

Mapping the evidence of plant-based alternative foods: A systematic literature review protocol on nutritional, health, and environmental impacts

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List of Terms

ASF	Animal-sourced foods
HPRU	Health Protection Research Unit
NIHR	National Institute for Health Research
PBAF	Plant-based alternative foods
PB	Plant-based

1. Aim and objectives

The aim of this systematic review is to answer the primary research question: “What are the nutrient compositions, environmental footprints and health impacts of plant-based alternative foods (PBAF)?”

The study objectives are to map and synthesize the evidence of both peer-reviewed studies and grey literature assessing 1) population health, 2) nutrient composition and 3) environmental impacts of PBAF sold in high-income countries; to understand the context of the literature and identify the main gaps. Each category will be assessed under the following evidence:

Population Health

- Diet related chronic diseases and risks
- Prevalence of nutrient deficiencies
- All-cause and premature mortality rate and/or diet related morbidity

Nutrient Composition

- Nutrients associated with the highest burden of disease in high-income countries (e.g., saturated fat, sugar, and sodium)
- Common nutrients associated with micronutrient deficiencies when shifting from animal sourced foods (ASF) to inadequate plant-based (PB) diets (e.g., calcium, iodine, iron, and Vit B12)

Environmental footprints

- Differences in environmental categories (e.g., greenhouse gas emission, land use and water use) when shifting from ASF to PB foods

2. Protocol

2.1 Search strategy peer-reviewed studies

We will search on the following five literature databases with the search concepts presented in Table 1 – Table 5 for literature published between January 2016 and June 2022:

1. Medline (OVID) (Table 1)
2. Embase (OVID) (Table 2)
3. Global Health (OVID) (Table 3)
4. GreenFILE (Ebsco) (Table 4)
5. Web of Science Core Collection (Table 5)

Table 1: Search strategy for Medline (Ovid)

#	Query
1	((Alga* or Seaweed* or Insect* or Fungi* or "culture grown" or "lab grown" or cultivate* or "in vitro" or synthetic* or bioartificial or Frankenstein or artificial*) adj2 (food* or diet* or protein* or meat* or muscle* or burger*)).mp.
2	(Seitan* or "gluten based" or "wheat based" or Tofu* or tempeh* or Mycoprotein* or "Pea protein*" or "Bean protein*" or "pulse* protein*" or "Chickpea protein*" or "Rice protein*" or "Sunflower seed protein*" or "Coconut protein*" or "Rapeseed protein*").mp.
3	(Soy* adj2 (based* or food* or protein*)).mp.
4	((Meat or chicken or beef or lamb or pork or turkey or steak* or sausage* or Dairy or milk or cheese or yogurt or butter or cream or Egg* or Seafood or "Sea-food") adj2 (Alternative* or analog* or substitut* or replacement* or extender* or Emulsion*)).mp.
5	((Sustainab* or "Plant based" or Plantbased or "plant rich" or "plant food*" or "plant protein*" or "plant burger" or "plant sourced" or "vegetable sourced") adj2 (Food* or diet* or product* or ingredient* or protein* or substitut* or analog* or replacement* or meat* or milk* or vegan or vegetarian or flexitarian or pescatarian or extender* or beverage* or Emulsion*)).mp.
6	("novel food*" or "Alternative protein*" or "Alternative beverage*").mp.
7	("Non-dairy" adj2 (milk* or beverage*)).mp.
8	((("Dietary behaviour*" or "Dietary behavior*") adj6 (Alternative* or analog* or substitut* or replacement* or extender*)).mp.
9	exp grain proteins/ or exp plant proteins, dietary/
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11	((Nutrient* or Nutrition* or food* or micronutrient* or macronutrient*) adj2 (composition or value* or quality* or profile* or analysis or deficiency or availability)).mp.
12	((meat or "animal-sourced" or ultra-processed or UPF or dairy or chicken or beef or lamb or pork or turkey or steak* or sausage* or milk or cheese or yogurt or butter or cream or egg*) adj3 (reduc* or decreas* or free)).mp.
13	(health adj2 (impact* or effect* or deterioration* or improvement* or disease* or risk* or well-being* or wellbeing)).mp.
14	(BMI or "body mass index" or obesity or "over-weight" or overweight or "under-weight" or underweight or malnutrition or malnour*).mp.
15	(Anemia or anaemia or hypertension or "blood pressure" or BP or stroke or diabetes or "heart disease" or "cardio-vascular" or "kidney disease" or CKD or cancer or chronic* or "non-communicable disease*").mp.
16	((Protein* or Carbohydrate* or Fat or fats or fatty or Mineral* or Vitamin* or Iron or Iodine or Calcium or Zinc or Magnesium or "Dietary mineral*" or Flavonoid* or "ascorbic acid" or Carotenoid* or Phenolic* or Antioxidant*) adj2 (deficien* or shortage* or value* or profile* or quality or score* or availability)).mp.
17	exp Diet, Vegetarian/ or exp Nutritive Value/ or exp Food Analysis/
18	11 or 12 or 13 or 14 or 15 or 16 or 17
19	((climate* or environment*) adj4 (friendly or footprint or "foot-print" or impact* or damage* or greenhouse* or emission* or land* or water* or benefit* or implication* or carbon* or sustain* or nitrogen* or biodivers* or "CO2" or "O3" or ozone* or contamination*)).mp.
20	(Ecohealth or "Eco-health" or "Planetary health").mp.
21	Climate Change/ or Carbon Footprint/
22	19 or 20 or 21
23	18 or 22
24	10 and 23
25	24 not (Animals/ not (Animals/ and Humans/))
26	25 and 2016:2021.(sa_year).

Table 2: Search strategy for Embase (Ovid)

#	Query
1	((Alga* or Seaweed* or Insect* or Fungi* or "culture grown" or "lab grown" or cultivate* or "in vitro" or synthetic* or bioartificial or Frankenstein or artificial*) adj2 (food* or diet* or protein* or meat* or muscle* or burger*)).mp.
2	(Seitan* or "gluten based" or "wheat based" or Tofu* or tempeh* or Mycoprotein* or "Pea protein*" or "Bean protein*" or "pulse* protein*" or "Chickpea protein*" or "Rice protein*" or "Sunflower seed protein*" or "Coconut protein*" or "Rapeseed protein*").mp.
3	(Soy* adj2 (based* or food* or protein*)).mp.
4	((Meat or chicken or beef or lamb or pork or turkey or steak* or sausage* or Dairy or milk or cheese or yogurt or butter or cream or Egg* or Seafood or "Sea-food") adj2 (Alternative* or analog* or substitut* or replacement* or extender* or Emulsion*)).mp.
5	((Sustainab* or "Plant based" or Plantbased or "plant rich" or "plant food*" or "plant protein*" or "plant burger" or "plant sourced" or "vegetable sourced") adj2 (Food* or diet* or product* or ingredient* or protein* or substitut* or analog* or replacement* or meat* or milk* or vegan or vegetarian or flexitarian or pescatarian or extender* or beverage* or Emulsion*)).mp.
6	("novel food*" or "Alternative protein*" or "Alternative beverage*").mp.
7	("Non-dairy" adj2 (milk* or beverage*)).mp.
8	((("Dietary behaviour*" or "Dietary behavior*") adj6 (Alternative* or analog* or substitut* or replacement* or extender*)).mp.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	((Nutrient* or Nutrition* or food* or micronutrient* or macronutrient*) adj2 (composition or value* or quality* or profile* or analysis or deficiency or availability)).mp.
11	((meat or "animal-sourced" or ultra-processed or UPF or dairy or chicken or beef or lamb or pork or turkey or steak* or sausage* or milk or cheese or yogurt or butter or cream or egg*) adj3 (reduc* or decreas* or free)).mp.
12	(health adj2 (impact* or effect* or deterioration* or improvement* or disease* or risk* or well-being* or wellbeing)).mp.
13	(BMI or "body mass index" or obesity or "over-weight" or overweight or "under-weight" or underweight or malnutrition or malnour*).mp.
14	(Anemia or anaemia or hypertension or "blood pressure" or BP or stroke or diabetes or "heart disease" or "cardio-vascular" or "kidney disease" or CKD or cancer or chronic* or "non-communicable disease*").mp.
15	((Protein* or Carbohydrate* or Fat or fats or fatty or Mineral* or Vitamin* or Iron or Iodine or Calcium or Zinc or Magnesium or "Dietary mineral*" or Flavonoid* or "ascorbic acid" or Carotenoid* or Phenolic* or Antioxidant*) adj2 (deficien* or shortage* or value* or profile* or quality or score* or availability)).mp.
16	exp Diet, Vegetarian/ or exp Nutritive Value/ or exp Food Analysis/
17	10 or 11 or 12 or 13 or 14 or 15 or 16
18	((climate* or environment*) adj4 (friendly or footprint or "foot-print" or impact* or damage* or greenhouse* or emission* or land* or water* or benefit* or implication* or carbon* or sustain* or nitrogen* or biodivers* or "CO2" or "O3" or ozone* or contamination*)).mp.
19	(Ecohealth or "Eco-health" or "Planetary health").mp.
20	Climate Change/ or Carbon Footprint/
21	18 or 19 or 20
22	17 or 21
23	9 and 22
24	23 not (Animals/ not (Animals/ and Humans/))
25	24 and 2016:2021.(sa_year).

Table 3: Search strategy for Global Health (Ovid)

#	Query
1	((Alga* or Seaweed* or Insect* or Fungi* or "culture grown" or "lab grown" or cultivate* or "in vitro" or synthetic* or bioartificial or Frankenstein or artificial*) adj2 (food* or diet* or protein* or meat* or muscle* or burger*)).mp.
2	(Seitan* or "gluten based" or "wheat based" or Tofu* or tempeh* or Mycoprotein* or "Pea protein*" or "Bean protein*" or "pulse* protein*" or "Chickpea protein*" or "Rice protein*" or "Sunflower seed protein*" or "Coconut protein*" or "Rapeseed protein*").mp.
3	(Soy* adj2 (based* or food* or protein*)).mp.
4	((Meat or chicken or beef or lamb or pork or turkey or steak* or sausage* or Dairy or milk or cheese or yogurt or butter or cream or Egg* or Seafood or "Sea-food") adj2 (Alternative* or analog* or substitut* or replacement* or extender* or Emulsion*)).mp.
5	((Sustainab* or "Plant based" or Plantbased or "plant rich" or "plant food*" or "plant protein*" or "plant burger" or "plant sourced" or "vegetable sourced") adj2 (Food* or diet* or product* or ingredient* or protein* or substitut* or analog* or replacement* or meat* or milk* or vegan or vegetarian or flexitarian or pescatarian or extender* or beverage* or Emulsion*)).mp.
6	("novel food*" or "Alternative protein*" or "Alternative beverage*").mp.
7	("Non-dairy" adj2 (milk* or beverage*)).mp.
8	((("Dietary behaviour*" or "Dietary behavior*") adj6 (Alternative* or analog* or substitut* or replacement* or extender*)).mp.
9	exp protein/
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11	((Nutrient* or Nutrition* or food* or micronutrient* or macronutrient*) adj2 (composition or value* or quality* or profile* or analysis or deficiency or availability)).mp.
12	((meat or "animal-sourced" or ultra-processed or UPF or dairy or chicken or beef or lamb or pork or turkey or steak* or sausage* or milk or cheese or yogurt or butter or cream or egg*) adj3 (reduc* or decreas* or free)).mp.
13	(health adj2 (impact* or effect* or deterioration* or improvement* or disease* or risk* or well-being* or wellbeing)).mp.
14	(BMI or "body mass index" or obesity or "over-weight" or overweight or "under-weight" or underweight or malnutrition or malnour*).mp.
15	(Anemia or anaemia or hypertension or "blood pressure" or BP or stroke or diabetes or "heart disease" or "cardio-vascular" or "kidney disease" or CKD or cancer or chronic* or "non-communicable disease*").mp.
16	((Protein* or Carbohydrate* or Fat or fats or fatty or Mineral* or Vitamin* or Iron or Iodine or Calcium or Zinc or Magnesium or "Dietary mineral*" or Flavonoid* or "ascorbic acid" or Carotenoid* or Phenolic* or Antioxidant*) adj2 (deficien* or shortage* or value* or profile* or quality or score* or availability)).mp.
17	exp Nutritive Value/ or exp Food Analysis/
18	11 or 12 or 13 or 14 or 15 or 16 or 17
19	((climate* or environment*) adj4 (friendly or footprint or "foot-print" or impact* or damage* or greenhouse* or emission* or land* or water* or benefit* or implication* or carbon* or sustain* or nitrogen* or biodivers* or "CO2" or "O3" or ozone* or contamination*)).mp.
20	(Ecohealth or "Eco-health" or "Planetary health").mp.
21	Climate Change/ or Carbon Footprint/
22	19 or 20 or 21
23	18 or 22
24	10 and 23
25	24 not (Animals/ not (Animals/ and Humans/))
26	25 and 2016:2021.(sa_year).

Table 4: Search strategy for GreenFILE (Ebsco)

#	Query
1	((Alga* OR Seaweed* OR Insect* OR Fungi* OR "culture grown" OR "lab grown" OR cultivate* OR "in vitro" OR synthetic* OR bioartificial OR Frankenstein OR artificial*) W2 (food* OR diet* OR protein* OR meat* OR muscle* OR burger*))
2	Seitan* or "gluten based" or "wheat based" or Tofu* or tempeh* or Mycoprotein* or "Pea protein*" or "Bean protein*" or "pulse* protein*" or "Chickpea protein*" or "Rice protein*" or "Sunflower seed protein*" or "Coconut protein*" or "Rapeseed protein*"
3	(Soy* W2 (based* OR food* OR protein*))
4	((Meat OR chicken OR beef OR lamb OR pork OR turkey OR steak* OR sausage* OR Dairy OR milk OR cheese OR yogurt OR butter OR cream OR Egg* OR Seafood OR "Sea-food") W2 (Alternative* OR analog* OR substitut* OR replacement* OR extender* OR Emulsion*))
5	((Sustainab* or "Plant based" or Plantbased or "plant rich" or "plant food*" or "plant protein*" or "plant burger" or "plant sourced" or "vegetable sourced") W2 (Food* or diet* or product* or ingredient* or protein* or substitut* or analog* or replacement* or meat* or milk* or vegan or vegetarian or flexitarian or pescatarian or extender* or beverage* OR Emulsion*))
6	"novel food*" or "Alternative protein*" or "Alternative beverage*"
7	("Non-dairy" W2 (milk* or beverage*))
8	((("Dietary behaviour*" or "Dietary behavior*") W6 (Alternative* or analog* or substitut* or replacement* or extender*))
9	(DE "plant proteins" OR DE "proteins")
10	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9
11	((Nutrient* or Nutrition* or food* or micronutrient* or macronutrient*) W2 (composition or value* or quality* or profile* or analysis or deficiency or availability))
12	((meat or "animal- sourced" or ultra-processed or UPF or dairy or chicken or beef or lamb or pork or turkey or steak* or sausage* or milk or cheese or yogurt or butter or cream or egg*) W3 (reduc* or decreas* or free))
13	(health W2 (impact* or effect* or deterioration* or improvement* or disease* or risk* or well- being* or wellbeing))
14	(BMI or "body mass index" or obesity or "over-weight" or overweight or "under- weight" or underweight or malnutrition or malnour*)
15	(Anemia or anaemia or hypertension or "blood pressure" or BP or stroke or diabetes or "heart disease" or "cardio-vascular" or "kidney disease" or CKD or cancer or chronic* or "non- communicable disease*")
16	((Protein* or Carbohydrate* or Fat or fats or fatty or Mineral* or Vitamin* or Iron or Iodine or Calcium or Zinc or Magnesium or "Dietary mineral*" or Flavonoid* or "ascorbic acid" or Carotenoid* or Phenolic* or Antioxidant*) W2 (deficien* or shortage* or value* or profile* or quality or score* or availability))
17	(DE "veganism" OR DE "vegans" OR DE "Vegetarian foods") OR (DE "Plant-based diet")
18	S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17
19	((climate* or environment*) W4 (friendly or footprint or "foot print" or impact* or damage* or greenhouse* or emission* or land* or water* or benefit* or implication* or carbon* or sustain* or nitrogen* or biodivers* or "CO2" or "O3" or ozone* or contamination*))
20	(Ecohealth or "Eco- health" or "Planetary health")
21	(DE "Climate Change" OR DE "Ecological impact")
22	S19 OR S20 OR S21
23	S18 OR S22
24	S10 AND S23
25	S10 AND S23 Limiters - Publication Date: 20160101-20211231

Table 5: Search strategy for Web of Science Core Collection

#	Query
1	TS=(((Alga* or Seaweed* or Insect* or Fungi* or "culture grown" or "lab grown" or cultivate* or "in vitro" or synthetic* or bioartificial or Frankenstein or artificial*) near/2 (food* or diet* or protein* or meat* or muscle* or burger*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
2	TOPIC: ((Seitan* or "gluten based" or "wheat based" or Tofu* or tempeh* or Mycoprotein* or "Pea protein*" or "Bean protein*" or "pulse* protein*" or "Chickpea protein*" or "Rice protein*" or "Sunflower seed protein*" or "Coconut protein*" or "Rapeseed protein*")) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
3	TS=((Soy* near/2 (based* or food* or protein*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
4	TS=(((Meat or chicken or beef or lamb or pork or turkey or steak* or sausage* or Dairy or milk or cheese or yogurt or butter or cream or Egg* or Seafood or "Sea-food") near/2 (Alternative* or analog* or substitut* or replacement* or extender* or Emulsion*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
5	TS=(((Sustainab* or "Plant based" or Plantbased or "plant rich" or "plant food*" or "plant protein*" or "plant burger" or "plant sourced" or "vegetable sourced") near/2 (Food* or diet* or product* or ingredient* or protein* or substitut* or analog* or replacement* or meat* or milk* or vegan or vegetarian or flexitarian or pescatarian or extender* or beverage* or Emulsion*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
6	TOPIC: (("novel food*" or "Alternative protein*" or "Alternative beverage*")) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
7	TS=(("Non-dairy" near/2 (milk* or beverage* or emulsion*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
8	TOPIC: (((("Dietary behaviour*" or "Dietary behavior*") near/6 (Alternative* or analog* or substitut* or replacement* or extender*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
9	#8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1 <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
10	TS=(((Nutrient* or Nutrition* or food* or micronutrient* or macronutrient*) near/2 (composition or value* or quality* or profile* or analysis or deficiency or availability))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
11	TS=(((meat or "animal-sourced" or ultra-processed or UPF or dairy or chicken or beef or lamb or pork or turkey or steak* or sausage* or milk or cheese or yogurt or butter or cream or egg*) near/3 (reduc* or decreas* or free))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
12	TS=((health) near/2 (impact* or effect* or deterioration* or improvement* or disease* or risk* or well-being* or wellbeing)) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
13	TOPIC: ((BMI or "body mass index" or obesity or "over-weight" or overweight or "under-weight" or underweight or malnutrition or malnour*)) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
14	TS=((Anemia or anaemia or hypertension or "blood pressure" or BP or stroke or diabetes or "heart disease" or "cardio-vascular" or "kidney disease" or CKD or cancer or chronic* or "non-communicable disease*")) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
15	TS=(((Protein* or Carbohydrate* or Fat or fats or fatty or Mineral* or Vitamin* or Iron or Iodine or Calcium or Zinc or Magnesium or "Dietary mineral*" or Flavonoid* or "ascorbic acid" or Carotenoid* or Phenolic* or Antioxidant*) near/2 (deficien* or shortage* or value* or profile* or quality or score* or availability))

	<i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
16	#15 OR #14 OR #13 OR #12 OR #11 OR #10 <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
17	TS=(((climate* or environment*) near/4 (friendly or footprint or "foot-print" or impact* or damage* or greenhouse* or emission* or land* or water* or benefit* or implication* or carbon* or sustain* or nitrogen* or biodivers* or "CO2" or "O3" or ozone* or contamination*))) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
18	TOPIC: ((Ecohealth or "Eco-health" or "Planetary health" or "climate change")) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
19	#18 OR #17 <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
20	#19 OR #16 <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
21	#20 AND #9 <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>
22	#20 AND #9 Refined by: PUBLICATION YEARS: (2021 OR 2020 OR 2019 OR 2018 OR 2017 OR 2016) <i>Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan=All years</i>

2.2 Search strategy grey literature

Inclusion of grey literature in systematic evidence synthesis becomes increasingly important because it contains relevant information on trends, market growth and share, and health and environmental data not necessarily found in academic literature, particularly in this field. However, due to the vast amount of literature online, it becomes increasingly challenging to synthesize this manually.

To reduce the risk of publication bias and to take into consideration any research outside the peer-reviewed evidence it is recommended to systematically search on specialist online catalogues of grey literature like Open Grey and the Environment Agency Grey Literature; and other databases and institutional websites depending on the context of the field (Haddaway et. al., 2015). However, as this field is rather novel, most of these catalogues do not have relevant information.

Therefore, we will systematically hand-search on search engines as follows:

- Google search: top brands of PBAF (Table 6)
- Clinical Trials search (Table 7)

We will also explore the development of a novel (pre-) trained supervised machine learning algorithm to help us identify other relevant grey literature sources.

Table 6: Search strategy for manual searches on Google

#	Query
1	<i>Top plant-based food companies UK (3 top links)</i>

Table 7: Search strategy for ClinicalTrials.gov

#	Query
1	"plant-based" OR "plant based" OR "meat alternatives" OR "Dairy alternatives" OR "plant-based diet" OR "vegan diet" OR "vegetarian diet" OR "novel food" OR "Alternative protein" OR "meat analogue" OR "Meat analog"

2.3 Inclusion and exclusion criteria

We will include peer-reviewed papers and grey literature following the inclusion and exclusion criteria from Table 8 that cover any PBAF associated with nutrient, health and/or environmental data. We will assess the literature in all languages (that include an abstract in English) but limiting the search to high-income countries.

Table 8: Inclusion and exclusion criteria for peer-reviewed papers and grey literature

	Selection criteria
Inclusion	<ul style="list-style-type: none"> • Contains data on PBAF on at least one of the following in high-income countries: nutrient composition, environmental footprints, environmental and health impacts • Any population • Published in the last 5 years
Exclusion	<ul style="list-style-type: none"> • Does not mention nutrient composition, environmental footprints, and/or environmental and health impacts of alternative foods • Review articles with no original results presented • Plant-based creamer, cream, pate, buttermilk and butter • Studies using PBAF data from food composition tables • In-vitro studies and animal studies • Single ingredients such as insect flour, plant-based protein isolate, plant-based flours, plant-based protein hydrolysed without a specified PBAF product • PBAF used as single ingredients (e.g., cultured fat, flavouring ingredients) • Unclear data units • Minimally processed plant-based whole foods (nuts & seeds, legumes, grains etc.) and other traditional plant-based products (e.g., tofu, tempeh and seitan) • Infant formula • PBAF in diets or composite dishes/meals* • Modelling studies that do not include data on PBAF • Experiment studies
*For health studies composite dishes/meals were included only if PBAF product were specifically measured without the inclusion of other minimally processed plant-based whole foods and/or other traditional plant-based products	

3 Quality assessment and risk of bias

We will assess study quality and potential bias after full-text screening. We will perform a critical appraisal of the reporting in each included study considering the quality criteria described in Table 8. Studies will not be ranked as high or low quality. However, if data and units are unclear, we will contact authors for clarification. If authors do not respond, studies will be excluded from further analysis. The quality assessment will be completed by the first reviewer and a second reviewer(s) will independently assess 10-20% of the full texts included in the analysis.

4 Data management and extraction

We will create a library with all search results using a citation manager (EndNote), comprising identified studies after the initial search of peer-reviewed and grey literature. We will automatically remove duplicates by using EndNote, as well as by manual screening of titles, authors and years. Titles will be screened by three reviewers (100% SNE; and 10% each by two reviewers). For abstract screening, we will perform a manual screening by one (human) screener (SNE) alongside a supervised machine learning algorithm based on a priori inclusion criteria from Table 8. By using this approach, the computer algorithm learns to mimic decisions made by a human screener (Berrang-Ford, 2021 #475) i.e., it will select articles likely to be relevant, which will then be screened manually. This method will reduce 50% of the manual screening of the remaining abstracts and can also be used to screen new publications before publishing the systematic literature review. Full-text papers that meet the inclusion criteria described above will also be screened by two reviewers. When necessary, translators will be sought for the data extraction of papers in languages not spoken within the research team.

Data will be extracted independently for the three themes on Microsoft Excel. We will develop summary tables to describe study characteristics (e.g., year, type, country) and results from the articles depending on the variable outcome. One type of PBAF (e.g., PB drinks) will be selected to pilot the extraction.

5 Data synthesis

Data synthesis will be conducted by the first author (SNE) and reviewed by other contributors.

5.1 Evidence mapping

Given the nature of the three main themes, novelty and literature sources covered in this review, we do not anticipate to perform a meta-analysis, but we will aim to map the peer-reviewed and grey literature, and analyze and syntheses it on the evidence base as a whole. The direction of impact (positive or negative health/environmental impact/risk) of each of the papers by product type will be reported and where possible graphically displayed.

5.2 Data analysis

If there is enough qualitative data in the same 'outcome' and 'sub-outcome', we will explore the possibility of qualitative pooled analysis and develop data visualization (i.e., energy content of PB drinks in kcal/100ml). If not possible, a summary table alongside a descriptive analysis will be presented.

5.3 Outputs

This review will assess nutrient content, health, and environmental impacts of PBAF and their potential role towards more sustainable diets. Results of the analysis will map the evidence of novel PBAF and identify gaps in the literature and inform policy decision around sustainable dietary changes as potential solutions to help with climate change mitigation while reassuring population health. Expected outputs include comprehensive summary tables for each theme,

evidence mapping and synthesis (as a whole) on the role of PBAF for our health and the environment.

6 Data availability

No data are associated with this protocol.

7 References

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