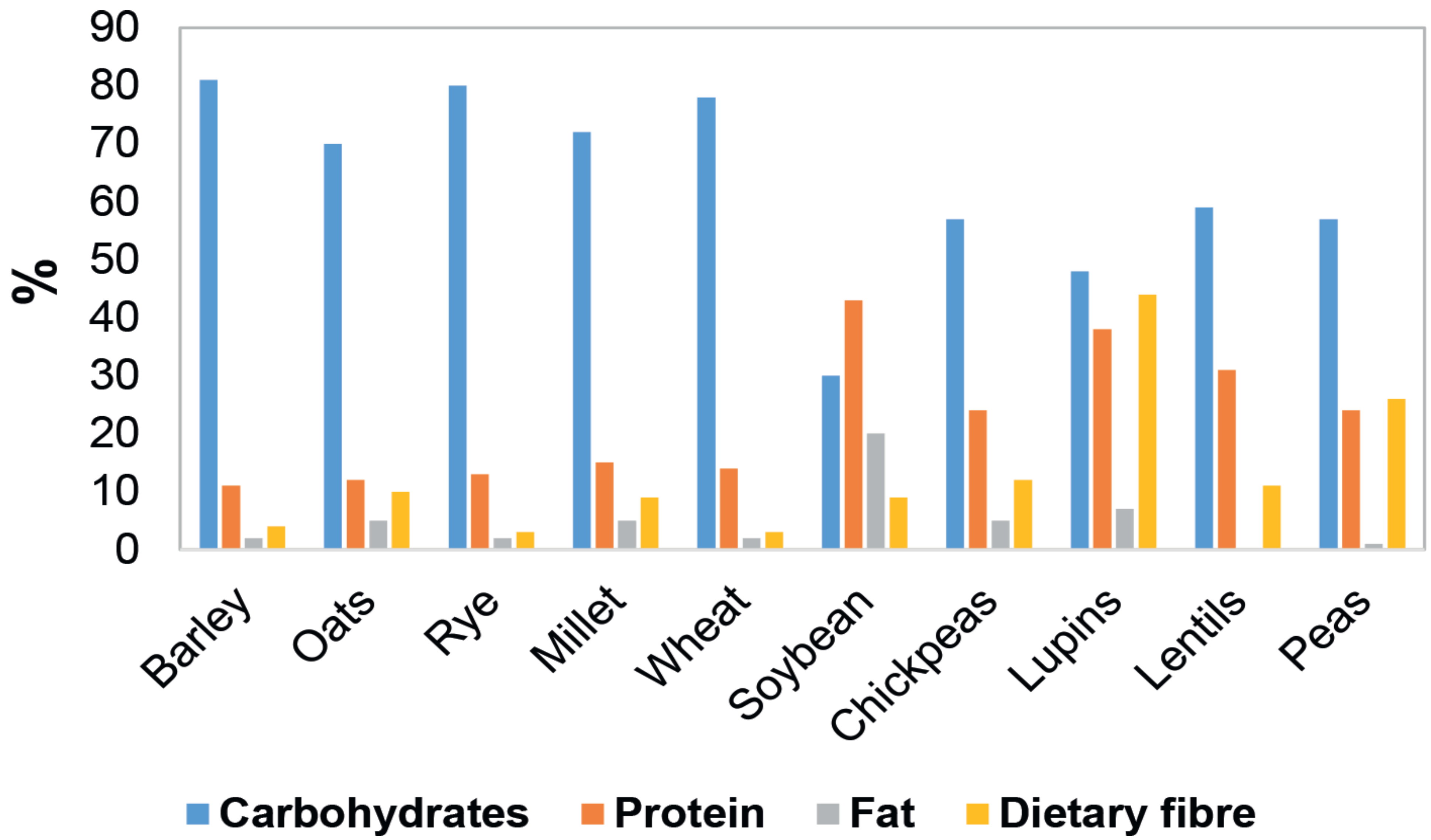
Reduce environmental pollution
and impact of climate change
Reduce dependency on synthetic fertilizers
Fix soil nitrogen

LEGUME BENEFITS FOR AGRICULTURE SUSTAINABILITY



The potentials, limitations, and applications in the food industry

Nutrition potential



Nutrition potential (per 100g)

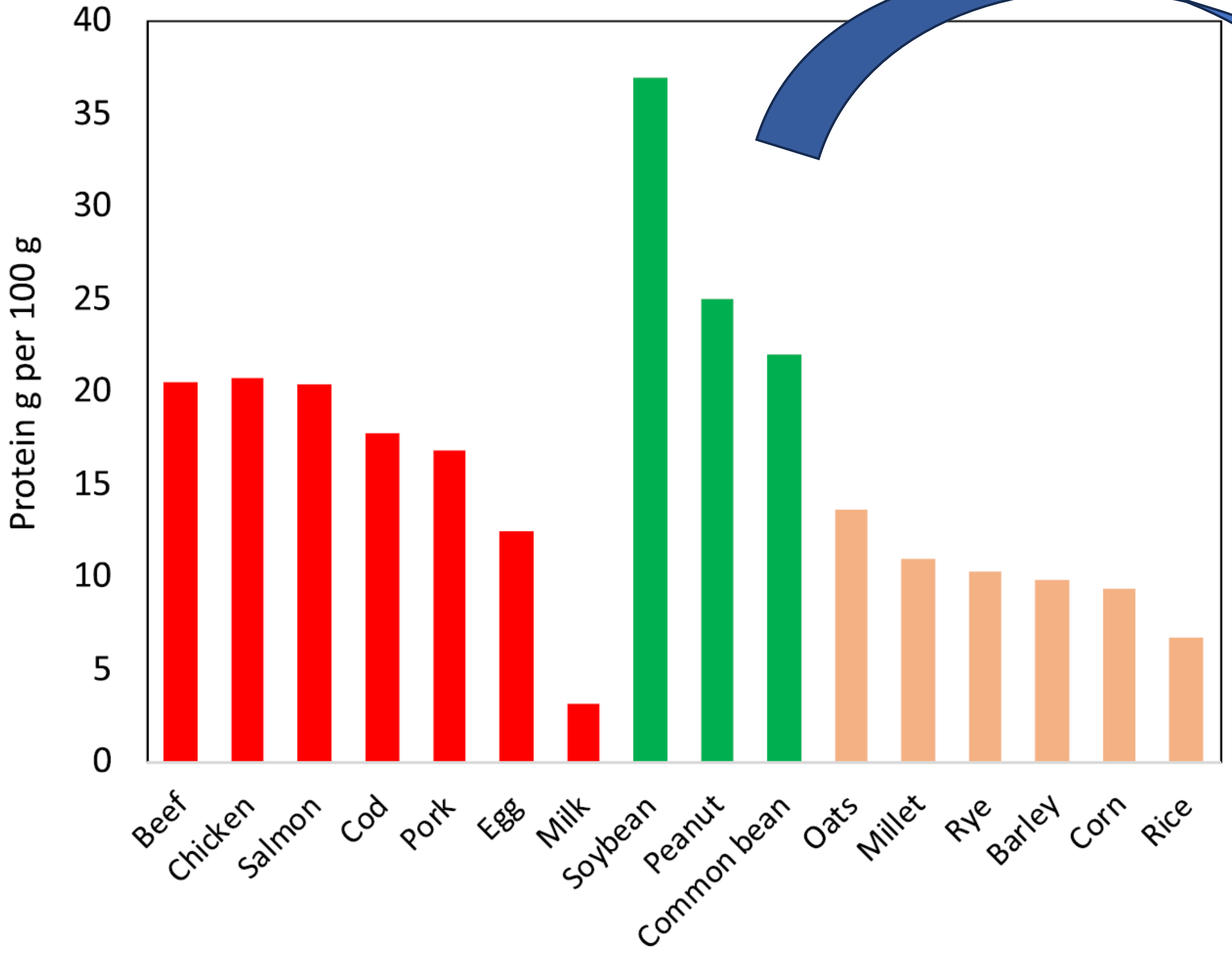
Bean/pulses	Water (g)	Energy (kcal/kJ)	Protein (g)	Total lipid/fat (g)	Ash (g)	Carbohydrate (g)	Dietary fiber (g)
Adzuki bean	13.40	329/1377	19.90	0.53	3.26	62.90	12.70
Black bean	11.02	341/1427	21.60	1.42	3.60	62.36	15.50
Chickpeas	7.68	378/1582	20.47	6.04	2.85	62.95	12.20
Cowpea	11.05	343/1435	23.85	2.07	3.39	59.64	10.70
Cranberry bean	12.40	335/1402	23.00	1.23	3.31	60.00	24.70
Faba/broad bean	10.98	341/1427	26.12	1.53	3.08	58.29	25.00
Great northern bean	10.70	339/1418	21.90	1.14	3.93	62.40	20.20
Lentil	8.26	352/1473	24.63	1.06	2.71	63.35	10.70
Lima bean, large	10.20	338/1414	21.50	0.69	4.30	63.40	19.00
Lima bean, baby	12.10	335/1402	20.60	0.93	3.55	62.80	20.60
Lupin	10.44	371/1552	36.17	9.74	3.28	40.37	18.90
Moth bean	9.68	343/1435	22.94	1.61	4.26	61.52	--
Mung bean	9.05	347/1452	23.86	1.15	3.32	62.62	16.30
Navy bean	12.10	337/1410	22.33	1.50	3.32	60.75	15.30
Pigeonpea	10.59	343/1435	21.70	0.38	3.45	62.78	15.00
Pink bean	10.10	343/1435	21.00	1.13	3.66	64.20	12.70
Pinto bean	11.33	347/1452	21.42	1.23	3.46	62.55	15.50
Red kidney bean	11.75	337/1410	22.53	1.06	3.37	61.29	15.20
White bean	11.30	333/1393	23.40	0.85	4.20	60.30	15.20
Average	*10.74*	*344/1438*	*23.10*	*1.86*	*3.50*	*60.76*	*15.55*

Source: USDA (2022).

Nutrition potential

Legumes	Water (%)	Energy (kcal)	Protein (%)	Carbohydrates (%), Excluding Fiber)	Total Fibers (%)	Soluble Fibers (%)	Insoluble Fibers (%)	Lipids (%)	Resistant Starch (%)	Oligosaccharides (%)	Other Non-Digestible Fibers (%)
Common beans	11.9	333	23.6	45.0	15.0	2.0	13.0	1.2	4.8	1.9	0.8
Lentils	11.8	353	24.6	52.2	10.8	1.0	9.8	1.1	2.9	1.8	0.8
Chickpeas	10.7	364	19.0	44.0	17.0	3.4	13.6	6.0	1.7	2.7	1.3
Peas	10.7	338	25.0	44.0	16.0	2.0	14.0	1.2	0.8	1.6	0.7
Broad beans	11.3	341	26.0	33.0	25.0	1.8	23.2	1.5	1.8	1.0	2.2
Soybeans	8.5	446	36.0	21.0	9.0	2.0	7.0	20.0	1.4	4.9	0.6

Nutrition potential ➔ Protein



Protein sources
Protein Isolate

Nutrition potential ➔ Protein sources

Essentials amino acid score of selected protein sources

Amino acid	CI	Soy	Pea	Potato	Rice	Wheat	Corn	Oat	Lupin	Whey	Casein	Milk	Egg
His	167.2	166.1	150.7	108.2	132.6	132.6	150.9	166.7	184.0	108.3	168.3	176.2	150.0
Lys	139.9	122.6	152.6	123.6	62.5	52.9	48.3	87.2	97.8	189.6	164.2	151.7	151.8
Phe + Tyr	243.3	199.3	199.4	206.5	232.1	181.3	244.2	217.0	166.6	146.4	255.3	251.3	254.1
Leu	134.2	116.2	122.2	121.3	124.2	115.9	203.6	128.3	108.3	165.9	150.2	166.5	159.4
Iso	167.3	142.1	140.3	132.2	123.2	136.3	117.4	133.2	122.9	181.3	167.1	182.9	198.1
Val	127.8	108.9	114.5	126.7	128.4	109.7	115.3	173.2	89.1	134.1	156.3	162.7	174.7
Thr	142.1	144.6	147.9	181.3	131.8	118.8	137.3	132.9	129.5	264.6	166.8	175.1	205.9
Met + Cys	111.6	106.2	78.0	117.9	171.8	173.1	148.4	219.7	82.5	157.0	115.6	158.8	303.9
Trp	124.7	203.3	137.1	138.2	184.1	177.3	114.5	241.3	120.6	292	185.6	224.9	266.2

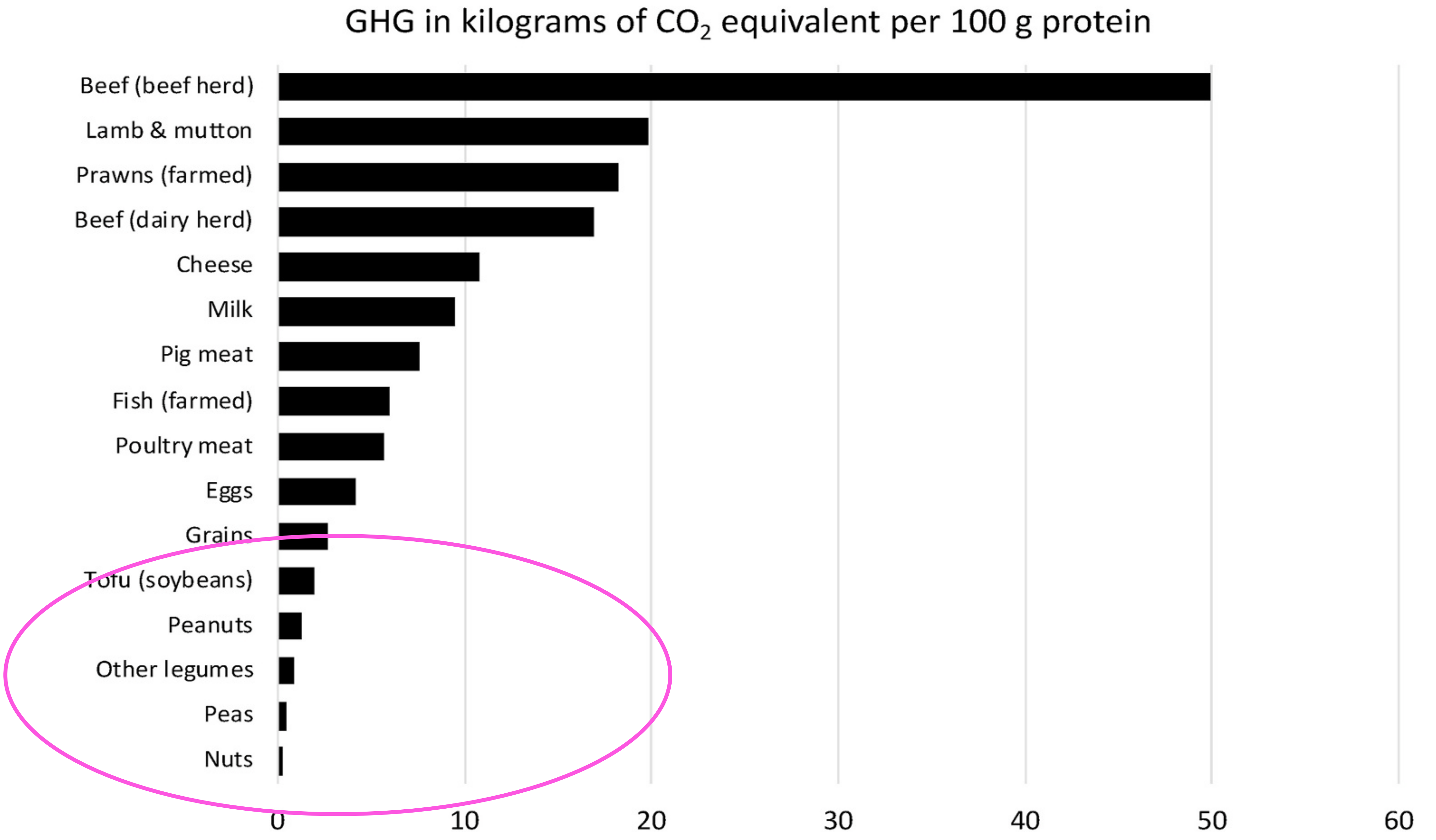
Notes: The amino acid score parameter is based on comparison of the mean amino acid requirements with milk protein as a reference. CI = Chickpea isolate

Nutrition potential → Protein sources

Main fatty acid concentration of various animal and plant protein sources

Protein sources		Fatty acid (g/100 g lipid)							
		C16:0	C18:0	C18:1	C18:2	C18:3	SFAs	MUFAs	PUFAs
Plant	Soybean	11.76	3.68	19.20	55.15	8.88	15.44	19.20	64.03
	Chickpea	10.94	1.80	37.87	45.78	2.33	12.74	37.87	48.11
	Lentil	21.40	2.77	28.06	38.21	9.07	24.29	28.06	47.27
	Cowpea	27.68	4.76	7.35	35.97	23.34	33.34	7.35	59.31
	Pea	13.48	4.50	34.40	38.66	8.78	17.98	34.40	47.44
	Mung bean	27.04	5.73	6.54	43.71	15.82	33.75	6.54	59.53
	Fava bean	15.25	3.65	24.57	52.68	3.61	19.14	24.57	56.29
	Kidney bean	17.97	2.40	12.71	29.02	35.71	20.49	12.71	64.74
	Black bean	17.17	2.39	8.29	33.65	37.30	19.56	8.29	70.95
Animal	Beef	27	7	48	2	–	37	59	2
	Pork	27	11	44	11	–	40	48	11
	Poultry	22	6	37	20	1	29	44	21
	Salmon	11	4	25	5	5	18	30	50
	Milk	26	11	28	2	–	61	31	2
	Egg	23	6	41	21	–	29	43	23

Notes: C16:0 = palmitic acid; C18:0 = stearic acid; C18:1 = oleic acid; C18:2 = linoleic acid; C18:3 = α-linolenic acid; SFAs = saturated fattyacids; MUFAs = monounsaturated fatty acids; PUFAs = polyunsaturated fatty acids.



Greenhouse gas emissions of dietary protein (Semba et al., 2021)

Nutrition potential → DF and RS sources

Fibre fractions					Total dietary fibre[b]
Fructans	Arabinoxylans	Cellulose	β-Glucan	Resistant starch	
Cooked wheat (1.60 g)	Cooked wheat (3.20 g)	Cooked peas (4.98 g)	Oat flakes (1.39 g)	Cooked peas (3.90 g)	Cooked peas (12.83 g)
Cooked wholemeal rice (1.14 g)	Rye flakes (2.01 g)	Cooked kidney beans (3.56 g)	Barley flakes (1.30 g)	Cooked kidney beans (2.83 g)	Cooked kidney beans (11.66 g)
Cooked kidney beans (0.83 g)	Cooked kidney beans (1.32 g)	Cooked lentils (2.84 g)	Rye flakes (0.51 g)	Cooked sweet corn (1.96 g)	Cooked wheat (8.63 g)
Cooked lentils (0.79 g)	Barley flakes (0.93 g)	Cooked string beans (2.55 g)	Cooked wheat (0.34 g)	Cooked millet (1.53 g)	Cooked lentils (7.41 g)
Cooked peas (0.71 g)	Cooked sweet corn (0.85 g)	Cooked wheat (1.38 g)		Rye flakes (1.10 g)	Cooked string beans (5.86 g)
Cooked sweet corn (0.69 g)					

[a] Data for fibre content are in parenthesis and are expressed as g in one portion of original food item (portion = 200 g for cooked cereals and legumes, 30 g for flakes and breads (Source: Dunne, 2002)).
[b] Total dietary fibre represent sum of dietary fibre and fructans

DF sources
RS sources

Total and fractional fibre content in analysed cooked legumes (g/100 g of dry matter).

Samples	Fructans	Arabinoxy-lans	Cellulose	β-Glucan	Resistant starch	Dietary fibre[a]	Total dietary fibre[b]
Kidney beans	1.39 ± 0.15	2.21 ± 0.31	5.98 ± 0.53	n.d.	4.75 ± 0.27	18.21 ± 1.57	19.60 ± 1.72
Lentils	1.49 ± 0.29	1.03 ± 0.09	5.37 ± 1.27	n.d.	2.05 ± 0.23	12.52 ± 2.03	14.01 ± 2.32
Peas	1.15 ± 0.09	1.07 ± 0.15	8.05 ± 0.51	n.d.	6.30 ± 0.08	19.59 ± 2.31	20.74 ± 2.40
String beans	0.78 ± 0.08	0.97 ± 0.22	10.63 ± 0.89	n.d.	1.91 ± 0.08	23.71 ± 3.44	24.49 ± 5.52

Data are expressed as mean ± SD of three independent determinations.
n.d. – non detected.
[a] Results for dietary fibre shown in Table 1 are results obtained with AOAC Method 985.29.
[b] Results for total dietary fibre represent sum of dietary fibre (obtained with AOAC Method 985.29) and fructans (AOAC Method 999.03).

Total and fractional dietary fibre content in analysed cereals (g/100 g of dry matter).

Samples	Fructans	Arabinoxylan	Cellulose	β-Glucan	Resistant starch	Dietary fibre[a]	Total dietary fibre[b]
Cooked cereals							
Wheat	2.93 ± 0.78	5.86 ± 0.43	2.53 ± 0.43	0.63 ± 0.04	1.33 ± 0.19	12.88 ± 2.12	15.81 ± 2.90
Millet	0.58 ± 0.10	0.45 ± 0.03	1.23 ± 0.20	n.d.	2.84 ± 0.23	5.02 ± 1.10	5.60 ± 1.20
Sweet corn	1.10 ± 0.13	1.35 ± 0.08	1.85 ± 0.31	n.d.	3.11 ± 0.57	8.11 ± 0.97	9.21 ± 1.10
Rice	0.33 ± 0.09	0.13 ± 0.02	n.d.	n.d.	1.62 ± 0.32	2.21 ± 0.53	2.54 ± 0.62
Wholemeal rice	2.24 ± 0.21	0.51 ± 0.04	1.60 ± 0.24	0.39 ± 0.11	0.53 ± 0.16	6.98 ± 0.79	9.22 ± 1.00
Breads							
White wheat bread	1.42 ± 0.05	1.61 ± 0.05	0.45 ± 0.07	0.20 ± 0.04	1.45 ± 0.22	4.32 ± 0.57	5.74 ± 0.62
Wheat/corn bread	1.40 ± 0.31	1.33 ± 0.02	0.39 ± 0.10	0.24 ± 0.06	1.81 ± 0.18	3.41 ± 0.57	4.81 ± 0.88
Wheat/rye bread	2.20 ± 0.28	2.04 ± 0.12	0.68 ± 0.11	0.44 ± 0.07	1.97 ± 0.43	6.16 ± 0.89	8.36 ± 1.17
Whole wheat bread	1.60 ± 0.17	1.79 ± 0.24	1.05 ± 0.15	0.31 ± 0.07	1.76 ± 0.25	7.03 ± 1.11	8.63 ± 1.28
Flakes							
Corn flakes	1.88 ± 0.22	0.31 ± 0.12	0.13 ± 0.05	0.68 ± 0.06	2.00 ± 0.31	2.86 ± 0.35	4.74 ± 0.57
Barley flakes	1.66 ± 0.12	3.44 ± 0.57	0.55 ± 0.10	4.79 ± 0.25	2.61 ± 0.25	10.77 ± 0.68	12.43 ± 0.80
Oat flakes	0.35 ± 0.02	2.81 ± 0.23	0.73 ± 0.12	5.13 ± 0.33	0.37 ± 0.11	15.86 ± 0.91	16.21 ± 0.93
Rye flakes	5.00 ± 0.09	7.61 ± 0.21	1.53 ± 0.22	1.93 ± 0.17	4.17 ± 0.22	15.86 ± 1.10	20.85 ± 1.19

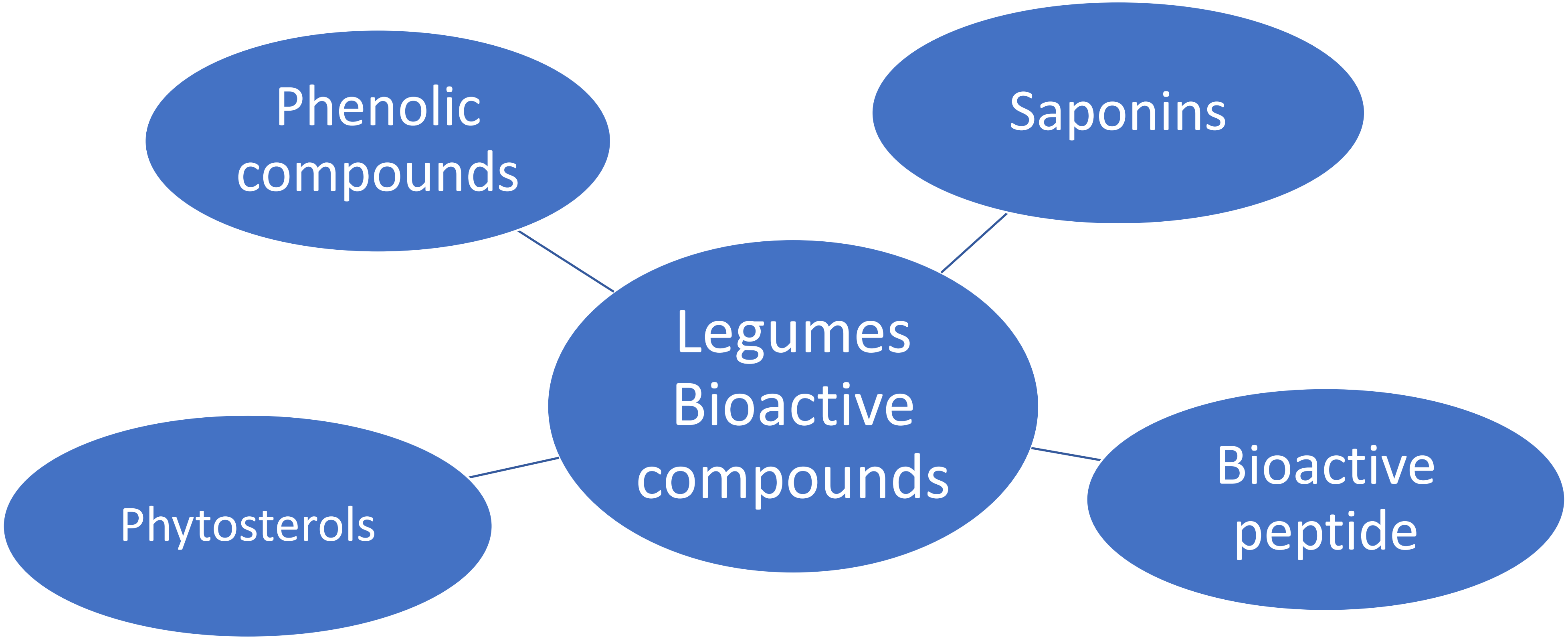
Data are expressed as mean ± SD of three independent determinations.
n.d. – non detected.
[a] Results for dietary fibre shown in Table 1 are results obtained with AOAC Method 985.29.
[b] Results for total dietary fibre represent sum of dietary fibre (obtained with AOAC Method 985.29) and fructans (AOAC Method 999.03).

Nutrition potential → Minerals sources

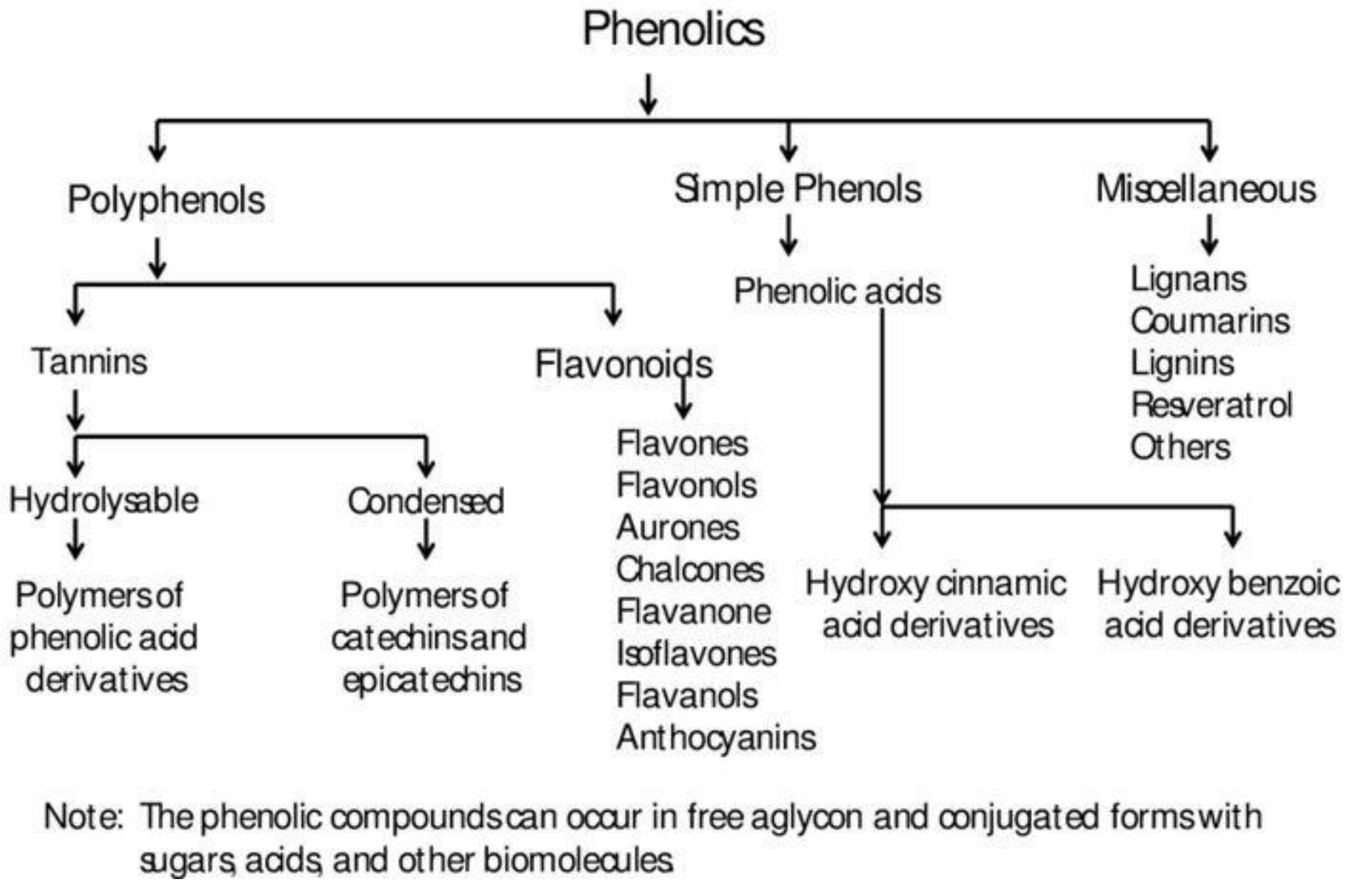
Bean/pulse	Ca	Fe	Mg	P	K	Na	Zn	Cu	Mn	Se
Adzuki bean	66	4.98	127	381	1250	5	5.04	1.09	1.73	3.1
Black bean	123	5.02	171	352	1483	5	3.65	0.84	1.06	3.2
Chickpeas	57	4.31	79	252	718	24	2.76	0.66	21.31	0.0
Cowpea	85	9.95	333	438	1375	58	6.11	1.06	1.54	9.1
Cranberry bean	127	5.00	156	372	1330	6	3.63	0.79	0.92	12.7
Faba/broad bean	22	1.90	38	95	250	50	0.58	0.07	0.32	1.2
Great northern bean	175	5.47	189	447	1390	14	2.31	0.84	1.42	12.9
Lentils	35	6.51	47	281	677	6	3.27	0.75	1.39	0.1
Lima bean (large)	81	7.51	224	385	1720	18	2.83	0.74	1.67	7.2
Lima bean (baby)	81	6.19	188	370	1400	13	2.60	0.67	1.69	7.0
Lupin	176	4.36	198	440	1013	15	4.75	1.02	2.38	8.2
Moth bean	150	10.85	381	489	1191	30	1.92	0.69	1.82	8.1
Mung bean	132	6.74	189	367	1246	15	2.68	0.94	1.04	8.2
Navy bean	147	5.49	175	407	1185	5	3.65	0.83	1.15	11.0
Pigeonpea	130	5.23	183	367	1392	17	2.76	0.13	0.57	1.5
Pink bean	130	6.77	182	415	1460	8	2.55	0.81	1.38	13.0
Pinto bean	113	5.07	176	411	1393	12	2.28	0.89	1.15	27.9
Red kidney bean	83	6.69	138	406	1359	12	2.79	0.70	1.11	3.2
White bean	240	10.40	190	301	1800	16	3.67	0.98	1.80	12.8
Average	*113*	*6.23*	*177*	*367*	*1244*	*17*	*3.15*	*0.763*	*2.392*	*7.9*

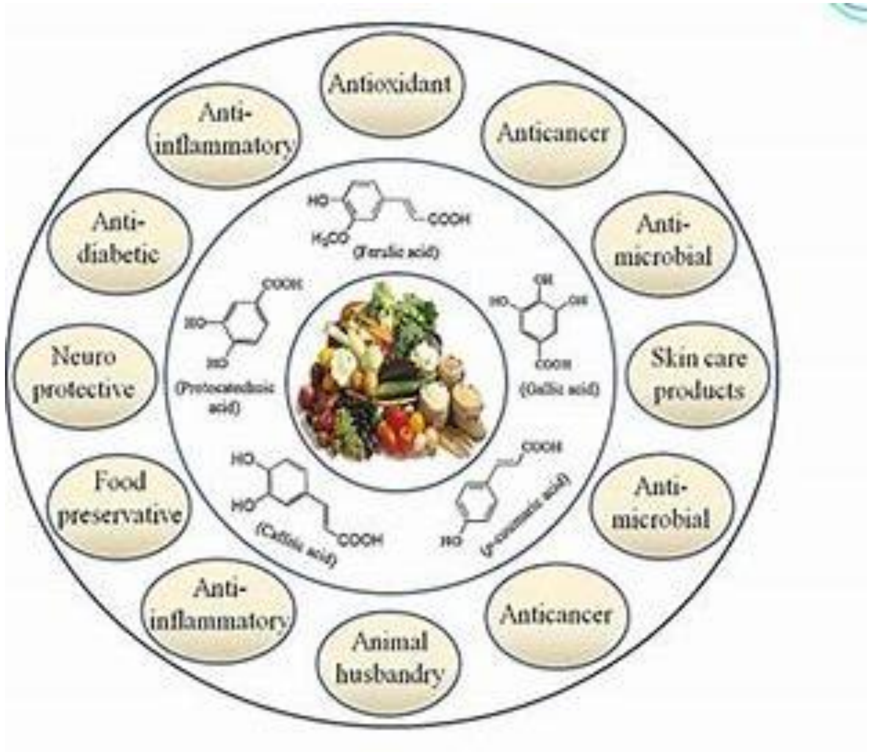
Source: USDA (2022). Mineral content of legumes (mg/100 g except μg/100 g for selenium, Se).

Bioactive compounds sources

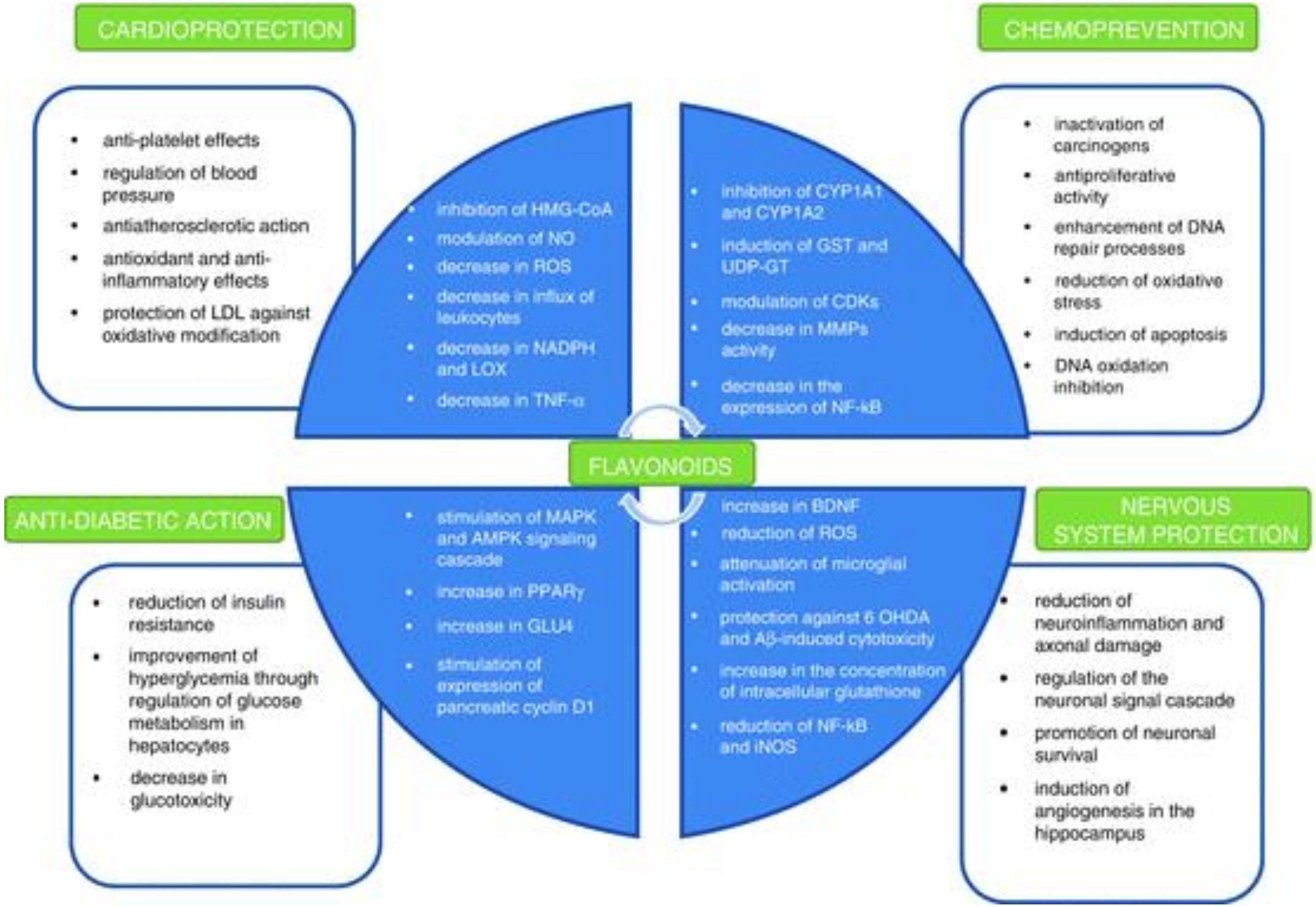


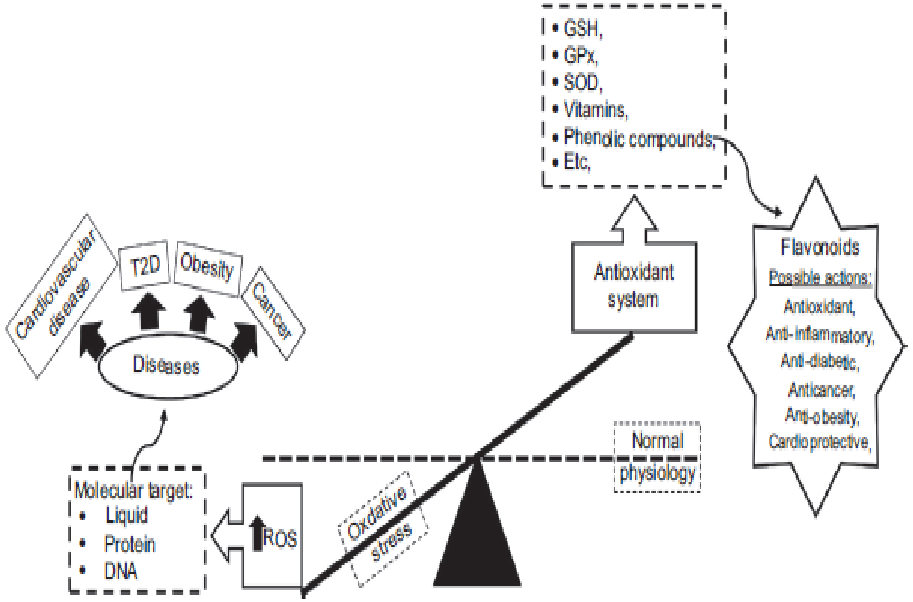
Phenolics compounds and health benefits



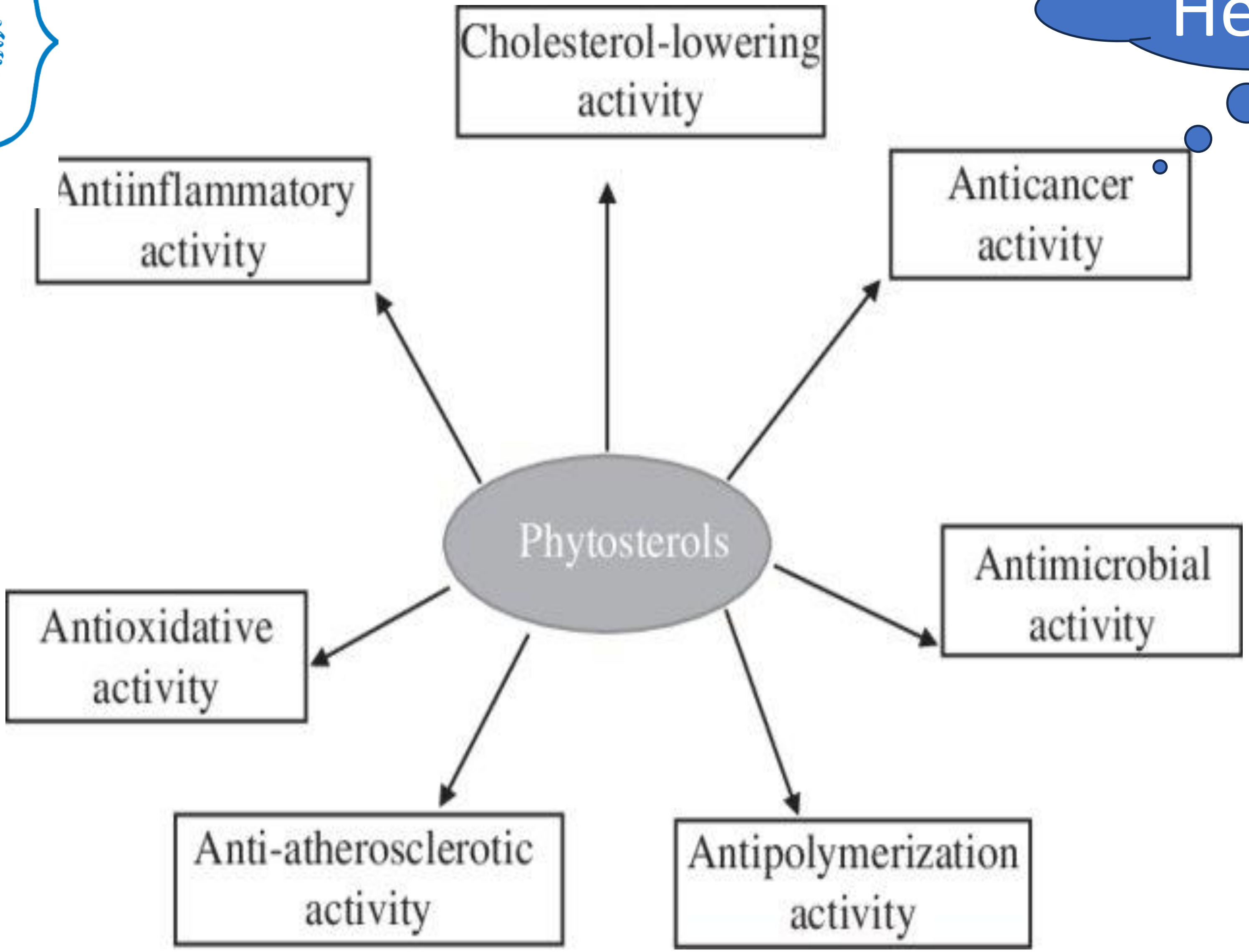


Flavonoids Health Benefit

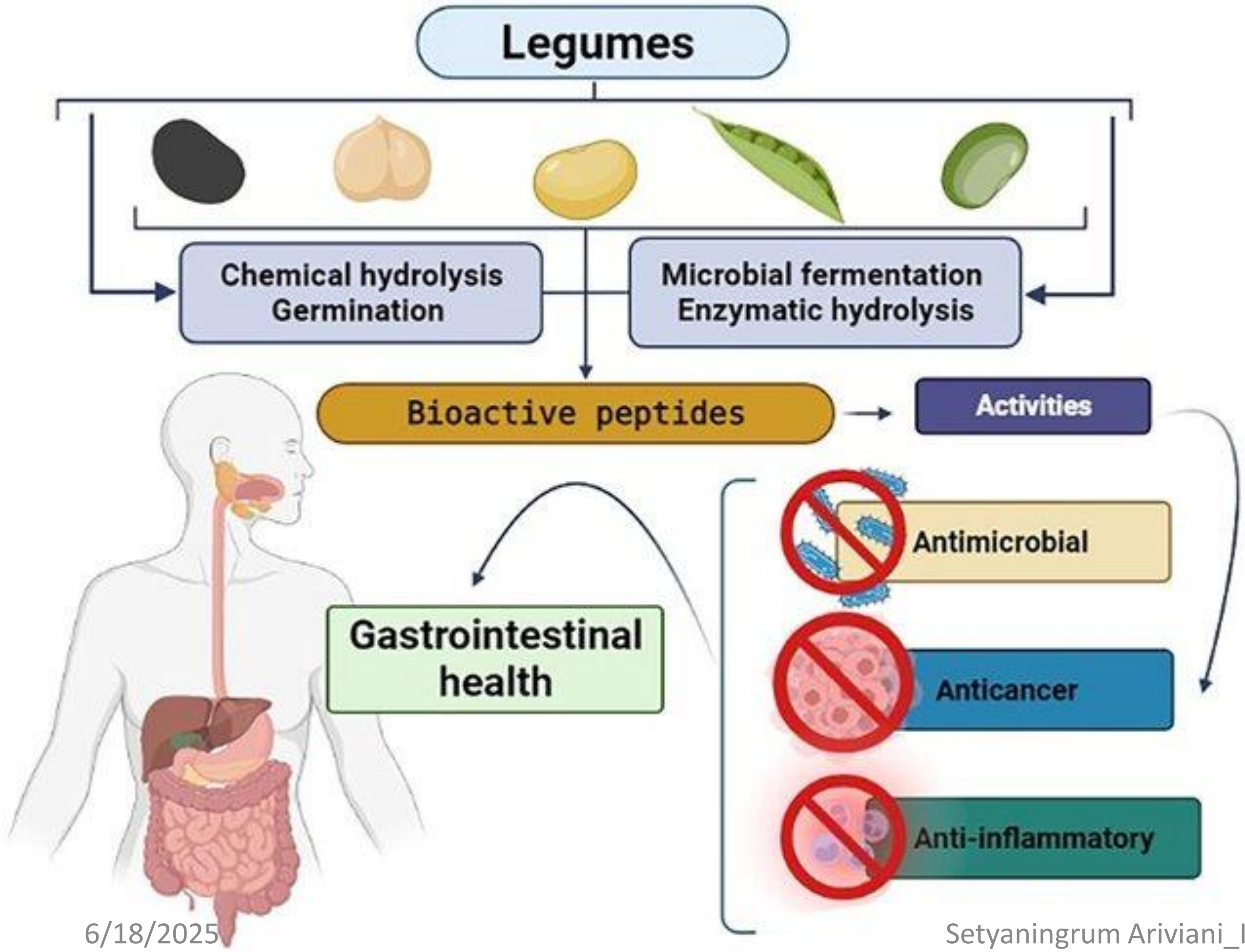


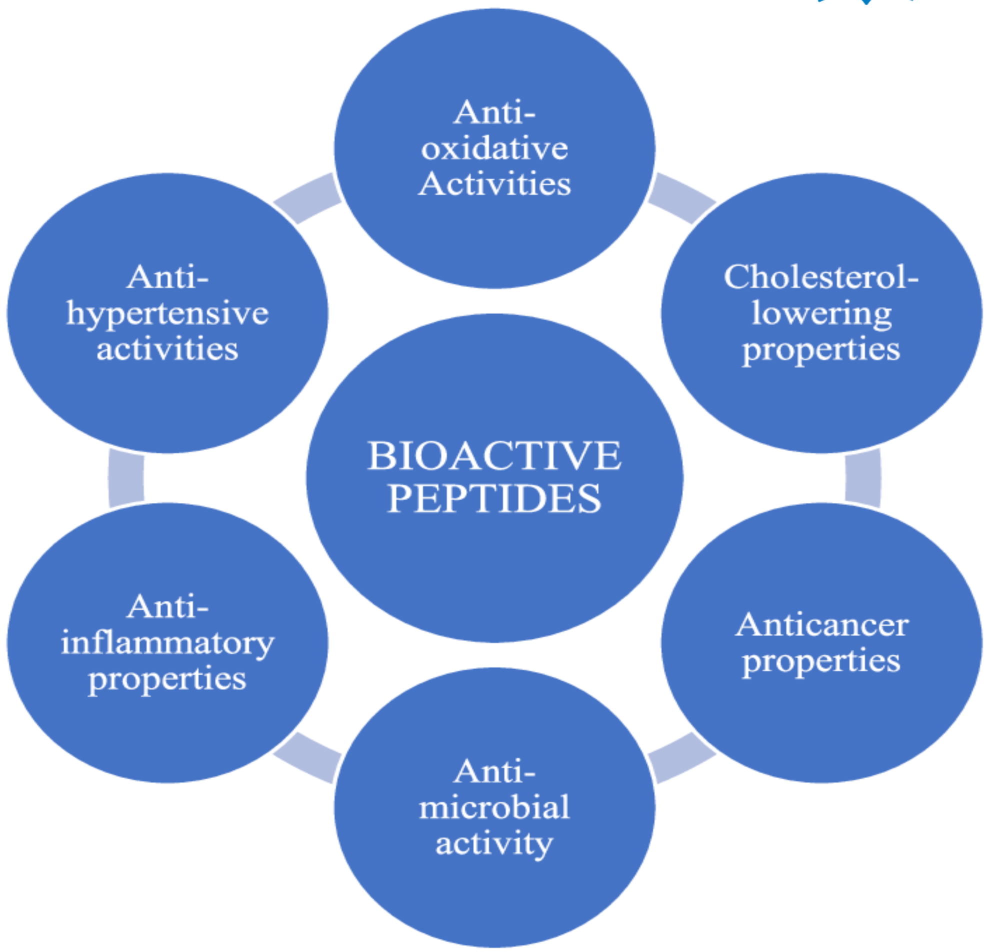


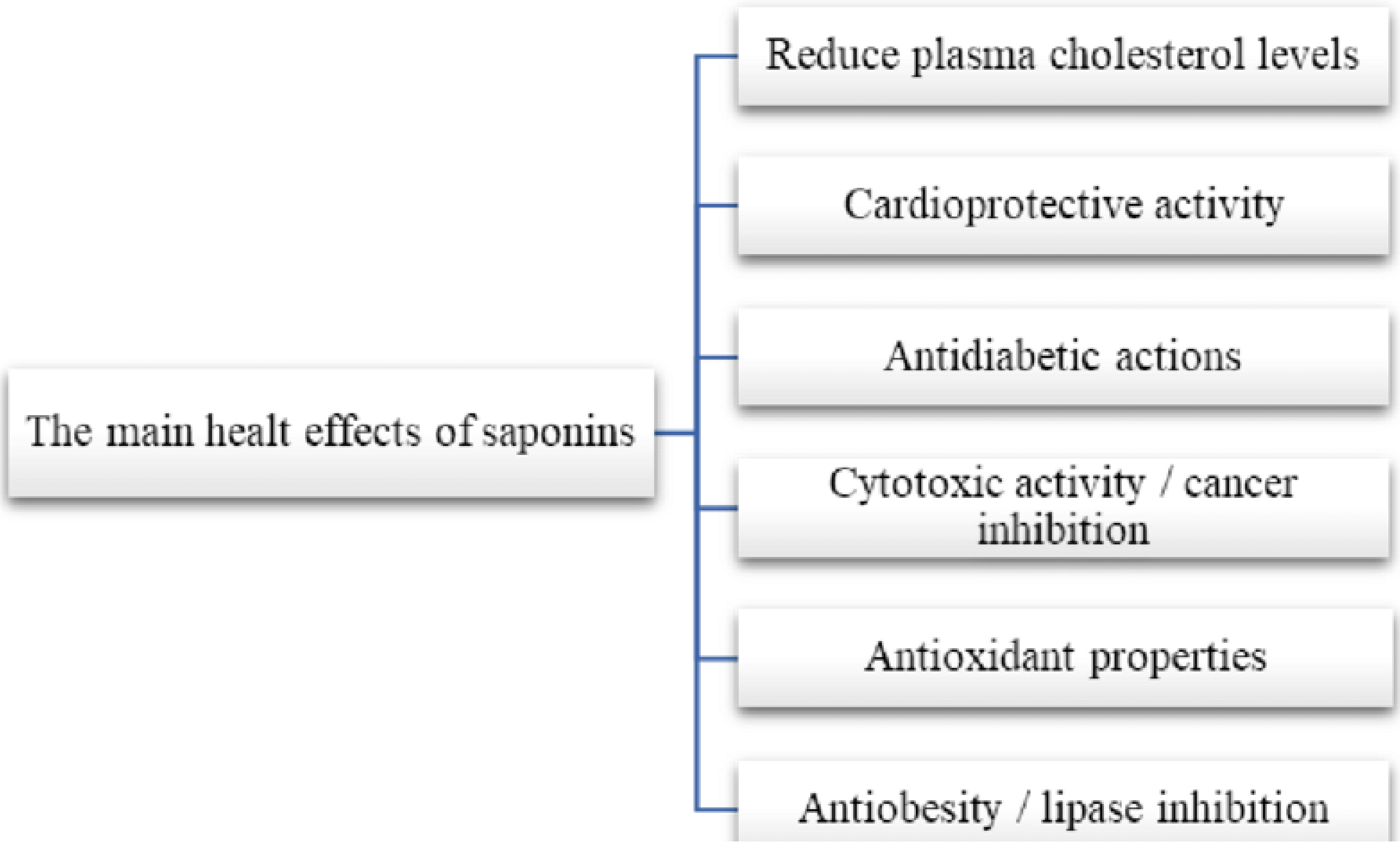
Phytosterol Health Benefit



Bioactive Peptide Health Benefit






The main healt effects of saponins
Reduce plasma cholesterol levels
Cardioprotective activity
Antidiabetic actions
Cytotoxic activity / cancer inhibition
Antioxidant properties
Antiobesity / lipase inhibition

Bioactive properties of common legume crops.

Species	Bioactive properties	Molecules involved	References
Cicer arietinum L. 	Antioxidant	Total extract, peptides, proteins, phenolic compounds, fibers	Faridy et al., 2020 (Faridy et al., 2020)
	Hypoglycemic and anti-diabetes	Genistein, formononetin, biochanin A	Lin et al., 2020 (Lin et al., 2020)
	Antimicrobial	Lectins	Gautam et al., 2018 (Gautam et al., 2018)
	Glucose metabolism modulation, body weight regulation and anti-diabetes	No one in particular (focus on legume based meals)	Becerra-Tomàs et al., 2018 (Becerra-Tomás et al., 2018)
Phaseolus vulgaris L. 	Anti-diabetes, anti-hypertensive, antioxidant	Digested peptides of seed globulin fractions	Garcia et al., 2020 (De Fátima Garcia et al., 2020)
	Prevention of cardiovascular disease	Peptides	Ngoh et al., 2017 (Ngoh et al., 2017)
	Hypocholesterolemic, prebiotic and fermentation modulator	Resistant starch and dietary fibers	Kilua et al., 2020 (Kilua et al., 2020)
	Anti-inflammatory, hypolipidemic and hypocholesterolemic, antioxidant	Bioactive hydrolyzed peptides	Gomes et al., 2020 (Gomes et al., 2020)
	Glucose metabolism modulation, body weight regulation and anti-diabetes	No one in particular (focus on legume based meals)	Becerra-Tomàs et al., 2018 (Becerra-Tomás et al., 2018)
Pisum sativum L. 	Protease inhibition	Bowman-Birk protease inhibitor	Clemente et al., 2018 (Clemente et al., 2012)
	Modulation of intestinal bacteria	Protein fraction	Ge et al., 2020 (Ge et al., 2020)
	Glucose metabolism modulation, body weight regulation and anti-diabetes	No one in particular (focus on legume based meals)	Becerra-Tomàs et al., 2018 (Becerra-Tomás et al., 2018)
Lens culinaris L. 	Prebiotic, hypocholesterolemic, fecal bile acids and SCFAs enhancer	Soyasaponins (group B)	Micioni Di Bonaventura et al., 2017 (Micioni Di Bonaventura et al., 2017)
	Anticancer potential	Seed aqueous extract conjugated to nanoparticles	Ahmeda et al., 2020 (Ahmeda et al., 2020)
	Glucose metabolism modulation, body weight regulation and anti-diabetes	No one in particular (focus on legume based meals)	Becerra-Tomàs et al., 2018 (Becerra-Tomás et al., 2018)
Glycine max L. 	Inhibition of proliferation, anti-inflammatory	Peptides derived from *in vitro* simulated digestion	Gonzalez-Montoya et al., 2018 (González-Montoya et al., 2018)
	Osteoporosis prevention	Isoflavones	Taku et al., 2011 (Taku et al., 2011)
	anti-inflammatory	Glucosylceramide and steroidal glucoside	Mizushina et al., 2012 (Mizushina et al., 2012)
Vicia faba L. 	Anti-oxidant, anti-biofilm and tyrosinase inhibition	Peptides	Karkouch et al., 2017 (65)
	Anti-carcinogenic and hypocholesterolemic	Protein hydrolysates	Leon-Spinosa et al., 2016 (León-Espinosa et al., 2016)
	Antimicrobial, antioxidant, anti-diabetes	Pods alcoholic extract	Mejri et al., 2018 (Mejri et al., 2018)
Lupinus spp. 	Anticancer	Alkaloids	Liu, 2009 (Liu, 2009)
	Anti-inflammatory	Protein hydrolysates	Millán-Linares et al., 2014 (Del Carmen Millán-Linares et al., 2014)
Arachis hypogea L. 	Hypolipidemic	Polyphenolic extract of peanut skin	Bansode et al., 2012 (Bansode et al., 2012)
	Antioxidant and antimicrobial	Spray dried extracts	Valle Calomeni et al., 2017 (do Valle Calomeni et al., 2017)

Bioactive properties of neglected and underutilized legume species.

Species	Distribution area	Bioactive properties	Molecules involved	Reference
Vigna spp.   	Africa and India	Anti-ageing and anti-neurodegenerative	Seed aqueous extract	Tripodi et al., 2020 (Tripodi et al., 2020)
		Anticancer	Purified extracts containing Bowman-Birk inhibitors	Panzeri & Guzzetti, 2020 (Panzeri et al., 2020)
		Antihypertensive and antioxidant	Peptides	Arise et al., 2017 (Arise et al., 2017)
		Hypocholesterolemic	Powder mix with soybean	Tan et al., 2020 (Tan et al., 2020)
		Anti-diabetes, anti-hypertensive, antioxidant	Digested peptides of seed globulin fractions	Garcia et al., 2020 (De Fátima Garcia et al., 2020)
Cajanus cajan L. 	Africa and India	Anti-inflammatory and cytotoxic	Cajaninstilbene acid and pinosylvin monomethylether	Schuster et al., 2016 (Schuster et al., 2016)
		Apoptosis inducer	Cajanol	Luo et al., 2010 (Luo et al., 2010)
Lablab purpureus (L.) Sweet 	India	Anti-obesity	Chikusetsu Saponin IVa	Yin et al., 2018 (Yin et al., 2018)
Lathyrus spp. 	Asia and West Africa	Antioxidant, enzyme inhibitory and cytotoxic	Extracts	Llorent-Martinez et al., 2017 (Llorent-Martínez et al., 2017)
		Anti-elastase	Bowman-Birk inhibitors	Rocco et al., 2011 (Rocco et al., 2011)

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Factors limiting the application of legumes in the food industry

ANTI-NUTRIENTS

Anti-Nutritional Factor	Legume(s) That Contain It	Possible Health Effects
Phytic acid	Soybeans, chickpeas, lentils, kidney beans, black beans	Diarrhea, nausea, vomiting, abdominal pain, impaired nutrient absorption
Lectins	Kidney beans, lima beans, peanuts	Reduced protein digestion, decreased protein utilization
Protease inhibitors	Soybeans, kidney beans, lima beans, peanuts	Impaired mineral absorption, reduced bioavailability of dietary minerals
Saponins	Chickpeas, lentils, peas	Reduced protein digestion, decreased protein utilization, impaired nutrient absorption
Tannins	Kidney Beans, lima beans, mung beans	Hemolysis, intestinal irritation, decreased nutrient absorption
Lathyrogens	Chickpeas, lentils, peas	Flatulence, abdominal bloating, decreased nutrient absorption
Oligosaccharides	Chickpeas, kidney beans, lentils, navy beans	Reduced protein digestion, decreased protein utilization
Cyanogens	Lima beans, fava beans	Neurotoxicity, paralysis
Phytoestrogens	Soybeans	Hemolytic anemia, favism
Trypsin Inhibitors	Soybeans, lima beans, kidney beans, peanuts	Autoimmune response, impaired nutrient absorption

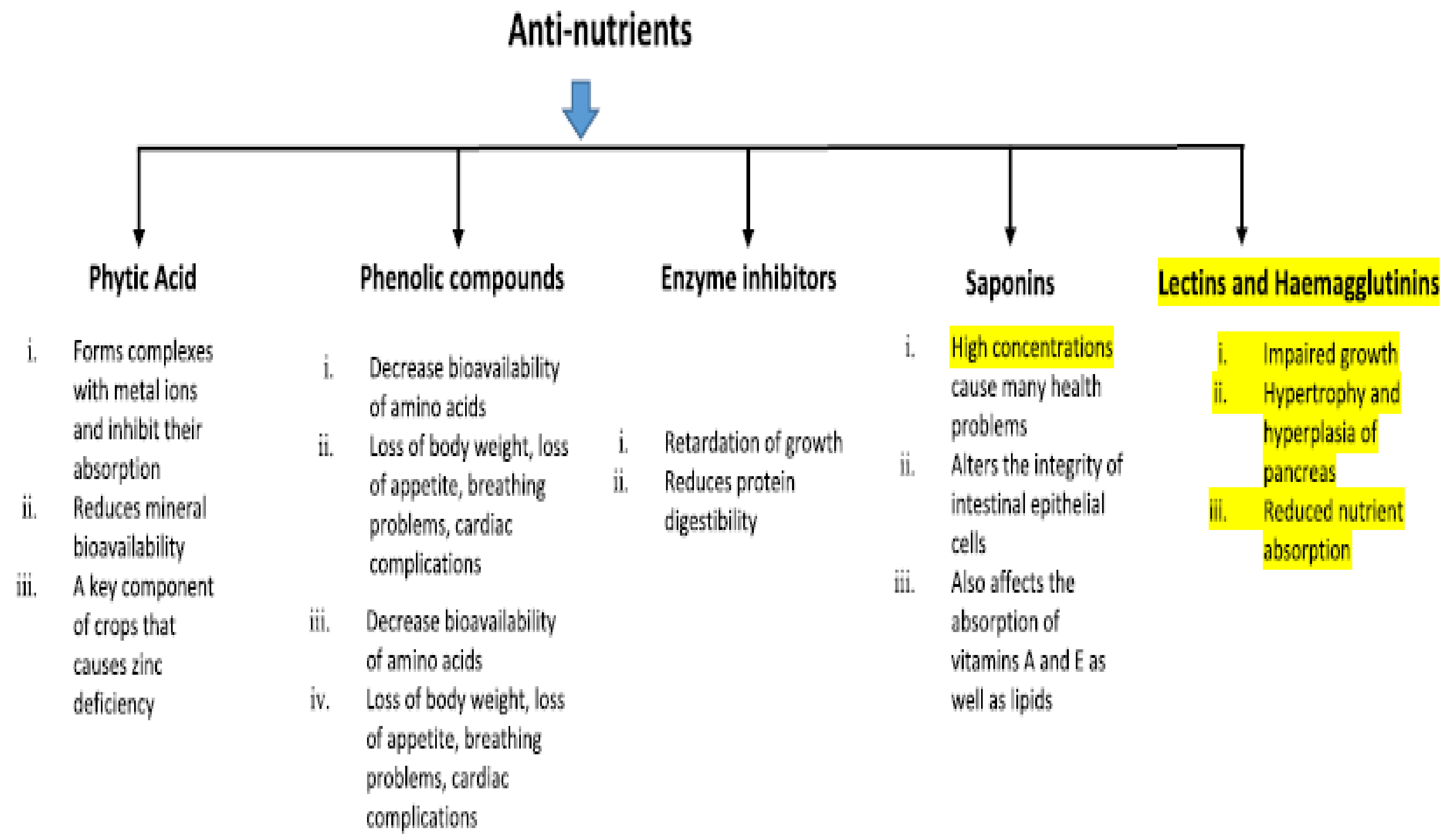
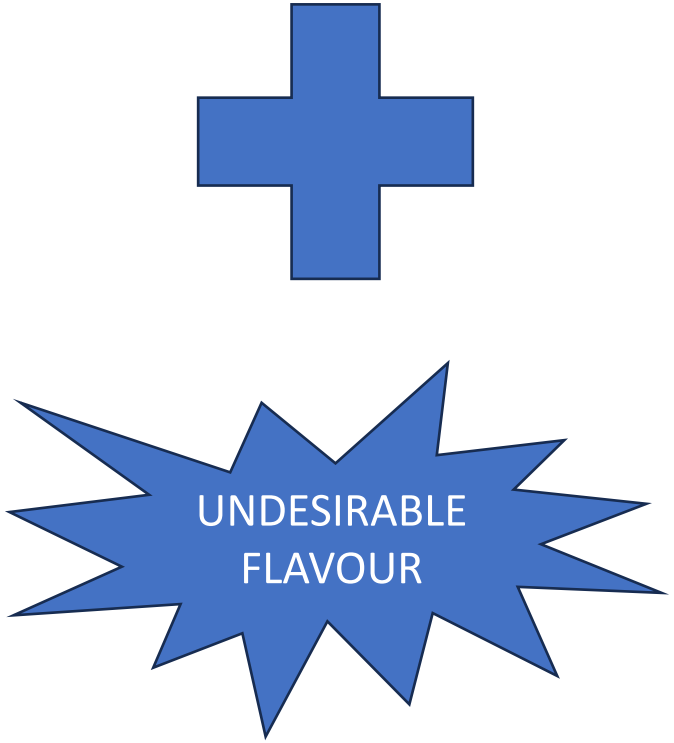
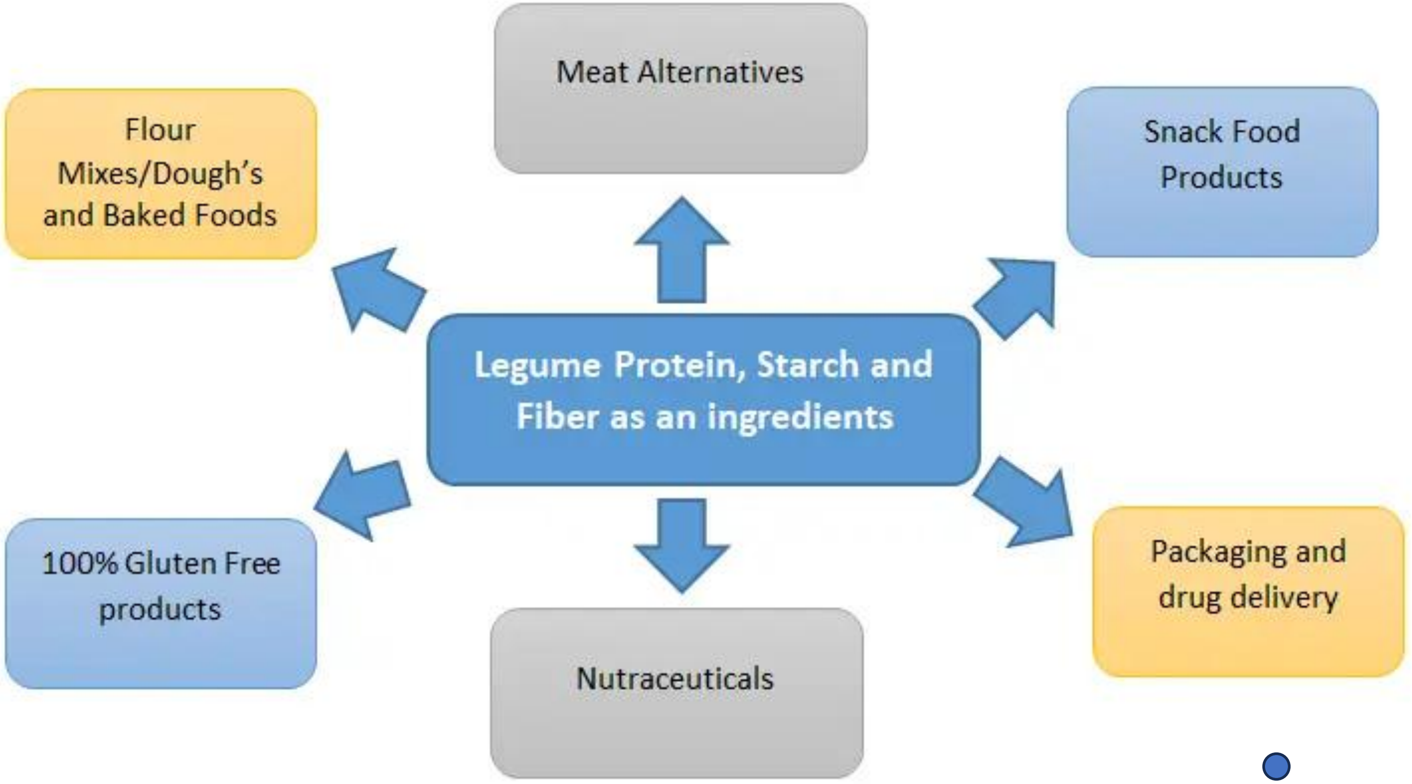


Fig. 1 A brief overview of the adverse effects of key anti-nutrients (Schlemmer et al. 2009; Wilson et al. 1981; Gemede and Ratta 2014; Jansman et al. 1998; Muramoto 2017)



Diverse applications of legumes or legume-based ingredients in various food applications

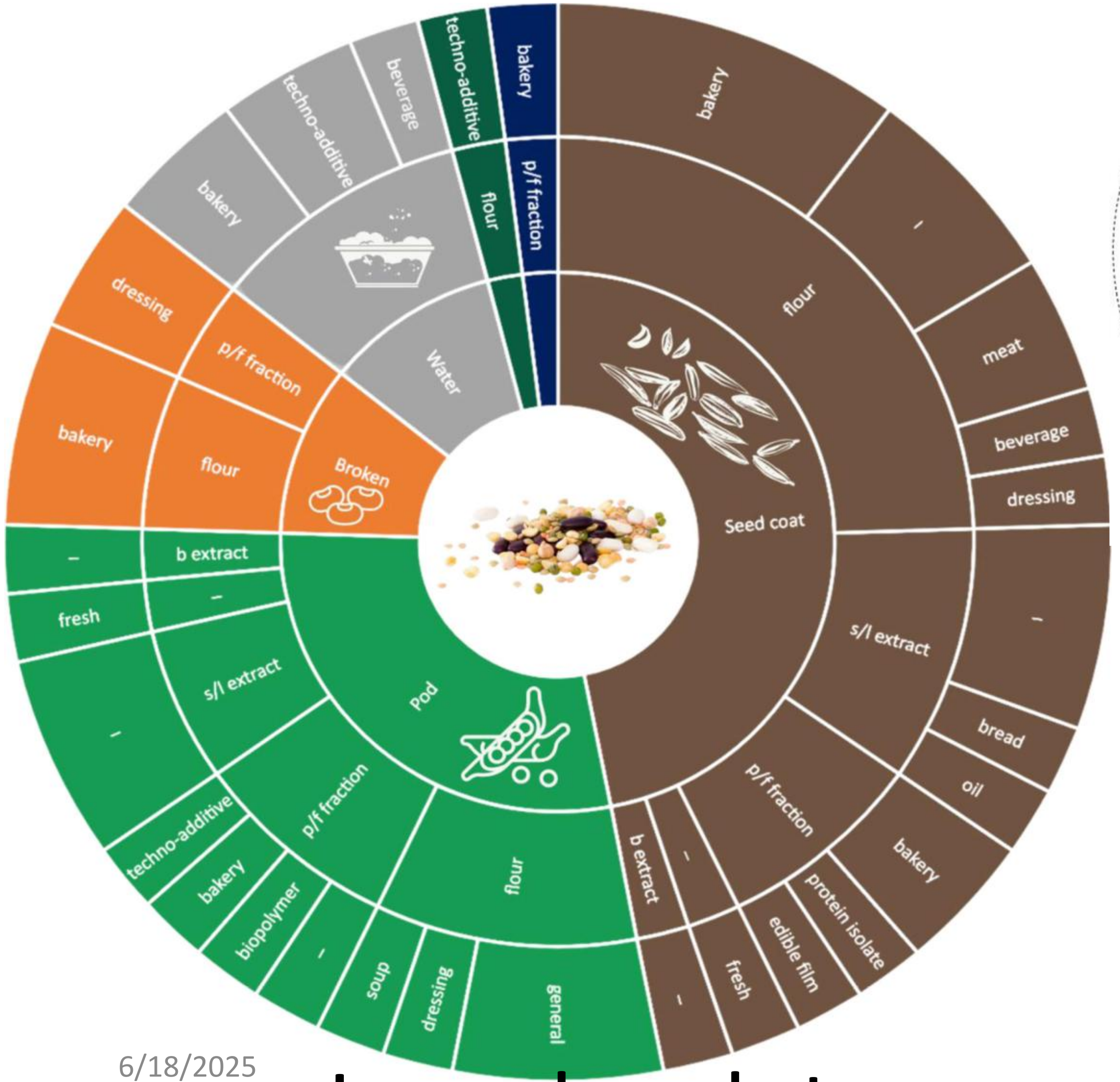


Legume Seeds

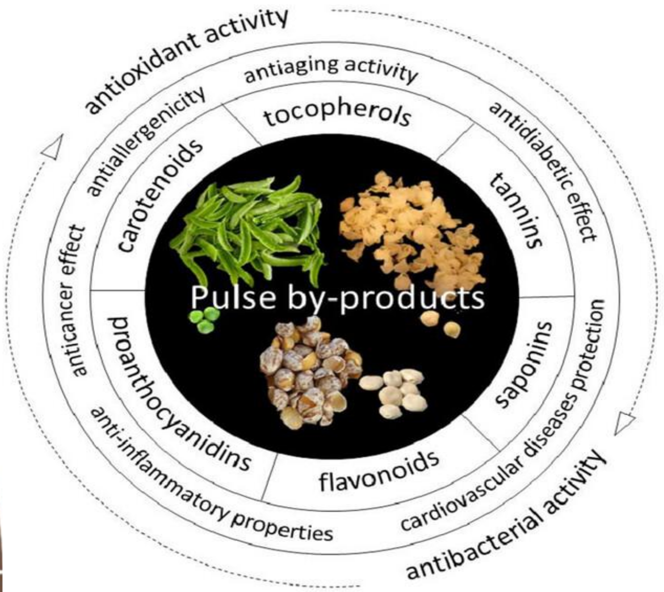
Directly as row materials => tofu, beverages, fermentation products, sprouts

Functional ingredient

Diverse applications of legumes or legume-based ingredients in various food applications



Legume byproducts



Functional ingredients
➔ functional food

Okara

Compr Rev Food Sci Food Saf. 2023;22:1953–1985.

Legume application in Food Products

Food applications	Legumes/pulses
Batters (*Akara*, *Akala*)	Cowpea, green gram, soybean, yellow peas, common beans
Dough	Chickpea, pea, navy beans, lupin
Breads	Bread (navy, great northern, pinto beans, field pea, yellow pea, chickpea, lentil, faba/broad bean, cowpea, lupin)
Tortilla, chapati or flat-bread	Tortilla (black, pinto, navy, small red, white beans, cowpea); Chapati (chickpea, lentil)
Other baked goods	Black, navy, and pinto beans, pea, chickpea, faba/broad bean, cowpea, soybean
Dairy (cheese, ice cream, milk pudding)	Soybean, chickpea, pea, lupin
Extruded snacks	Black, navy, pinto, white, and beans, chickpea, lentils, green gram, cowpea, pigeon pea, faba/broad bean, soybean, lupin, winged bean, velvet bean
Fried snacks	Desi chickpea, black gram, mung bean, soybean, cowpea
Meat (extenders, alternative)	Pea, soybean, chickpea, lentil, faba/broad bean, green gram, black gram, cowpea, lupin
Noodles	Navy, pinto, and red beans, filed pea, mung bean, soybean, chickpea, cowpea
Pasta	Navy and pinto beans, filed pea, yellow pea, mung bean, soybean, chickpea, lentil, cowpea, pigeon pea, faba/broad bean, lupin
Protein analogs	Pea, lentil, chickpea

Source: Maskus (2010); Keskin et al. (2022); Hill (2022).


Faba/Broad bean tofu


Egg replacer (Plant based garlic aioli)


Meat alternative (Tofu taquito filling)


Co-product utilization (Meat extender)


Dairy replacer (Plant-based spread)

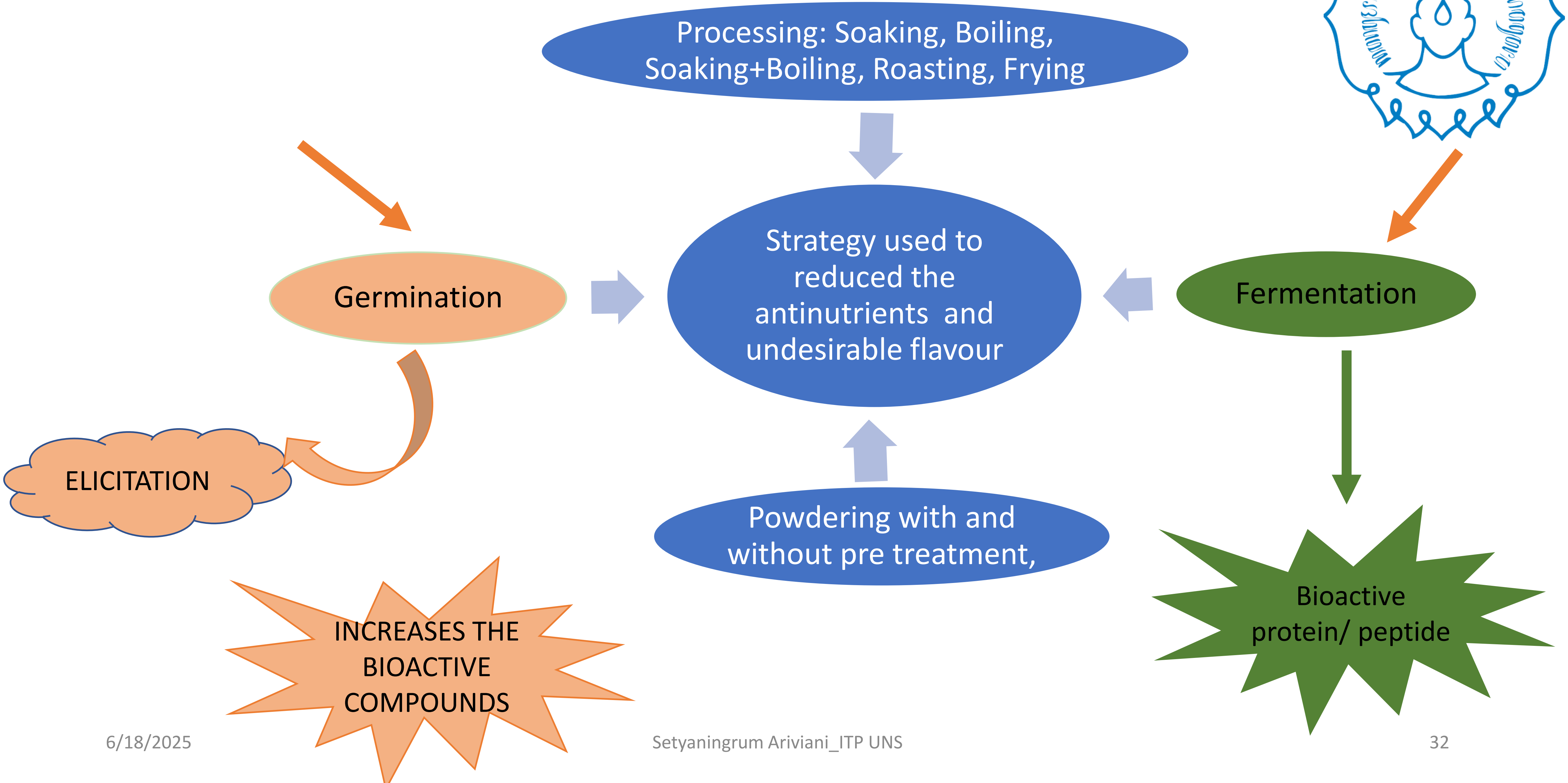
S/N	Legumes flour	Proportions of legumes in the GFF	Other Gluten free flour in the GFF	GFF	References
1	Chickpea	7.8%	Corn starch (100 and 92.2%) Corn starch-tiger nut flour (83.6%: 8.6%)	Bread	Aguilar et al. (2015)
		75%	Psyllium (5.5%) Cassava starch (25%)		Santos et al. (2021)
		2, 4, 6, 8, and 10%	Rice (98, 96, 94, 92, and 90%)	Noodles	Sofi et al. (2020a)
		20, 35, and 100%	Pumpkin (*Cucurbita pepo L*) (65 and 80%)	Crackers	Tomic et al. (2022)
2	Cowpea	30%	Rice flour (70%)	Cookies	De Souza et al. (2021)
		30%	Sorghum and cassava flour (0, 35 and 70%)	Flatbread	Dankwa et al. (2021)
3	Soybean	2, 4, 6, 8, and 10%	Rice flour (98, 96, 94, 92, and 90%)	Bread	Filipini et al. (2021)
4	Fava bean (*Phaseolus lunatus*)	99.5, 99, and 100%	Xanthan gum and galactomannan (0.5 and 1%, respectively)	Cookies	Andrade et al. (2018)
5	*Brachystegia eurycoma*	1.5 and 3%	Whole millet flour (97 and 98.5%)	Bread	Irondi et al. (2021a,b)
6	*Detarium microcarpum*	1.5 and 3%	Whole millet flour (97 and 98.5%)		Irondi et al. (2022)
7	Lentil (*Lens culinaris* Medik.)	Yellow, black, red, brown and green varieties (100%)	Lentil only	Cookies	Hajas et al. (2022)
		Extruded cooked and nature (10 g respectively)	Rice (20 g) and corn (7.5 g) flour, corn starch (7.5 g), HPMC (E464;1 g), psyllium seed husk powder (1 g)	Pizza	Pasqualone et al. (2022)
8	Bean	25, 37.3, and 75%	Rice flour (75, 25, and 62.7%)	Biscuit	Wesley et al. (2021)
		50%	Rice flour (50%)	Bread	Aguiar et al. (2022)
9	Carob	0.25, 0.5, and 0.75%	Coconut, almond and soy milk (100%)	Vegetable-milk based yoghurt	Froiio et al. (2020)
		5, 10, and 15%	Sorghum	Macaron	Bissar and Ozcan (2022)
10	Bambara groundnut	10, 15, 20, and 25%	Rice flour (75, 80, 85 and 90%)	Cookies	Dzandu et al. (2023)
11	Yellow Pea, chickpea and lentil	10, 20, and 30%	Rice flour (100%)	Pasta (spaghetti-type pasta)	Bouasla et al. (2017)
12	Chickpea, pea, lentil and bean	50%	Rice flour (50%)	Cake	Gularte et al. (2012)

Strategy for optimizing the utilization of legumes in the food industry

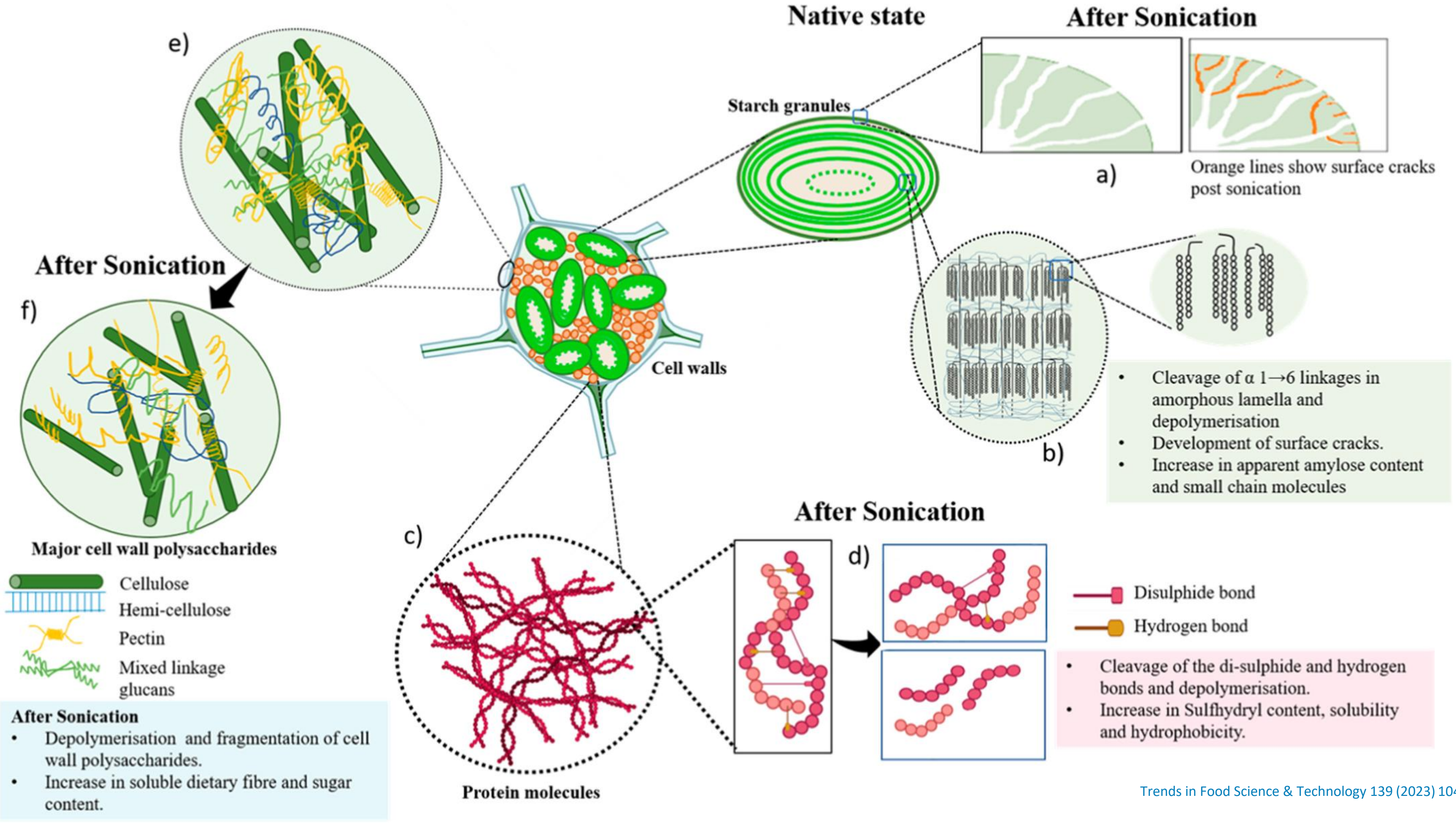
- On-farm => biotechnology to produce legumes with a higher protein, RS, DF, bioactive compounds, and reduced beany flavour.
- Off-farm: Technological innovation to:

1. Reduce the antinutritional compounds and beany flavour on time increases nutrition quality and bioactive compounds of legume seeds
2. Produce legume flours with improved functional properties, pasting properties, and thermal properties
3. Produce protein isolate or bioactive peptide
4. Utilization of legume by-products => extraction, flour preparation

Technological innovation ➔ 1, 2, 3



Technological innovation ➔ 2



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Production of bioactive protein/peptide fractions from various legume and their bioactivity ➔ Technological Innovation 3

Activity	Leguminous Source	Obtention of Bioactive Fraction	Experimental Model
Antioxidant	Bean	Alcalase hydrolysis	In vitro
		Alcalase/Savinase hydrolysis	In vitro
		In vitro digestion	In vitro
	Chickpea	Alcalase hydrolysis	In vitro
	Cowpea	Alcalase/Flavourzyme/pepsin-pancreatin	In vitro
	Lentil	In vitro digestion	In vitro
	Lupin	Bacterial and Alcalase/Neutrase/Flavourzyme hydrolysis	In vitro
	Pea		In vitro
	Soybean	Corolase PP hydrolysis	In vitro
		In vitro digestion	In vitro
Anti-inflammatory	Bean	Alcalase/Savinase hydrolysis	In vitro
	Pea	Thermolysin hydrolysis	In vitro/in vivo (mice)/ex vivo
		Lectin isolation	In vivo (rats)
	Soybean	Alcalase hydrolysis	In vitro
		Lunasin isolation	In vitro
			In vitro
		Specific peptides isolation	In vivo (mice)
Antihypertensive	Bean	Alcalase hydrolysis	In vitro
		In vitro digestion	In vitro
	Ckickpea	Alcalase hydrolysis	In vitro
	Lentil	Alcalase/Protamex/Savinase/Corolase 7089 hydrolysis	In vitro
	Mung bean	Alcalase hydrolysis	In vitro
			In vitro
	Pea	Thermolysin hydrolysis	In vitro/in vivo (rats)
		Alcalase hydrolysis	In vitro
		In vitro digestion/fermentation	In vitro
	Soybean	Pepsin/pancreatin hydrolysis	In vitro
		Corolase PP hydrolysis	In vitro
		Protease P/trypsin/chymotrpypsin	In vitro
		Fermentation	In vitro
Hypocholesterolemic	Cowpea	In vitro digestion	In vitro
	Lupin	Total protein extraction	In vivo (rats)
		Pepsin/Trypsin hydrolysis	In vitro
	Soybean	7S globulin isolation	In vitro/in vivo (rats)
			In vivo (rats)
		Pepsin hydrolysis	In vitro
	Chickpea	CPE-III peptide	In vivo (mice)
		Pepsin/pancreatin hydrolysis	

Activity	Leguminous Source	Obtention of Bioactive Fraction	Experimental Model
Antitumoral	Bean	Lectin isolation	In vitro
	Chickpea	Flavorzyme hydrolysis	In vivo (mice)
	Cowpea	BBI isolation	In vitro
	Lentil	Lectin isolation	In vitro
	Soybean	Pepsin/pancreatin hydrolysis	In vitro
		Alcalase hydrolysis	In vitro
		Lunasin isolation	In vitro
		In vitro digestion	In vitro
Mineral-chelating	Bean	Pepsin + pancreatin hydrolysis	In vitro
	Chickpea	Alcalase hydrolysis	In vitro
		Pepsin + pancreatin hydrolysis	In vitro
		Alcalase/flavourzyme hydrolysis	In vitro
	Soybean	Neutrase/flavourzyme hydrolysis	In vitro
		Protease M + glutaminase hydrolysis	In vitro
		Protease M + deamidase hydrolysis	In vitro
Antimicrobial	Bean	Alcalase hydrolysis	In vitro
	Bitter bean	Boiling + *L. fermentum* fermentation	In vitro/in silico
	Butterfly pea	Bromelain/trypsin hydrolysis	In vitro
	Soybean	Gastrointestinal digestion	In vitro
		B. subtilis fermentation	In vitro
Immune-modulatory	Bean	Pepsin/pancreatin/hydrolysis	In vitro
	Black bean	Alcalase hydrolysis	In vitro
	Soybean	Germinated	In vitro
Antidiabetic	Soybean	Pepsin/pancreatin/hydrolysis	In vitro
	Bean	Pepsin/pancreatin/hydrolysis	In vitro

Related research that previously carried out by our team…

Elicitation under salinity stress increases flavonoid content and antioxidant activity in cowpea (*Vigna unguiculata*) sprouts

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Abstract. Legumes are often used as a source of natural antioxidant. Elicitation is a promising alternative way of improving antioxidant compounds in legumes sprouts, such as flavonoid compound. NaCl stress can be used as one of abiotic elicitation that induced non-enzymatic defense in a plant, thus increases secondary metabolites which enhance the antioxidant capacity. However, its effects on cowpea (Vigna unguiculata) germination need to be more studied. In this study, we germinated cowpea under increasing salinity (0, 50, 100, 150mM NaCl) to investigate its effect on the total flavonoid content and antioxidant activity (radical scavenging activity and reducing power). Total flavonoid content and radical scavenging activity of cowpea sprouts increase along with increasing NaCl concentration. Meanwhile, only 150mM NaCl showed significantly higher reducing power among other concentrations. Total flavonoid content have a high correlation with radical scavenging activity ($r=0{,}962$; $p<0{,}01$) but not correlated with reducing power ($r=0{,}137$; $p>0{,}05$). This research results proved that elicitation using 150mM NaCl could be used as one of the strategies to enhance bioactive compound and antioxidant activity in legumes, thus increasing its potential to be developed as an antioxidant-based functional food.

Antioxidant capacity of pigeon pea (*Cajanus cajan* L.) sprouts elicited using NaCl with various elicitation time

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Abstract. Previous research showed that pigeon pea has potential as an anti-diabetic functional drink related to its antioxidant capacity. Antioxidant capacity in legumes can be increased by elicitation. Improvement of antioxidant capacity in legumes elicited by NaCl was significantly higher than that of other abiotic elicitation. The objective of this study was to determine the antioxidant capacity of pigeon pea (*Cajanus cajan* L.) sprouts which were elicited using NaCl (50mM) with various elicitation times (8 hours, 12 hours, 16 hours) and germinated for 48 hours. The results showed that elicitation time did not have a significant effect on the total flavonoids content, but significantly increased antioxidant activity (DPPH radical scavenging, and reducing power) of pigeon pea sprouts along with increasing elicitation time. This study proved that elicitation using NaCl 50mM for 16 hours increases the total flavonoid content (69,36%), DPPH radical scavenging activity (134,18%), and reducing power (24,54%) of pigeon pea sprouts. Elicitation using 50mM NaCl with 16 hours elicitation time and 48 hours germination time can be considered as a technique to enhance antioxidant capacity in legumes sprouts.

Continue…

The potential of pigeon pea (Cajanus cajan) beverage as an anti-diabetic functional drink

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Abstract. The number of patients with diabetes continues to increase. Diabetes complications might induce serious diseases such as kidney, nervous, cardiovascular diseases and stroke. Diabetic complications can be prevented by keeping blood glucose and cholesterol at normal levels. This study aims to determine the potential of pigeon pea beverage for lowering glucose and total cholesterol plasma levels and increasing the antioxidant status of diabetic-hypercholesterolemia rats. The research was conducted using 18 Sprague Dawley male rats aged 3 months old with an average body weight of 154 g. The rats were divided into three groups: normal group, D-H group (diabetic-hypercholesterolemia group), and pigeon pea beverage group. The results showed that pigeon pea beverage diet showed hypoglycemic and hypocholesterolemic activities, and could improve the antioxidant status of diabetic-hypercholesterolemia rats. Plasma glucose and total cholesterol levels of diabetic-hypercholesterolemia rats decreased 33.86% and 19.78% respectively. The improvement of the plasma antioxidant status was indicated by the decrease of plasma MDA (malondialdehyde) level, reaching 37.16%. The research result provides an alternative to diabetes management by using the local bean as an anti-diabetic functional drink.

Keywords: pigeon pea beverage, hypoglicemic, hypocholesterolemic.

The Potential of NaCl Elicitation on Improving Antioxidant Capacity and Functional Properties of Sprouted Pigeon Pea (*Cajanus cajan*) Flour

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Abstract. This study aims to evaluate the potential of elicitation using NaCl for improving the antioxidant capacity (total flavonoid content, radical scavenging activity, and reducing power) and functional properties (water absorption capacity/WAC, water holding capacity/WHC, oil absorption capacity/OAC, oil holding capacity/OHC, and emulsion stability/ES) of sprouted pigeon pea (Cajanus cajan) flour. It compared the flours processed from sprouted pigeon pea flour elicited by NaCl, sprouted pigeon pea flour, and non-sprouted pigeon pea flour. Sprouted pigeon pea flours prepared without and with elicitation technique were obtained by immersing pigeon peas in distilled water or 50 mM NaCl solution for 8 hours and followed by germination for 48 hours. The flours were produced by drying both raw pigeon pea and pigeon pea sprouts at a temperature of 80 ^{o}C, then processed into flour and sieved. The results show that flour prepared with NaCl-elicitation has the highest antioxidant capacity as well as the highest WAC, WHC, OAC, OHC, and ES values. It indicates that elicitation by NaCl potentially enhances the functional properties and antioxidant capacity of sprouted pigeon pea flour. Thus, the elicitation technique by NaCl can be considered as a technique to improve the antioxidant capacity and functional properties of legume flour.

Continue…

Investigation on Antioxidant Activity, Protein, and Whiteness Degree of Elicited Cowpea Sprouts Flour Prepared with Various Drying Technique

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Abstract. Cowpea (*Vigna unguiculata*) is a protein source legumes that exerted several advantages compared to the other legumes, such as rich in antioxidants and dietary fiber as well as provide various health benefits, can help restore soil fertility and more tolerant to the environmental stresses. Cowpea has a higher level of dietary fiber, productivity, and lower fat content than soybean. Germination prepared with elicitation techniques has been proved to be able to increase protein levels and antioxidant activity of legume sprouts. Previous author's research showed that elicitation using both NaCl as abiotic and Na-alginate as biotic elicitors effectively increased radical scavenging activity (RSA) and ferric reducing antioxidant power (FRAP) of cowpea sprouts. However, sprouts have a short shelf life due to the higher moisture content. A strategy to overcome this problem is by drying followed by milling sprouts to produce sprouts flour. This study aims to examine antioxidant activity (RSA, FRAP), nutrition (dissolved protein) and the whiteness degree of elicited cowpea sprouts flour prepared with various drying techniques (50ºC for 5 hours, 60ºC for 4 hours, 70ºC for 3 hours, and 80ºC for 2 hours). Cowpea sprouts were prepared by elicitation using 50 mM NaCl and 250 ppm Na-alginate solutions. The results showed that the drying technique had a significant effect on RSA, FRAP, dissolved protein levels and the whiteness degree of the flour. The drying technique using temperature of 80ºC for 2 hours resulted in elicited cowpea sprouts flour with higher RSA, FRAP, dissolved protein levels and whiteness degree than other drying techniques. These results have an important implication for the development of local legumes sprouts flour as a functional food.

Antioxidant capacity and germination power of NaCl-elicited cowpea (Vigna unguiculata) sprouts with various NaCl concentrations and elicitation durations

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Abstract. Cowpea (Vigna unguiculata) is one of legumes that have the potential as a source of food antioxidant related to the phenolic compounds. Germination can enhance the antioxidant capacity of cowpea and elicitation using NaCl within the germination process. It has been reported as an effective technique to improve the antioxidant potential of legumes sprouts. This study aimed to evaluate the antioxidant capacity (total phenolic content, DPPH radical scavenging activity, and reducing power (RP)) of NaCl-elicited cowpea sprouts with different concentrations of NaCl (50, 100, 150 mM) and elicitation durations (8, 12, 16 hours). The germination power of the NaCl-elicited cowpea was also investigated. Results showed that the total phenolic content, DPPH radical scavenging activity and RP of NaCl-elicited cowpea sprouts increase in line with the increase in NaCl concentrations and elicitation durations. Both DPPH radical scavenging activity and RP had significant correlation ($p<0.01$; $r = 0.805$; 0,785) with the total phenolic content. Nevertheless, germination power decreased along with increasing NaCl concentration and elicitation duration. The results of this study provide an alternative strategy for increasing the antioxidant capacity of cowpea through NaCl-elicitation. Thus, it can be a reference for developing cowpea-based functional food.

Continue…

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Evaluation of total phenolic content, antioxidant activity, germination power, and yield of pigeon pea (*Cajanus cajan*) sprouts elicited using various Na-alginate levels with different elicitation duration

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Pigeon pea

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Abstract

This study was aimed to investigate the total phenolic content and antioxidant activity of elicited pigeon pea (*Cajanus cajan*) sprouts prepared using various Na-alginate concentrations at different elicitation durations. The germination power and yield of the sprouts were also examined. Elicitation proved capable to improve the antioxidant capacity of legumes sprouts but the yield and germination rates were decreased due to the elicitation stress. In this study, elicitation conducted by immersing pigeon pea seeds in Na -alginate solutions (250, 300, and 350 ppm) for various duration (16, 20, and 24 hrs). The seeds were then germinated for 48 hrs to produce Na-alginate elicited pigeon pea sprouts. The results showed that the total phenolic content (TPC) and antioxidant activity (Trolox equivalent antioxidant capacity, TEAC, and Ferric reducing antioxidant power, FRAP) of elicited pigeon pea sprouts were significantly increased along with the increasing elicitation duration in all Na-alginate levels. The higher Na-alginate levels produce a higher level of TPC, TEAC, and FRAP values. On the other hand, germination power and the yield of the sprouts were significantly decreased along with increasing Na-alginate levels and elicitation duration. Elicitation using 350 ppm Na-alginate with an elicitation duration of 24 hrs produces elicited pigeon pea sprouts with the highest TPC and antioxidant activity, but lowest germination power and yield. These results have an important consequence in developing an elicitation technique to improve the antioxidant capacity of leguminous.

Na-alginate elicitation as an alternative strategy to improve the antidiabetic potential of pigeon pea (*Cajanus cajan*) flour

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TEAC

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Abstract

Pigeon pea (*Cajanus cajan*) has been reported to exhibit antidiabetic activity such as hypoglycemic and hypocholesterolemic effects as well as antioxidant capacity in diabetic-hypercholesterolemia rats, alpha-glucosidase and alpha-amylase inhibitory activity, due to the bioactive compounds. Germination proved capable to increases the antidiabetic activity of pigeon pea. Elicitation has been known as a simple method for increasing the bioactive compounds and bioactivity of legumes sprouts. This study aimed to investigate the potential of Na-alginate elicitation in improving the antidiabetic activity of pigeon pea flour. The antidiabetic activity was determined by measuring the total flavonoid compounds, antioxidant activity (Trolox equivalent antioxidant activity, TEAC), alpha-amylase and alpha-glucosidase inhibitory activities. The effectiveness of Na-alginate elicitation in improving the antidiabetic activity was evaluated by comparing its antidiabetic activity to that of non-elicited pigeon pea sprout flour and non-treated pigeon pea flour. Na-alginate elicited pigeon pea sprout flour showed the highest levels of total flavonoid compounds, TEAC, as well as alpha-amylase and alpha-glucosidase inhibitory activities. Na-alginate elicitation was capable to increase the total flavonoid compounds, TEAC, alpha-amylase inhibitory activity, and alpha-glucosidase inhibitory activity of pigeon pea flour reach 107.2%, 41.7%, 237.5%, and 85.8%, respectively. It could be concluded that Na-alginate elicitation proved as an effective strategy to improve the antidiabetic potential of pigeon pea flour. These results showed positive evidence of developing legumes flour as a functional ingredient with antidiabetic potential.

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FOOD RESEARCH

The improvement of nutrition quality, antioxidant capacity, and functional properties of cowpea (*Vigna unguiculata*) sprout flour through NaCl and Na-alginate elicitation

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Abstract

Cowpea exhibits potential antioxidant capacity, and various health benefits, as well as a good source of protein and nutraceutical compounds. Our previous study showed that elicitation using 50 mM NaCl or 250 ppm Na-alginate before germination is the most effective technique to improve the antioxidant capacity of cowpea sprout with the lowest impact on the reduction of germination power and yield. The objective of this research was to evaluate the potential of NaCl and Na-alginate elicitation on the improvement of the nutrition quality (proximate), antioxidant capacity (total phenolic content, total flavonoid content, reducing power, and Trolox equivalent antioxidant capacity (TEAC)), and functional properties (water absorption capacity (WAC), oil absorption capacity (OAC), water holding capacity (WHC), oil holding capacity (OHC) and emulsion stability (ES)) of cowpea sprout flour. The cowpea sprout was prepared with and without elicitation (control) by immersing the cowpea seeds either in 50 mM NaCl, 250 ppm Na-alginate or distillate water for 8 hrs prior to germination for 48 hrs. The sprouts then were dried, milled, and sieved to produce sprout flour. The research results proved that elicitation significantly increases the protein and total mineral levels, functional properties, and antioxidant capacity, and reduces the fat and carbohydrate levels of cowpea sprout flour. Elicitation using Na-alginate produced a higher improvement of OHC, nutrition, and antioxidant capacity of elicited cowpea sprout flour than that of NaCl elicitation. This study provides an alternative strategy for improving the nutrition, antioxidant capacity, and functional properties of legume flour.

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FOOD RESEARCH

RESEARCH PAPER

Investigation of the sensory quality, nutritional value and antioxidant capacity of flakes prepared using various pigeon pea-based flours

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Abstract

Pigeon pea (*Cajanus cajan* (L.)) is a potential source of nutritional and antioxidant compounds. Germination proved to improve the nutritional quality and antioxidant capacity of pigeon peas. The previous author's study showed that pigeon pea flour prepared by NaCl elicitation before germination exhibits significantly higher antioxidant capacity and functional properties than that prepared without elicitation or germination. The study aimed to examine the sensory quality, nutrition value, and antioxidant capacity of flakes formulated using non-germinated pigeon pea flour, pigeon pea sprout flour, and NaCl-elicited pigeon pea sprout flour. The potential of the flours to be developed as commercial flakes was also determined using oat-based commercial flakes as a comparator. The NaCl-elicited pigeon pea flour-based flakes showed a higher quality score of both texture and overall qualities than the other pigeon pea flour-based flakes and the commercial ones. Regarding nutritional value, flakes formulated using NaCl-elicited pigeon pea sprout flour also showed better nutritional value, indicated by the lowest fat content and highest soluble, insoluble, and total dietary fiber contents. The highest values of total phenolics content (TPC), Trolox equivalent antioxidant capacity (TEAC), and ferric reducing antioxidant power (FRAP) were also observed in the NaCl-elicited pigeon pea sprout flour-based flakes, even though its DPPH radical scavenging activity was not significantly different to the commercial flakes. These results have significant consequences for developing legume-based flakes with higher levels of dietary fibers and antioxidant potential, and lower fat content.

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Comparison study of antioxidant capacity, thermal and pasting properties, and microstructure of germinated and non-germinated pigeon peas flour from the Yogyakarta region of Indonesia

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Abstract. Pigeon peas are a legume spread throughout various regions of Indonesia and are widely cultivated in the Yogyakarta region. Pigeon peas are a multifunctional legume with higher protein content than adzuki bean, pink bean and chickpea, higher resistant starch levels than mung bean, chickpea and black bean, lower fat content than soybean and cowpea, and have potential as antidiabetic, anti-obesity, and hypocholesterolemic agents due to its phenolic compounds and antioxidant capacities. However, the utilization of pigeon peas in food applications is limited due to their anti-nutrient compounds. Germination reduces antinutrient compounds while increasing antioxidant capacity and modifying the flour characteristics of legume flour. This research aims to determine the effect of germination on alteration in antioxidative capacity, thermal and pasting properties, and microstructure of pigeon peas flour from the Yogyakarta region. The results showed that germinated pigeon peas flour exhibited significantly higher levels of total phenolic compounds and ABTS radical scavenging activity than the non-germinated flour. The lower onset (T_o) and peak temperature (Tp) levels and higher levels of conclusion temperature (Tc) and enthalpy (ΔH) were observed in germinated pigeon peas flour. The germinated pigeon peas flour also showed higher pasting temperature (PT) and peak time (PTime) levels. In contrast, the peak viscosity (PV), through viscosity (TV), breakdown viscosity (BV), setback viscosity (SV), and final viscosity (SV) values were lower than the non-germinated flour. The thermal and pasting properties of germinated pigeon peas flour were in line with its microstructure, which has a smaller starch granule size with an irregular shape, more protein and fiber attached to the starch granule surface and higher cellular material size than the non-germinated flour. The results have significant consequences in modifying thermal and pasting properties, antioxidant, and microstructural characteristics of local legumes flour. This is essential to provide functional ingredients sustainably by utilizing underutilized local legumes.

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Comparative Study of the Nutritional Value, Phytochemicals, and Sensory Quality of Flakes Prepared Using Elicited and Non-Elicited Cowpea Sprout Flours

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Abstract

Germination without and with elicitation using 50 mM NaCl or 250 ppm Na-alginate generated cowpea sprout flours with the levels of protein, total phenolic compounds (TPC), total flavonoid compounds (TFC), radical scavenging activity (RSA), and ferric reducing antioxidant power (FRAP), as well as functional properties that significantly higher than that of cowpea seed flour. Most cereal flakes lack protein content and health-promoting compounds. This study aims to investigate the potential for developing NaCl-elicited, Na-alginate-elicited, and non-elicited cowpea sprout flours for flakes production through a comparative study on the nutritional value (proximate, dietary fibers), phytochemicals (TPC, RSA, FRAP), and sensory quality. Oat-based commercial flake was used as a comparator. The flakes formulated using elicited cowpea sprout flours exhibited significantly lower fat and carbohydrate contents and higher levels of protein, soluble, insoluble, and total dietary fibers than those prepared using non-elicited cowpea sprout flour. The cowpea-based flakes showed more elevated carbohydrate, total, soluble, and insoluble dietary fiber levels and significantly lower fat levels than oat-based commercial flakes. The flakes designed using Na-alginate-elicited cowpea sprout flour have the highest TPC, RSA, and FRAP values. Compared to the commercial ones, flakes prepared with elicited cowpea sprout flours produce better aroma, texture, and overall qualities. These results have significant implications for developing legume-based flakes with lower fat, higher levels of protein, dietary fibers, and phytochemicals, and good sensory quality.

Keywords: elicitation; health-promoting compounds; NaCl; Na-alginate; radical scavenging activities

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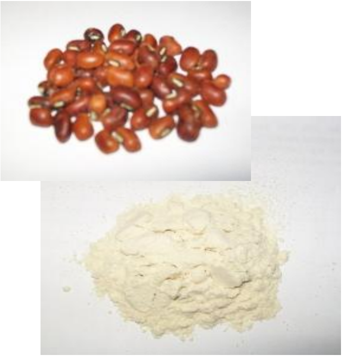


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COWPEA FLA
Elicited NaCl
COWPEA FLAKES
PEA FLAKES


PIGEONPEA FLA
PIGEONPEA FLAKES
PIGEONPEA FLAKES

Related research that previously carried out by our team…

- The optimization condition of germination to produce legumes sprout with higher antioxidant potential.
- Optimization condition of elicitation to produce elicited legumes sprout with the highest antioxidant potential with the lowest effect on germination power.
- Optimization of drying technique to produce legume sprout flour (with and without elicitation) with a higher whiteness degree, soluble protein content, and antioxidant retention
- Study of functional, thermal, and pasting properties of elicited and non-elicited legume sprout flours.
- Study on antidiabetic properties of elicited and non-elicited legumes sprout flours.
- Development of elicited and non-elicited legumes sprout flour to produce flakes with lower GI and GL as alternative diabetes management.

MATUR NUWUN…

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