

Flavour challenges in plant-based foods

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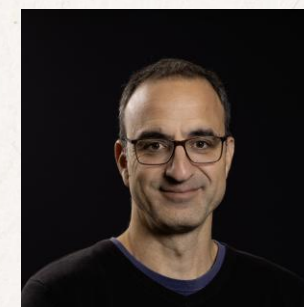


Flavour Group and Flavour Centre

Prof. Jane Parker

Dr Steve Elmore

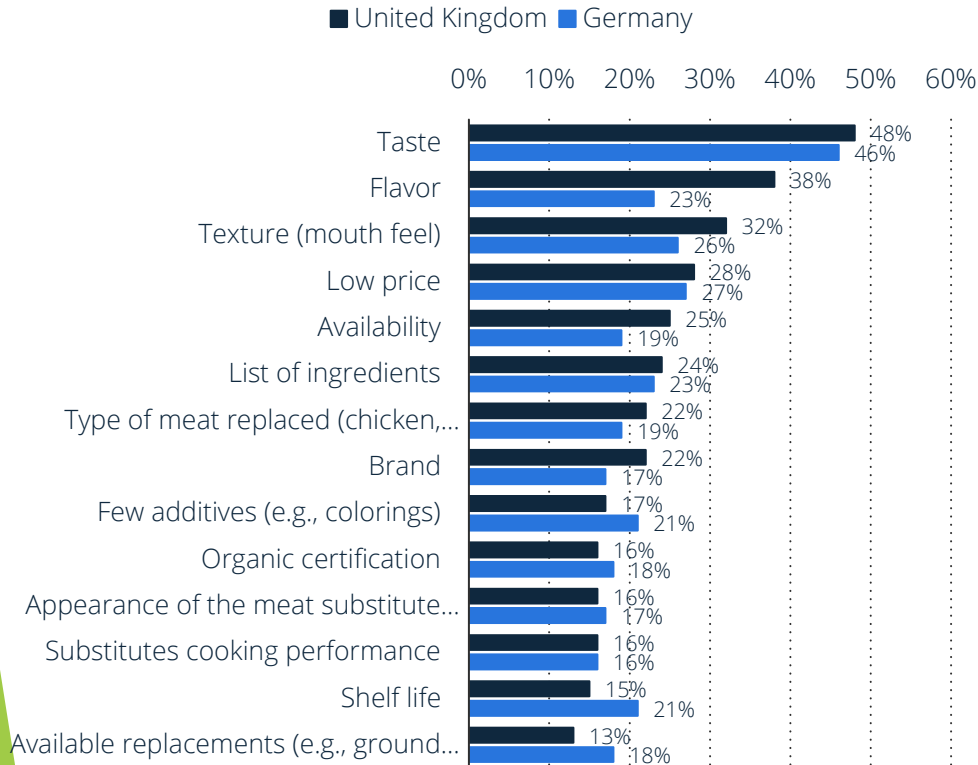
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Flavour challenges in plant-based foods

Importance of flavour

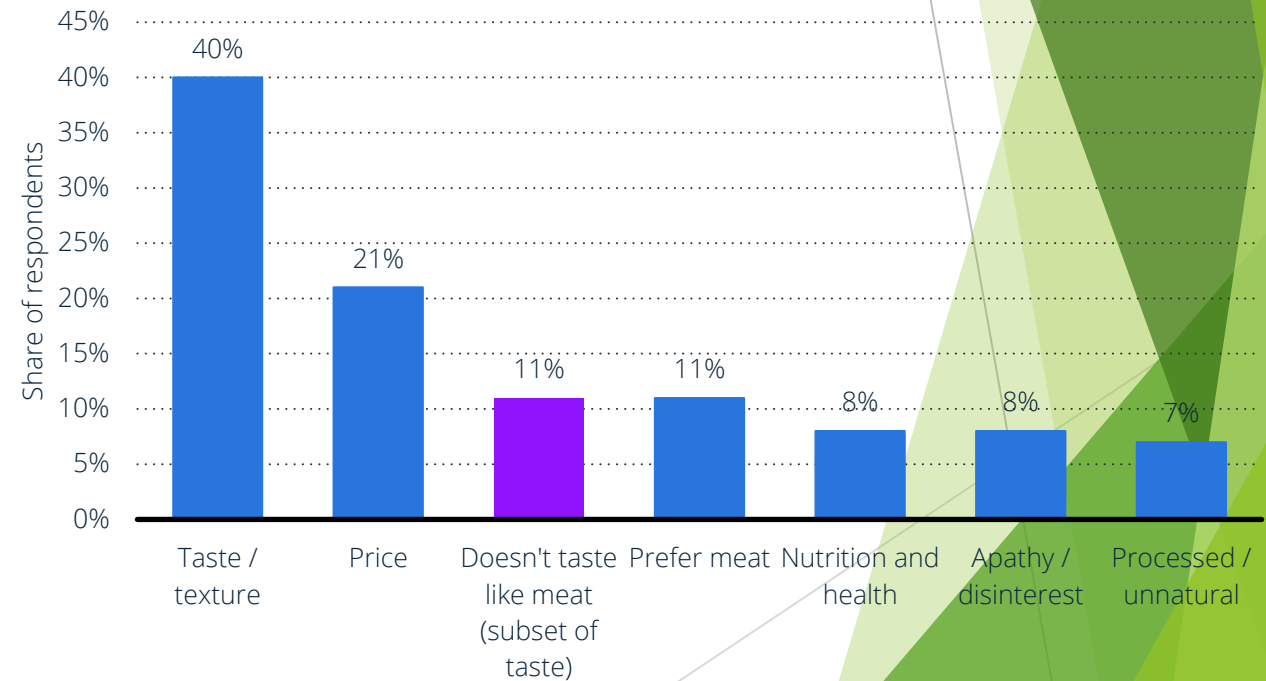
Purchase criteria for meat substitutes in Germany and the UK 2025



Note(s): Germany, United Kingdom; 17 June 2025 to 16 December 2025; 18-64 years; 8,730*; residential online population
Further information regarding this statistic can be found on [page 8](#).
Source(s): Statista; Statista Consumer Insights; ID 1660253



Plant-based meat consumers' reasons for reducing meat substitutes consumption in the United Kingdom (UK) in 2023



Note(s): United Kingdom; July 2023; 1,000 respondents; The participants were representative of the UK in terms of age groups, gender, and region, and were compensated for their participation.
Source(s): Bryant Research; Attest; ProVeg; ID 1482112

Flavour challenges in plant-based foods

- ▶ Aroma
 - ▶ Lack of authentic notes
 - ▶ Off-flavours
 - ▶ Low abundance of desirable aromas
- ▶ Taste
 - ▶ Lack of authentic taste (e.g. umami, richness)
 - ▶ Undesirable taste compounds
 - ▶ Low abundance of key tastants

Flavour challenges in plant-based foods

Off-flavours

▶ Off-flavours - Aroma

- ▶ Main precursor is fat/oil content of legumes
 - ▶ Lipid oxidation products
 - ▶ Grassy, beany (Hexanal, (Z)-3-hexenal, 2-pentylfuran, 2-(1-pentenyl)furan, 1-penten-3-one)
 - ▶ Aldol condensation products (aldehydes, e.g. (E)-2-Butyl-2-octenal)
 - ▶ Old soap, planty (Mayo et al. 2025)
 - ▶ Free Amino acids derived products - biosynthetic pathways
 - ▶ Green, earthy, bell pepper (3-alkyl-2-methoxypyrazines)

Flavour challenges in plant-based foods

Off-flavours

▶ Off-flavours - Taste

▶ Plant metabolites

▶ Saponins

▶ Bitter (e.g. pea, soy, biosynthetic pathways)

▶ Kaempferol glycosides

▶ Bitter, Astringent (rapeseed)

▶ peptides/amino acids

▶ Bitter

Flavour challenges in plant-based foods

Solutions - Control of off-notes

Masking

- ▶ Sauce/marinade/seasoning
- ▶ Evidence based masking
 - ▶ Suppress bitterness/astringency,
e.g. umami peptides suppress bitterness (Kim, Son et al. 2015)

Flavour challenges in plant-based foods

Solutions - Control of off-notes

Raw materials selection and handling

- ▶ Clean flavour
- ▶ Minimal off-notes
- ▶ Special breeds
- ▶ Redesign/optimisation of extraction of protein isolates?
 - ▶ Lipid free
 - ▶ Minimise lipid degradation
- ▶ Controlled storage (Nagassa, He et al. 2025)
 - ▶ Temperature (e.g. 4°C), low humidity/moisture, appropriate packaging type

Flavour challenges in plant-based foods

Solutions - Mitigation of off-notes

Fermentation/enzymatic treatment

▶ Aroma

- ▶ Reduce off-notes
 - ▶ Sequential fermentation (Kaur, Gray et al. 2026)
- ▶ Generate desirable precursors
 - ▶ Enzymatic treatment of protein to generate free amino acids
- ▶ Enhance desirable aromas

▶ Taste

- ▶ Reduce off-tastes
 - ▶ e.g. laccase (LAC) enzymatic treatment of rapeseed protein concentrate reduced bitterness/astringency (Spaccasassi, Walser et al. 2025)
- ▶ Generate desirable taste compounds
 - ▶ Enzymatic treatment of yeasts extracts to generate umami compounds (glutamate)

Flavour challenges in plant-based foods

Solutions - Application of desirable flavour

Hybrid products

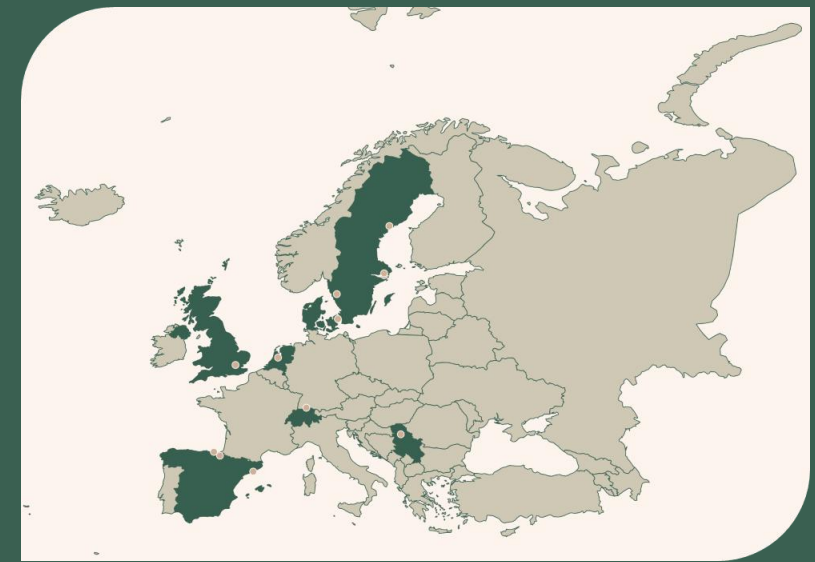
- ▶ Combine plant-based protein with mycoprotein



- **Funding Program:** Horizon Europe
- **Call:** HORIZON-CL6-2024-FARM2FORK-01
- **Duration:** 2025-2028
- **EC Funding:** € 4,618,367.50
- 7 countries
- 11 partners



PLANTOMYC



PIONEERING HYBRID PROTEIN SOLUTIONS



Project funded by



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic Affairs,
Education and Research EAER
State Secretariat for Education,
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Product prototypes

- By upcycling food waste and food by-products
- Key process(es): Fermentation
 - Solid State
 - Submerged

A hybrid meat analogue

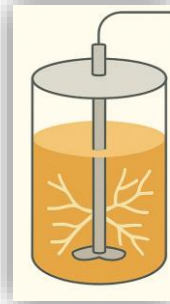
A whole cut meat analogue

A GABA rich beverage

A meaty savoury Bouillon



Pea protein by-product (rich in starch)



Fungal Submerged fermentation

Fermentation broth

Meat/savoury bouillon

GABA rich beverage



Mycelium Protein Biomass

extrusion

Hybrid texturized meat analogue



Pea protein Isolate



Brewers Spent Grains



Unused bread



Fungal Solid-State Fermentation



Whole cut meat analogue

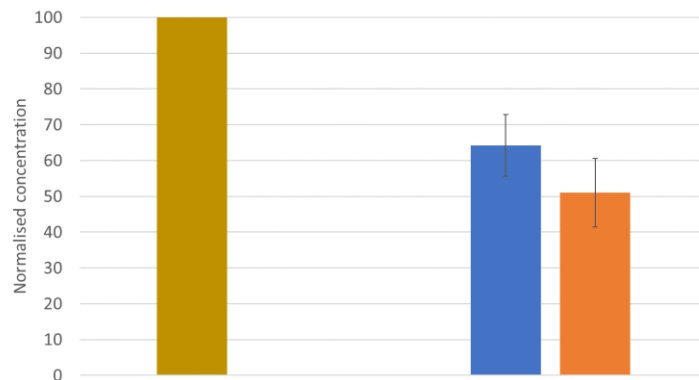
Flavour challenges in plant-based foods

Solutions - Application of desirable flavour

Apply flavouring in the matrix

Aroma

- ▶ Added herbs/spices
- ▶ Top notes/process flavours
- ▶ Consider binding to the matrix



Taste

- ▶ Added herbs/spices
- ▶ Taste enhancers
- ▶ Yeast extracts (umami)

Flavour challenges in plant-based foods

Solutions - Application of desirable flavour

Generate flavour in the matrix

- ▶ Generate precursors
 - ▶ Fermented/Enzymatically treated matrix
- ▶ Add precursors (sugars, amino acids, lipids, iron/myoglobin/leghaemoglobin)
 - ▶ E.g. ribose+cysteine are precursors of meaty compounds
 - ▶ Lipids control species aroma in meat
 - ▶ Iron modifies oxidation of lipids
- ▶ Use of emulsions/oleogels to optimise flavour (Yiltirak et al. 2026)
 - ▶ Modify meat species character
 - ▶ More effective than in aqueous solutions- cost reduction due to efficient flavour generation from emulsions
 - ▶ Positive effect in flavour perception

Flavour challenges in plant-based foods

Solutions - Formation of desirable flavour

Controlled processing

Fermentation

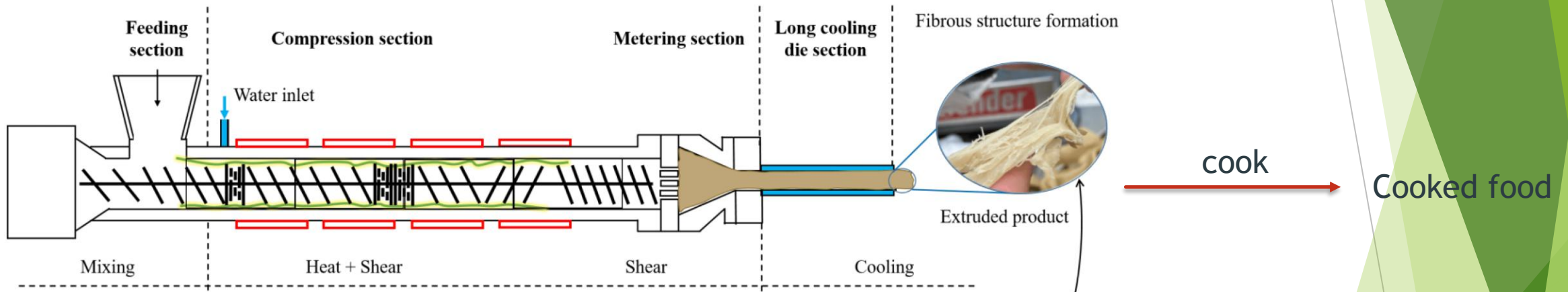
- ▶ Enhance desirable aromas
(Boukid, Hassoun et al. 2023)

Extrusion

- ▶ Off-flavours reduction
- ▶ Thermal generation intermediates
 - ▶ Final flavour profile formed after final cooking process
- ▶ Thermal generation of flavour

Flavour challenges in plant-based foods

Solutions - Formation of desirable flavour



Precursors of flavour
sugars
amino acids
lipid

Intermediates of flavour

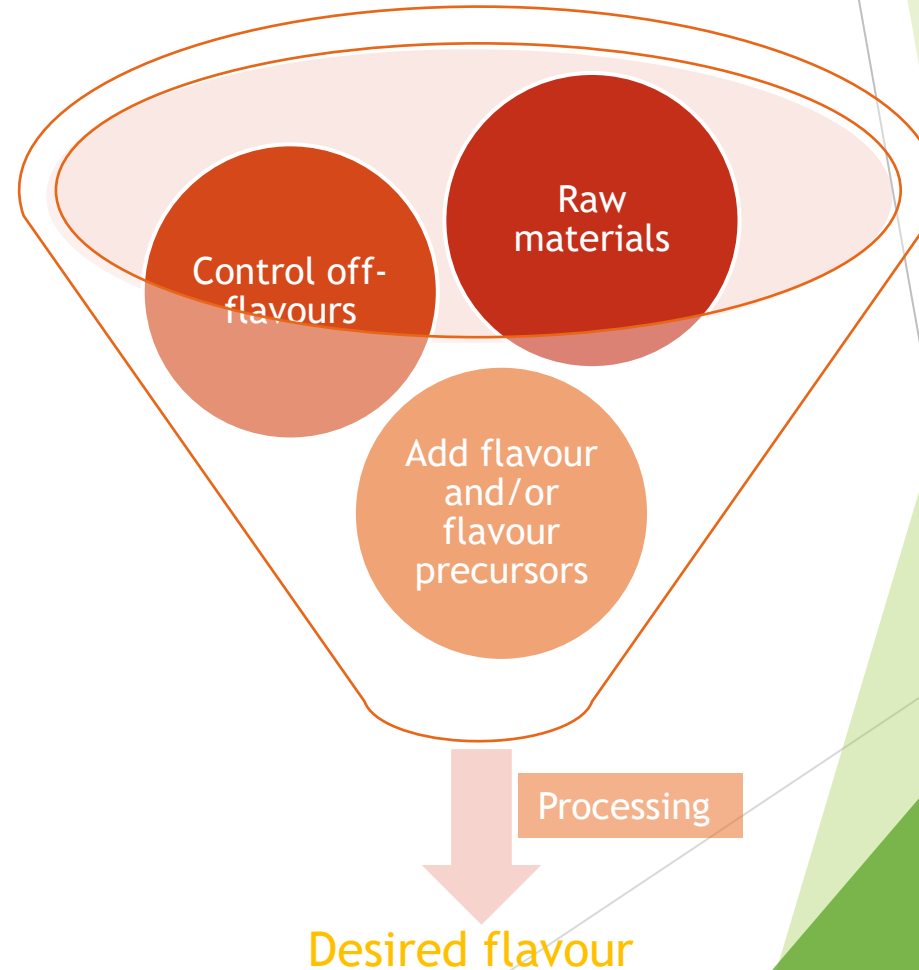
Intermediates of flavour
or
Flavour
or
Application of
precursors

Flavour

Flavour challenges in plant-based foods

Several approaches should be employed in parallel

- ▶ Raw materials manufacturing and handling
 - ▶ Avoid/reduce off-notes
- ▶ Fermentation/precision fermentation
 - ▶ Reduce off-notes
 - ▶ Generate desirable precursors
 - ▶ Enhance desirable aromas
- ▶ Added flavourings: top notes/process flavours
- ▶ Added precursors
 - ▶ To generate flavour after thermal processing
 - ▶ Emulsions could optimise/control flavour formation
- ▶ Controlled processing
 - ▶ Reduce off-flavours
 - ▶ Optimise generation of desired compounds



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Thank you

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