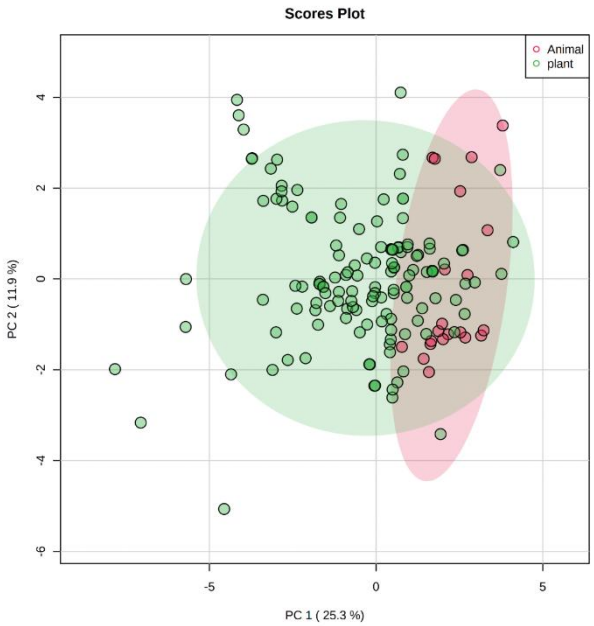
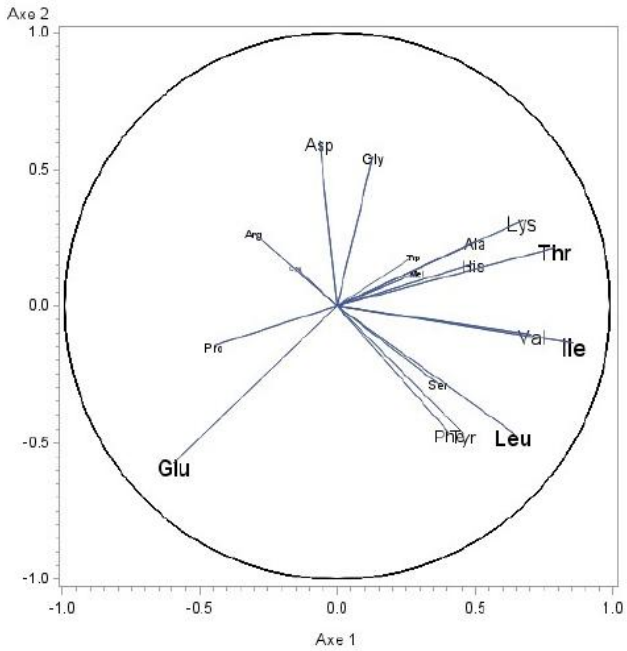
Supplementary Material



Supplementary Figure 1. Plot of Principal Component Analysis (PCA) scores. Clusters of protein ingredients are based on their source.



Supplementary Figure 2. PCA/ loading plot. Variables that contribute the most to data variance**.**

Supplementary Table 1. Amino acid Profile 1 - IAA requirements for adults and infants (WHO) used as constraints during optimization.

IAA	2007 WHO adult requirements (19,20)		2007 WHO infant (0-6 months) requirements (19,20)	
	mg/g	**g/30g**	mg/g	**g/30g**
Tryptophan	15	**0.18**	17	**0.51**
Threonine	30	**0.69**	44	**1.32**
Isoleucine	59	**0.9**	55	**1.65**
Leucine	45	**1.77**	96	**2.88**
Lysine	22	**1.35**	69	**2.07**
Met+Cys	38	**0.66**	33	**0.99**
Phe+Tyr	23	**1.14**	94	**2.82**
Valine	6	**1.17**	55	**1.65**
Histidine	39	**0.45**	21	**0.63**

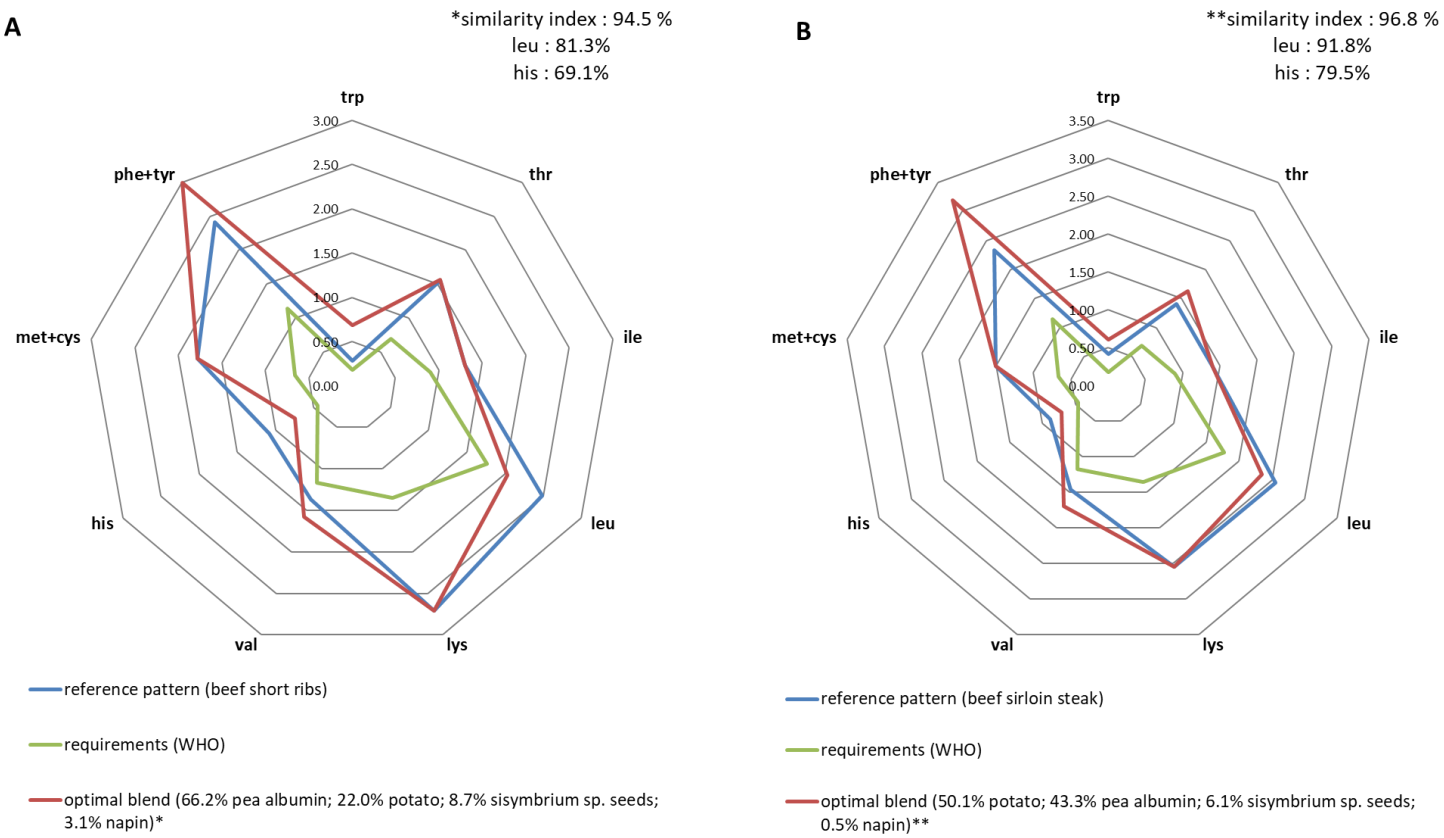
Supplementary Table 2. Animal profiles added to the database and used as targets for optimization in order to study how plant-based protein isolates can reproduce animal IAA profiles as a function of animal species and meat cuts.

Animal product	Profile Reference
Beef: short ribs and sirloin steak	◦[1]CIV-INRA
Veal: shoulder and chop	◦[1]CIV-INRA
Lamb: leg and neck	◦[1]CIV-INRA
Horse: topside and rib steak	◦[1]CIV-INRA
Pork	ref: 10024 (USDA database)
Rabbit	ref: 17180 (USDA database)
Chicken	ref: 05011 (USDA database)
Turkey	ref: 05167 (USDA database)
Duck	ref: 05141 (USDA database)
Egg white	ref: 01124 (USDA database)
Cow milk	ref: 01151 (USDA database)
Acid whey	ref: 01113 (USDA database)
Casein	personal data
Goat milk	ref: 01106 (USDA database)
Sheep milk	ref: 01109 (USDA database)

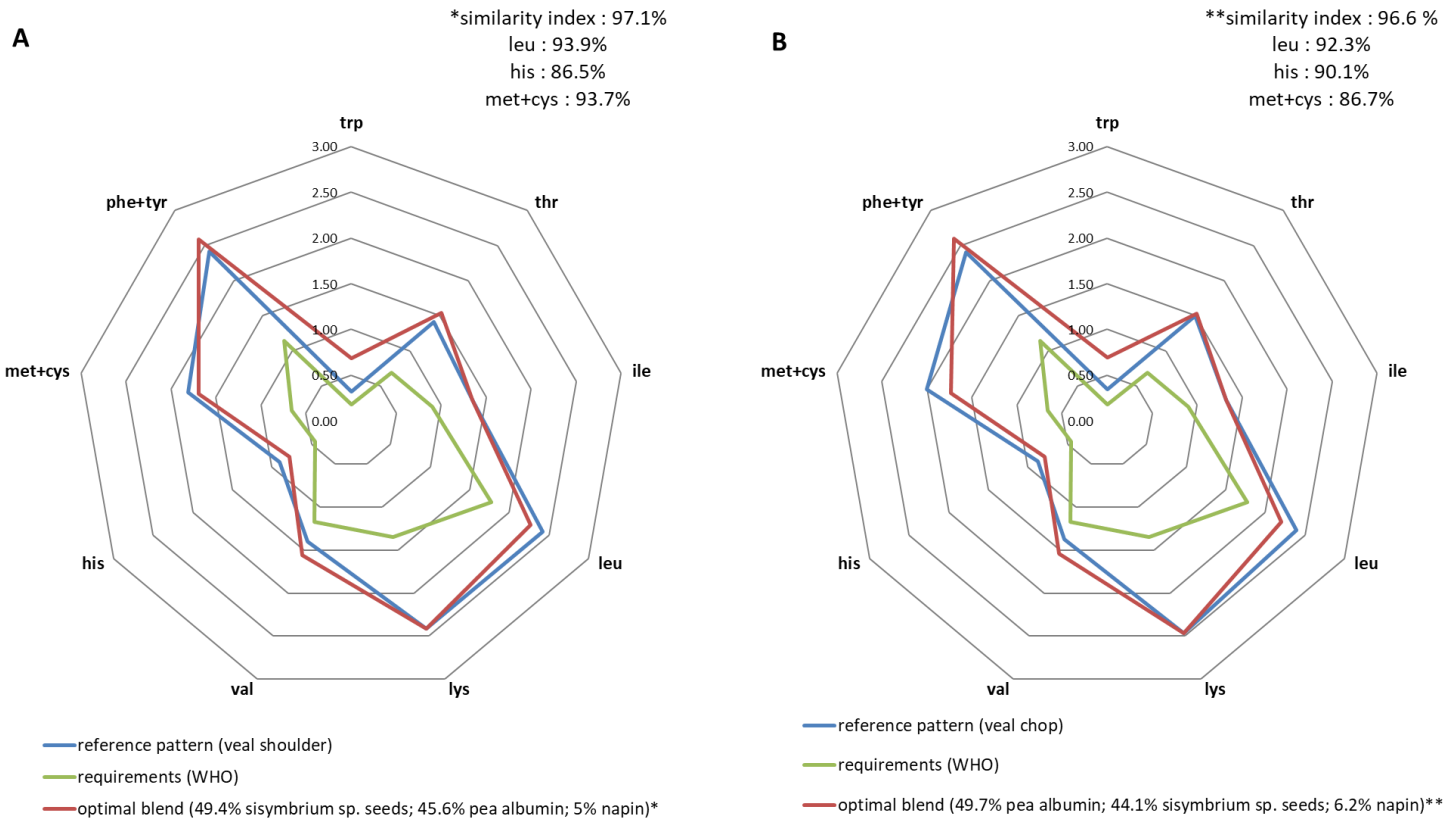
[1] CIV-INRA. Valeurs nutritionnelles des viandes crues. L'essentiel des viandes, 2009

Supplementary Table 3. Top 15 protein ingredients with the richest phenylalanine content (in g/100g of amino acids) – protein ingredients of animal and plant origin confounded.

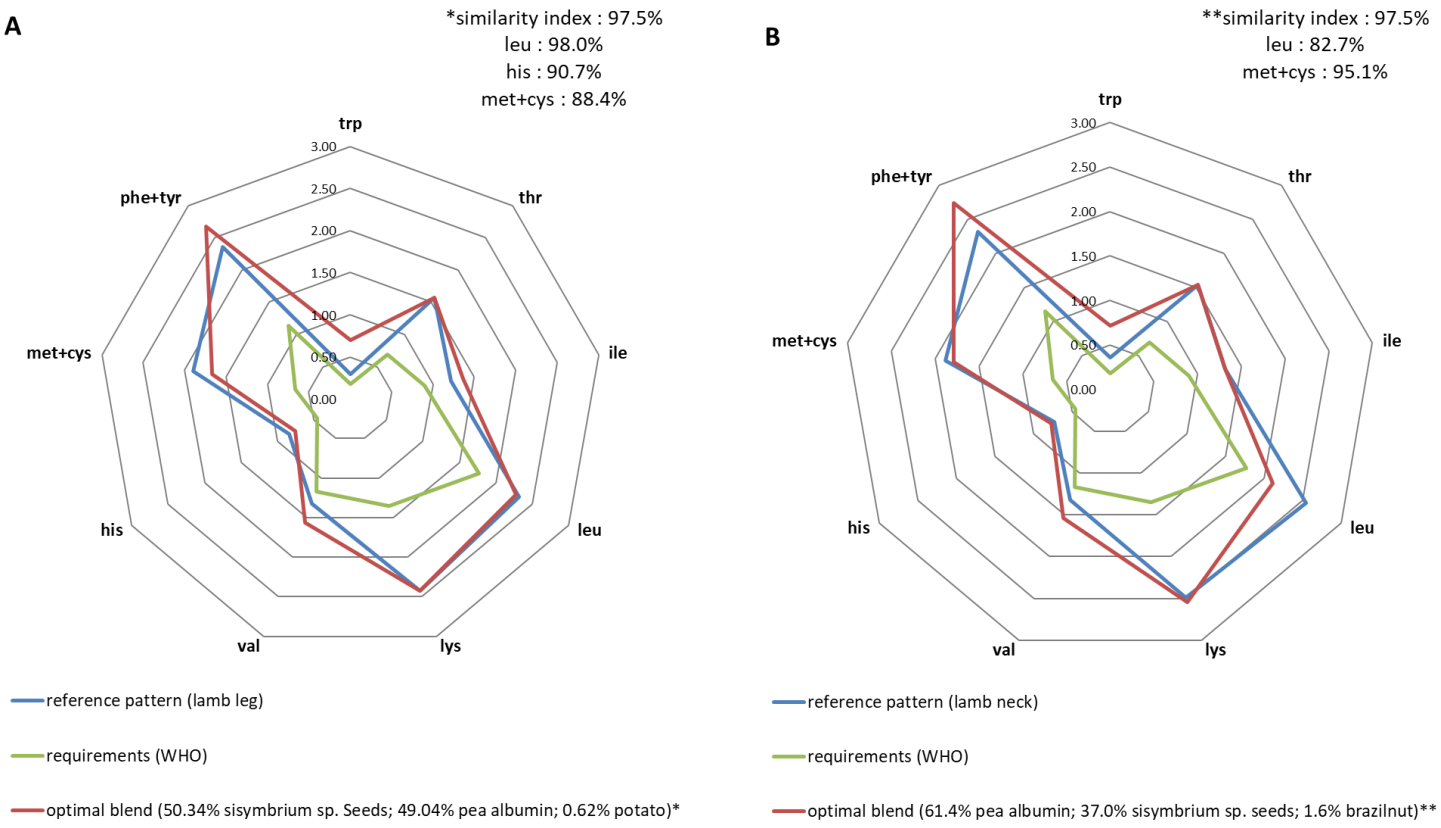
Protein ingredients	Breadfruit seeds	Pigeon peas	Macadamia nuts	watermelon seed kernels	Mung beans	Potato Protein Concentrate	Alfalfa Protein Concentrate	Spearmint	Mung beans	Navy beans	Corn Gluten Meal	Yardlong beans	Cowpeas catjang	Cowpeas common	Pinto beans
Data source	USDA 12001	USDA 16101	USDA 12131	USDA 12174	USDA 16080	Personal Data	Personal Data	USDA 02066"	USDA 16083	USDA 16037	Personal Data	USDA 16133	USDA 16060	USDA 16062	USDA 16042
Tryptophan	1.47	0.98	0.70	1.23	1.12	1.54	2.05	1.82	1.07	1.27	0.52	1.24	1.24	1.24	1.27
Threonine	4.59	3.54	3.84	3.50	3.38	5.81	4.93	4.85	3.57	3.65	3.20	3.84	3.84	3.84	4.34
Isoleucine	5.28	3.62	3.26	4.22	4.36	5.27	5.34	4.85	5.25	4.89	3.83	4.10	4.10	4.10	4.67
Leucine	6.71	7.15	6.25	6.76	7.99	9.65	9.65	8.89	8.52	8.84	15.35	7.73	7.73	7.73	8.35
Lysine	6.79	7.02	0.19	2.79	7.20	7.49	6.37	5.10	6.83	6.57	1.63	6.82	6.83	6.82	7.27
Methionine	1.14	1.12	0.24	2.62	1.24	2.17	2.05	1.67	1.50	1.40	2.22	1.43	1.44	1.44	1.39
Cystine	1.38	1.15	0.06	1.38	0.91	1.33	1.03	1.31	0.95	0.96	1.86	1.12	1.11	1.12	1.00
Phenylalanine	9.50	8.58	6.90	6.39	6.24	6.24	6.16	6.04	6.01	5.94	5.91	5.89	5.89	5.89	5.87
Tyrosine	6.48	2.48	5.31	3.19	3.09	5.41	4.52	3.56	3.20	2.48	4.63	3.26	3.26	3.26	2.29
Valine	6.38	4.32	3.77	4.89	5.35	6.31	6.37	5.91	5.78	6.37	4.34	4.81	4.81	4.81	5.35
Arginine	5.89	6.00	14.56	15.40	7.23	4.87	6.37	5.45	6.70	5.23	3.01	6.99	6.99	6.99	5.87
Histidine	2.47	3.57	2.02	2.44	3.01	2.16	2.46	2.37	2.88	2.60	2.15	3.13	3.13	3.13	2.98
Alanine	4.00	4.49	4.03	4.69	4.54	4.89	6.37	6.15	4.39	4.66	8.12	4.60	4.60	4.60	4.67
Aspartate	9.74	9.90	11.41	8.69	11.92	12.09	10.27	13.98	12.03	13.33	5.52	12.18	12.18	12.18	12.16
Glutamate	12.35	23.22	23.54	17.92	18.45	10.28	11.50	12.90	16.84	15.90	20.71	19.11	19.11	19.10	16.23
Glycine	5.54	3.70	4.71	5.23	4.13	4.68	5.54	5.68	4.30	4.11	2.68	4.16	4.17	4.16	4.27
Proline	4.40	4.41	4.86	3.93	4.74	4.67	4.72	4.85	4.76	5.73	9.48	4.54	4.53	4.53	5.75
Serine	5.91	4.74	4.35	4.74	5.09	5.15	4.31	4.62	5.42	6.06	4.84	5.05	5.05	5.05	6.28
Total AA (g)	100	100	100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



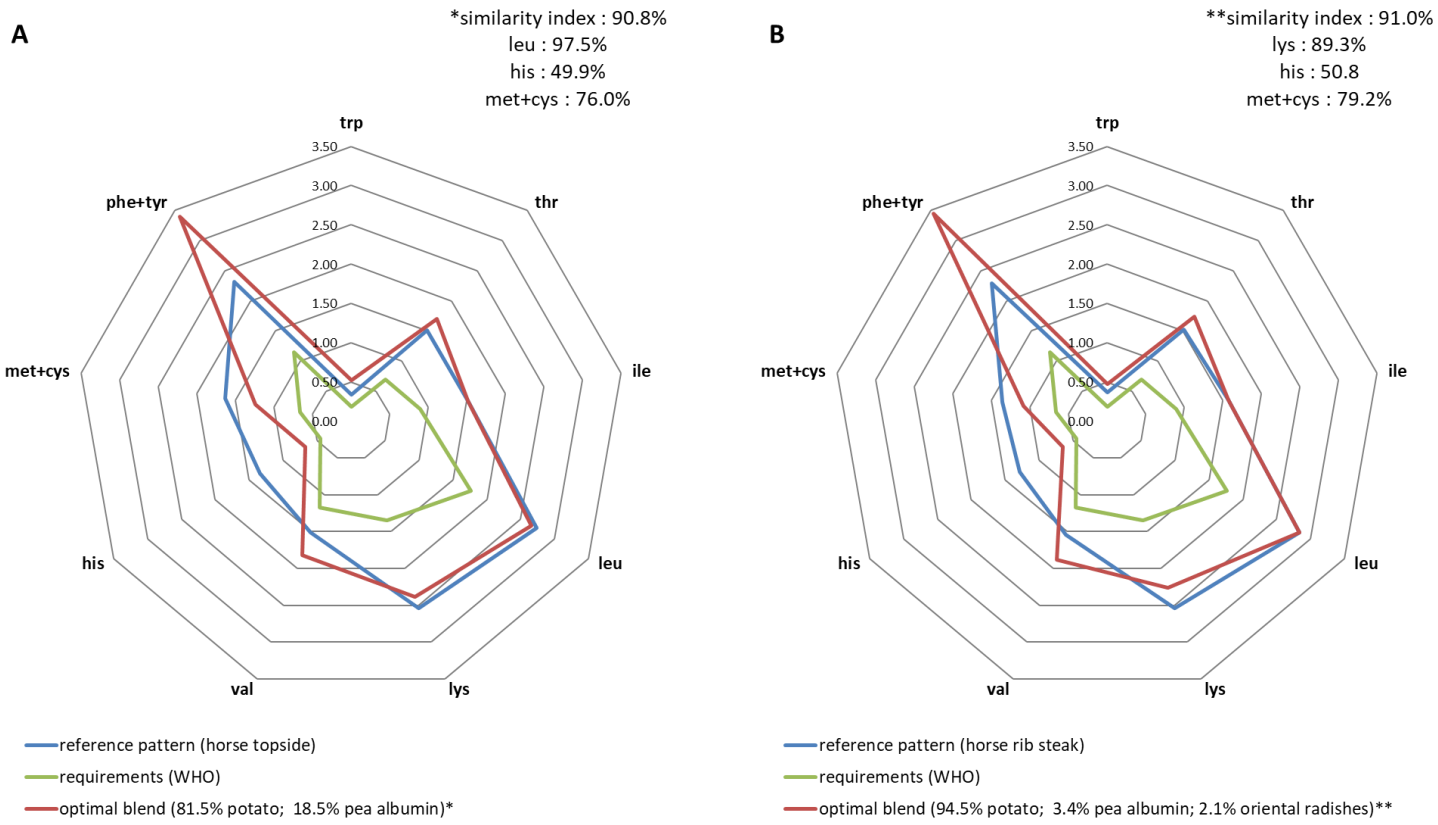
Supplementary Figure 3. IAA profiles (g/30g) of plant blends that best replicate the IAA profiles of beef short ribs (panel A) and beef sirloin steak (panel B).



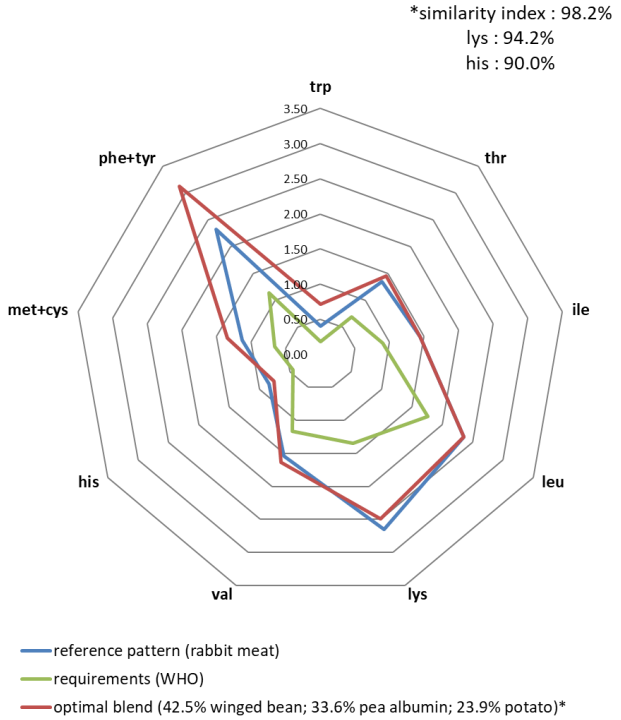
Supplementary Figure 4. IAA profiles (g/30g) of plant blends that best replicate the IAA profiles of veal shoulder (panel A) and veal chop (panel B).



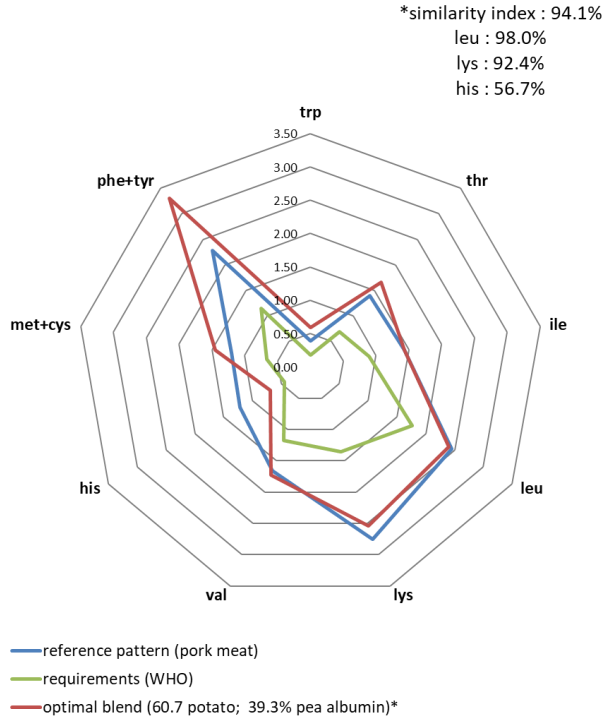
Supplementary Figure 5. IAA profiles (g/30g) of plant blends that best replicate the IAA profiles of lamb leg (panel A) and lamb neck (panel B).



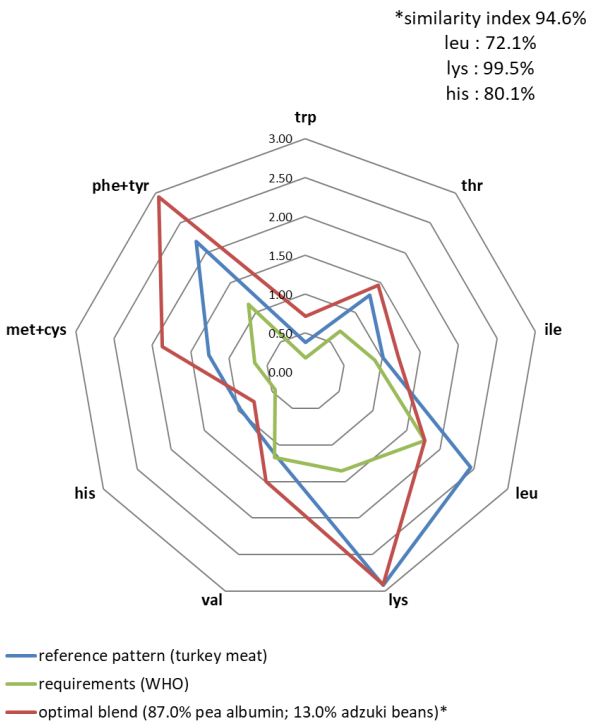
Supplementary Figure 6. IAA profiles (g/30g) of plant blends that best replicate the IAA profiles of horse topside (panel A) and horse rib steak (panel B).



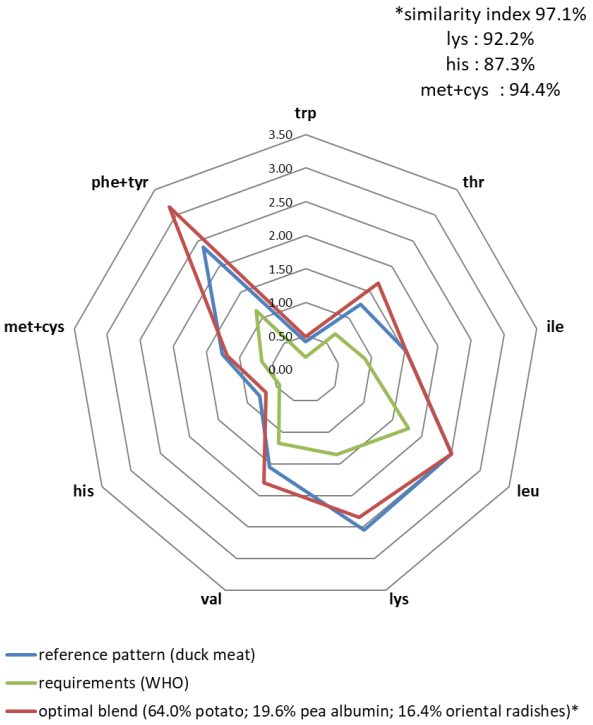
Supplementary Figure 7. IAA profiles (g/30g) of plant blends that best replicate the IAA profile of rabbit.



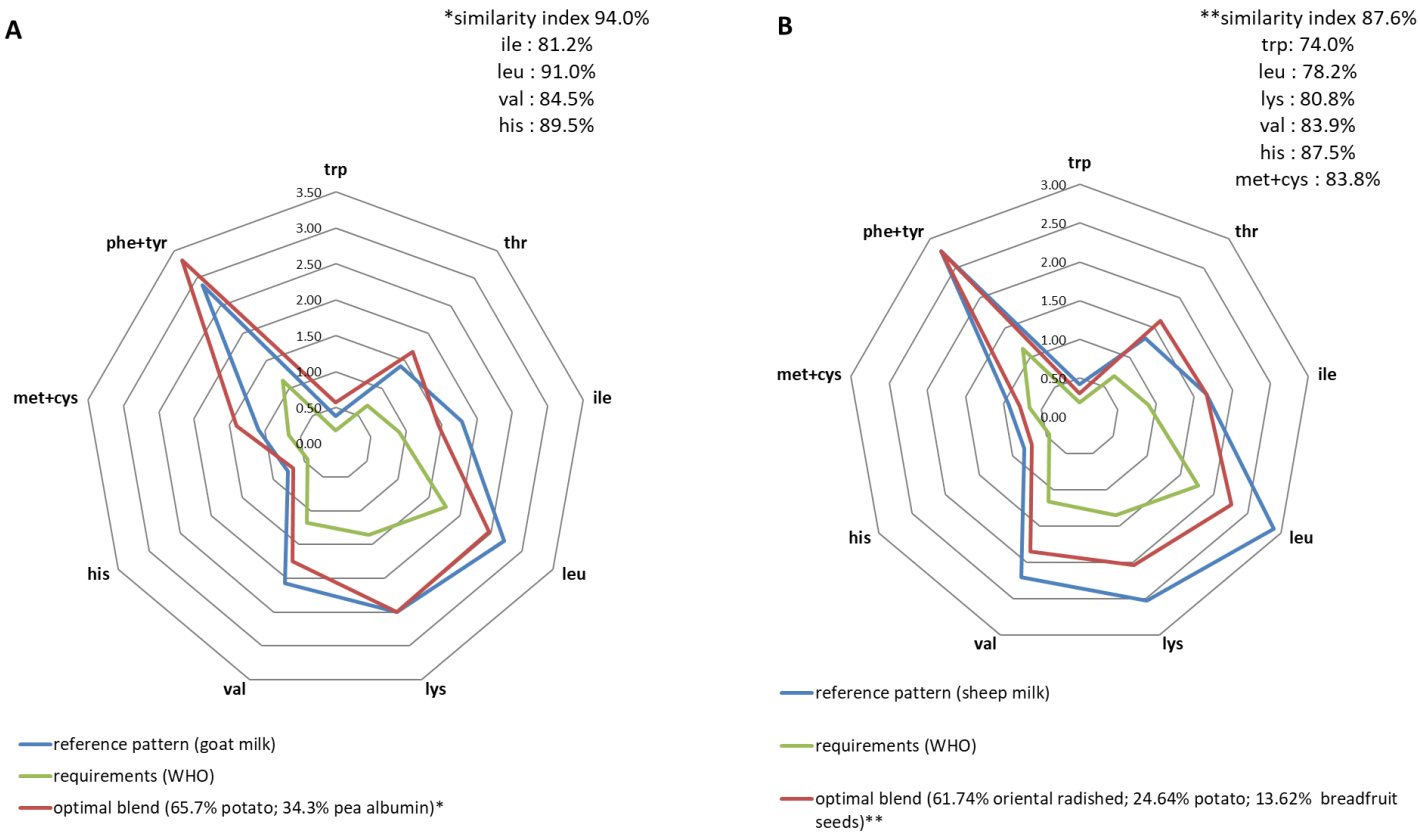
Supplementary Figure 8. IAA profiles (g/30g) of plant blends that best replicate the IAA profile of pork.



Supplementary Figure 9. IAA profiles (g/30g) of plant blends that best replicate the IAA profile of turkey.

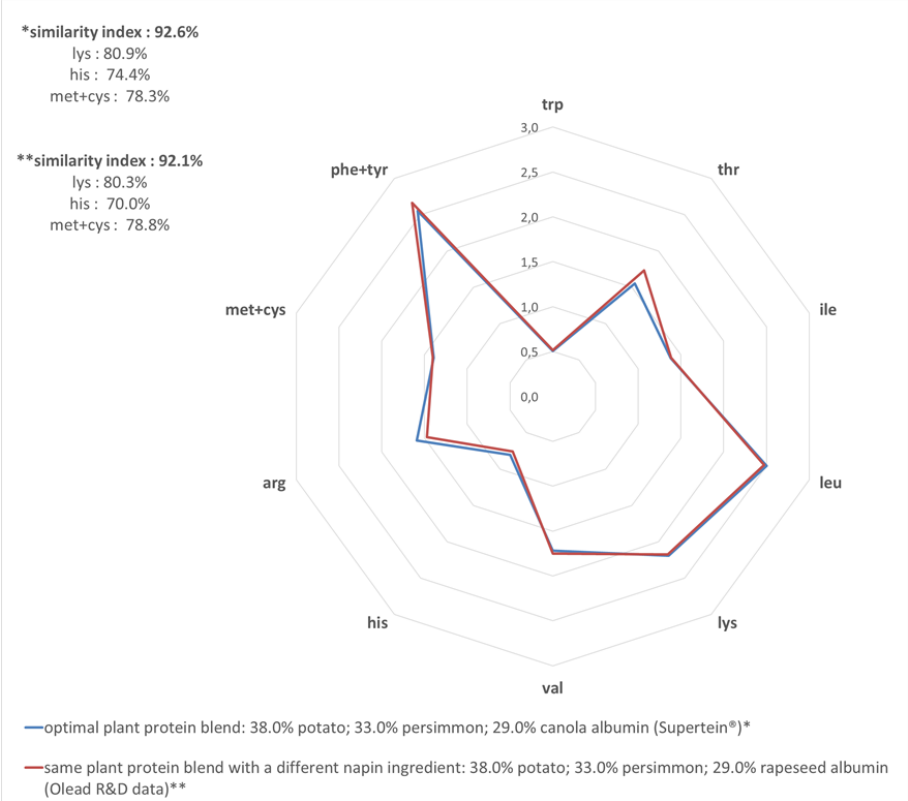


Supplementary Figure 10. IAA profiles (g/30g) of plant blends that best replicate the IAA profile of duck.



Supplementary

Figure 11. IAA profiles (g/30g) of plant blends that best replicate the IAA profile of total goat milk (panel A) and total sheep milk (panel B).



Supplementary Figure 12. variability of IAA profiles according to the origin of the rapeseed/ canola albumin fraction.

Supplementary Table 4. Active constraints during optimization that rendered the problems unworkable and led to unmet non-active constraints. Active constraints needed to be relaxed and any violation of the constraints was minimized by optimization.

Target AA profile	Active constraints*	Unmet constraints
‘animal’: beef short ribs	his, leu	his, leu
‘animal’: beef sirloin steak	lys, leu	leu, his
‘animal’: veal shoulder	ile, cys+met	leu, his, cys+met
‘animal’: veal chop	ile, met+cys	leu, his, cys+met
‘animal’: lamb leg	thr, met+cys	leu, his, cys+met
‘animal’: lamb neck	thr, leu, met+cys	cys+met
‘animal’: horse topside	his	leu, lys, met+cys, his
‘animal’: horse rib steak	lys, leu	his, met+cys, lys
‘animal’: rabbit	leu, lys	His, lys
‘animal’: pork	his	leu, lys, his
‘animal’: chicken	lys, ile	trp, leu, his, met+cys, lys
‘animal’: turkey	lys, his	leu, lys, his
‘animal’: duck	ile, lys	his, met+cys, lys
‘animal’: egg white	ile, met+cys	val, ile
‘animal’: breast milk	met+cys, ile	Vvl, ile
‘animal’: cow milk	his, leu, lys	his
‘animal’: whey	leu, lys	trp, met+cys, leu, lys
‘animal’: casein	leu, lys	his, leu
‘animal’: goat milk	ile	leu, val, his, ile
‘animal’: sheep milk	ile, lys	trp, leu, val, his, met+cys, lys

*** By definition, the weight of the blend is always an active constraint.**

Supplementary Table 5. amino acid composition (g/30g) of animal products and the plant blends that best mimicked their composition.

	Amino acid content (g / 30g protein)																	
	trp	**thr**	**ile**	**leu**	**lys**	**met**	**cys**	**phe**	**tyr**	**val**	arg	**his**	ala	asp	glu	gly	pro	ser
1: Beef short ribs AA profile	0.28	1.55	1.30	2.48	2.71	1.27	0.51	1.34	1.07	1.37	1.90	1.08	1.73	2.81	4.92	1.34	1.12	1.20
Optimal plant blend replicating 1	0.69	1.56	1.30	**2.03**[1]	2.71	0.54	1.24	1.71	1.29	1.58	1.53	**0.75**	2.18	3.36	2.97	1.74	1.82	1.01
2: Beef sirloin steak AA profile	0.42	1.40	1.41	2.55	2.55	1.06	0.45	1.29	1.04	1.45	1.93	0.89	1.81	2.61	4.83	1.73	1.35	1.21
Optimal plant blend replicating 2	0.61	1.63	1.41	**2.35**	2.55	0.57	0.93	1.78	1.42	1.69	1.50	**0.71**	1.94	3.50	2.94	1.63	1.65	1.20
3: veal shoulder AA profile	0.32	1.41	1.35	2.42	2.41	1.10	0.71	1.31	1.11	1.40	1.94	0.90	1.90	2.74	4.79	1.70	1.34	1.16
Optimal plant blend replicating 3	0.69	1.54	1.35	**2.27**	2.41	**0.61**	**1.08**	1.51	1.08	1.56	1.70	**0.78**	2.01	3.30	3.60	1.74	1.81	0.98
4: veal chop AA profile	0.34	1.50	1.33	2.39	2.46	1.29	0.71	1.33	1.07	1.37	2.00	0.87	1.75	2.78	4.89	1.52	1.21	1.20
Optimal plant blend replicating 4	0.69	1.53	1.33	**2.21**	2.46	**0.60**	**1.14**	1.52	1.08	1.55	1.68	**0.78**	2.05	3.26	3.58	1.74	1.84	0.97

5: lamb leg AA profile	0.30	1.56	1.21	2.32	2.43	1.23	0.66	1.35	1.01	1.32	1.99	0.84	1.93	2.84	4.82	1.73	1.22	1.23
Optimal plant blend replicating 5	0.70	1.56	1.36	**2.27**	2.43	0.60	1.08	1.55	1.12	1.57	**1.68**	0.76	2.06	3.43	3.35	1.76	1.75	0.98
6: lamb neck AA profile	0.35	1.54	1.31	2.55	2.49	1.11	0.78	1.27	1.04	1.32	2.09	0.73	1.87	2.77	4.11	2.06	1.40	1.22
Optimal plant blend replicating 6	0.71	1.54	1.31	**2.11**	2.55	0.59	1.20	1.59	1.14	1.54	1.67	0.76	2.17	3.40	3.20	1.79	1.79	0.94
7: horse topside AA profile	0.34	1.51	1.51	2.73	2.54	1.14	0.49	1.28	1.04	1.51	1.78	1.34	1.77	2.84	4.60	1.33	1.10	1.14
Optimal plant blend replicating 7	0.52	1.70	1.51	**2.66**	**2.38**	0.62	0.62	1.85	1.55	1.82	1.47	**0.67**	1.66	3.58	2.98	1.49	1.50	1.41
8: horse rib steak AA profile	0.37	1.52	1.57	2.83	2.54	0.96	0.40	1.28	1.02	1.54	1.83	1.29	1.73	2.74	4.61	1.44	1.20	1.14
Optimal plant blend replicating 8	0.47	1.73	1.57	2.83	**2.27**	**0.64**	**0.44**	1.85	1.59	1.88	1.48	**0.65**	1.50	3.60	3.16	1.42	1.41	1.51
9: pork meat AA profile	0.39	1.39	1.43	2.45	2.75	0.81	0.39	1.22	1.06	1.66	1.90	1.22	1.78	2.83	4.78	1.45	1.23	1.26
Optimal plant blend replicating 9	0.59	1.65	1.43	**2.40**	**2.54**	0.58	0.87	1.82	1.48	1.73	1.47	**0.69**	1.89	3.53	2.87	1.59	1.61	1.26
10: rabbit meat AA profile	0.40	1.35	1.44	2.36	2.65	0.76	0.38	1.24	1.08	1.54	1.87	0.85	1.83	2.96	4.85	1.64	1.48	1.34

Optimal plant blend replicating 10	0.71	1.45	1.44	2.36	**2.49**	0.47	0.88	1.67	1.46	1.63	1.69	**0.76**	1.67	3.42	3.38	1.48	1.84	1.20
11: chicken meat AA profile	0.37	1.35	1.69	2.40	2.71	0.88	0.41	1.27	1.08	1.58	1.92	0.99	1.74	2.85	4.78	1.57	1.31	1.10
Optimal plant blend replicating 11	**0.29**	1.63	1.69	**2.23**	**2.02**	**0.42**	**0.34**	1.41	0.93	1.82	2.13	**0.73**	1.27	2.88	6.57	1.26	1.13	1.26
12: turkey meat AA profile	0.38	1.29	1.02	2.46	2.92	0.93	0.33	1.14	1.05	1.13	2.01	0.96	1.92	2.83	4.81	1.51	1.91	1.40
Optimal plant blend replicating 12	0.72	1.46	1.21	**1.77**	**2.91**	0.45	1.43	1.73	1.21	1.49	1.56	**0.77**	2.44	3.42	2.86	1.80	1.86	0.91
13: duck meat AA profile	0.41	1.27	1.53	2.51	2.54	0.80	0.46	1.25	1.13	1.56	1.90	0.79	1.88	2.91	4.65	1.67	1.46	1.28
Optimal plant blend replicating 13	0.48	1.68	1.53	2.51	**2.35**	0.57	0.62	1.75	1.41	1.80	1.60	**0.69**	1.64	3.42	3.69	1.47	1.44	1.34
14: egg white AA profile	0.32	1.15	1.69	2.59	2.06	1.02	0.73	1.75	1.17	2.07	1.65	0.74	1.80	3.11	3.96	1.05	1.11	2.04
Optimal plant blend replicating 14	0.50	1.33	**1.24**	2.59	2.06	0.76	0.99	1.66	1.26	**1.53**	1.69	0.74	2.03	2.84	4.14	1.48	1.98	1.18
15: breast milk AA profile	0.52	1.40	1.70	2.89	2.07	0.64	0.58	1.40	1.61	1.91	1.31	0.70	1.09	2.49	5.11	0.79	2.49	1.31
Optimal plant blend	0.52	1.64	**1.52**	2.89	2.07	0.69	0.52	1.66	**1.35**	1.76	1.63	0.70	1.58	3.45	3.64	1.48	1.55	1.36

replicating 15																		
16: cow milk AA profile	0.36	1.20	1.45	2.66	2.35	0.73	0.18	1.46	1.42	1.84	0.80	0.85	0.95	2.40	6.32	0.56	2.77	1.69
Optimal plant blend replicating 16	0.46	1.22	1.45	2.66	2.35	0.35	0.55	1.74	1.25	1.88	1.83	**0.76**	1.41	3.62	4.02	1.39	1.64	1.42
17: cow acid whey AA profile	0.66	1.61	1.59	3.05	2.75	0.60	0.58	1.05	0.82	1.58	0.89	0.63	1.38	3.14	5.72	0.58	1.91	1.48
Optimal plant blend replicating 17	**0.45**	1.74	1.59	**2.86**	**2.23**	**0.64**	**0.40**	1.85	1.59	1.89	1.49	0.65	1.46	3.59	3.27	1.40	1.39	1.53
18: cow casein AA profile	0.39	1.23	1.53	2.88	2.37	0.75	0.21	1.38	1.44	1.86	0.99	0.78	0.93	2.19	6.30	0.54	2.79	1.44
Optimal plant blend replicating 18	0.42	1.28	1.53	**2.72**	2.37	0.34	0.62	1.88	1.32	2.10	1.69	**0.68**	1.31	3.76	3.45	1.53	1.58	1.43
19: goat milk AA profile	0.38	1.41	1.78	2.71	2.50	0.69	0.40	1.34	1.54	2.07	1.03	0.77	1.02	1.81	5.40	0.43	3.17	1.56
Optimal plant blend replicating 19	0.57	1.67	**1.45**	**2.46**	2.50	0.59	0.81	1.83	1.50	**1.75**	1.47	**0.69**	1.83	3.54	2.90	1.57	1.58	1.29
20: sheep milk AA profile	0.41	1.32	1.67	2.89	2.53	0.76	0.17	1.40	1.38	2.21	0.98	0.82	1.33	1.62	5.02	0.20	2.86	2.42
Optimal plant blend replicating 20	**0.31**	1.62	1.67	**2.26**	**2.04**	**0.44**	**0.35**	1.66	1.13	**1.85**	2.01	**0.72**	1.29	2.95	5.87	1.34	1.15	1.36