The Future for Satiety Enhancing Foods
Latest R&D driving innovation in new product development

Protein and snacking, Professor Alexandra Johnstone

• Snacking science
• Consumer demand

• Do we eat enough protein?
• Protein distribution and snackification – not just what we eat, but when we eat that is important
• Ageing and snacking

• Protein quality – types of protein - we eat food not nutrients
• Future perspectives for protein as a functional snack food

COI: Funding from UKRI, CSO, EU Framework, acts as a consultant for food sector
Q- What is a snack - no universal definition of a ‘snack’, either by time of day (e.g. inter-meal interval) or size (‘small meal’) or nutrient profile (food group) or structure (e.g. solid/liquid)...

Snacking science - Snacking and body weight control

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There are two alternative hypotheses about how snacking may influence EI and body weight:
• snacking helps ‘fine tune’ meal-time EIs to match intake with requirements (thus - snacking beneficial for weight control)
• habitual consumption of calorific drinks and snacks between meals is a major factor driving energy intake up and predisposing people to weight gain (thus - not beneficial for weight control)

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Findings from recent research support the notion that a high-protein snack has the highest satiety compared with snacks high in other nutrients.

Protein power!

Protein content and sources of protein in foods have gained a lot of attention during recent years both from health and sustainability points of view.

High protein diets are increasingly recommended for weight management, muscle loss occurring with ageing, blood-sugar and high-blood pressure control, as well as for combatting obesity and ageing.

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As a consequence, alternative protein sources, products naturally high in protein, foods and beverages with added protein, and protein supplements are among the fastest-growing categories targeting sustainable and health-focused consumers.

Consumer demand – what do consumers want?

Listed foods as the ones respondents would like to buy and consume, if they contained increased protein intake.

<table>
<thead>
<tr>
<th>a) protein enrichment from plant origin</th>
<th>b) protein enrichment from animal origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread</td>
<td>Yogurts</td>
</tr>
<tr>
<td>Legumes, soy, beans, lentils</td>
<td>Meat and sausages</td>
</tr>
<tr>
<td>Protein bars</td>
<td>Milk, milk shakes and smoothies</td>
</tr>
<tr>
<td>Cereals, oat flakes, muesli</td>
<td>Fish and seafood</td>
</tr>
<tr>
<td>Yogurts</td>
<td>Eggs</td>
</tr>
<tr>
<td>Pastry products</td>
<td>Cheese</td>
</tr>
<tr>
<td>Nuts, peanuts</td>
<td>Protein drinks</td>
</tr>
<tr>
<td>Protein drinks</td>
<td>Protein bar</td>
</tr>
</tbody>
</table>

Foods with increased protein content: A qualitative study on European consumer preferences and perceptions.
Banovic M, Arvola A, Pennanen K, Duta DE, Brückner-Gühmann M, Lähteenmäki L, Grunert KG.
Growth in protein foods across all categories
Consumer demand - Foods with increased protein content have rapidly become one of the fastest-growing product categories targeting health focused consumers.

Listed foods as the ones respondents would like to buy and consumer, if they contained increased protein:
- Most likely to buy
- Most likely to consume
Snack foods with increased protein content (high-protein)

Protein enriched snacks and yogurts have widely opened up the food market for healthier alternatives.

Using plant proteins instead of animal proteins seems to receive more attention among consumers for health, environmental and ethical reasons.

Protein as an added ingredient has been introduced to various food categories:
- Dairy products,
- Confectionery
- Soft drinks
- Bakery
- Sports products, claiming to improve the general conditions of the body (e.g. yogurts with increased protein content) and lower some health risks (e.g. protein deficiency)

Protein content of snack foods – protein snackification

Studies on DAIRY: mostly short term acute influences on feelings of hunger

The satiating effect of yogurt as a snack has also been explored in multiple studies - overall, results indicate that yogurt appears to promote satiety when eaten as a snack.

- Study in women - a high-protein afternoon yogurt snack improved satiety, compared with high-fat snacks.
- Study in women, an acute randomized crossover-design study comparing a low-protein or high-protein yogurt 3 h after lunch. Snacking led to reduced hunger and increased fullness, although no differences in post-snack perceived hunger or fullness were observed between the low-protein and high-protein yogurt snacks.
- Also in women, an afternoon snack of Greek yogurt containing 24 g protein led to significantly reduced hunger, increased fullness, and delayed subsequent eating than did lower-protein snacks.
- A fourth study observed that compared with other dairy products (e.g., milk and cheese), yogurt had a significantly greater effect on suppressing subjective appetite ratings but did not affect subsequent food intake.

Protein and snacking

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Current diet advice for protein

- The protein composition of an individual's diet can be considered in different ways:
  - Grams (g), or g/kg body weight
  - % of total energy (calories) as protein

- US is Recommended daily allowance (RDA) - 10-35% % of energy intake for a sedentary adult (approx 46-56g/d).

- UK is The Reference Nutrient Intake (RNI) for protein (0.8g per kg of body weight) may be insufficient in inhibiting age-related loss of muscle mass and strength (sarcopenia), and intake exceeding this amount might be preferential.
Do we eat enough protein?

Current evidence indicates intakes in the range of at least 1.2 to 1.6 g/(kg·day) of high-quality protein is a more ideal target for achieving optimal health outcomes in adults.

- The amount of each nutrient needed differs between individuals and at different life stages.
- Individual requirements of each nutrient are related to a person’s age, gender, level of physical activity and health status.

Protein Foods:
42% US age 1+ have intakes BELOW the goal (NHANES 2007-10)


The majority of trials and observational studies that consider protein consumption and issues such as adequacy and health outcomes focus on total daily protein consumption rather than when consumed.

The distribution of protein across ≥3 daily meals is seldom discussed.

Limited data on snacking.

Protein consumption per meal for adults (aged ≥19 y) in the United States shows a skewed intake pattern.

- Data were adapted from NHANES 2001–2008 survey
- The dotted line approximates the amount of protein required per meal to maximally stimulate muscle protein synthesis
- Data from U.S. National Health and Nutrition Examination Survey (NHANES) (Berner et al., 2013) stated that in 2006 the average protein intake (g/meal) among women aged 51-71 was
  - 11.9g (breakfast),
  - 17.9g (lunch)
  - 30.4g (dinner)
  - 7.4g (snacks)
- The intake in men was higher and accounted for
  - 15.8g (B) - 23.2 (L) - 43.5 (D) and 10.5 (S)
In most western societies, the daily pattern of dietary protein ingestion is skewed, with the lowest amount of protein being consumed in the morning and the greatest in the evening meal (regardless of age or gender).
Protein distribution – not just *what* we eat, but *when* we eat that is important to influence health

- The majority of clinical trials and observational studies that consider protein consumption and issues such as adequacy and health outcomes focus on total daily protein consumption rather than *when* consumed.
- The distribution of protein across ≥3 daily meals is seldom discussed.
- Very limited data on plant proteins.
- Limited data on snacking.

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Protein slows the decline of muscle mass and strength (sarcopenia) related to ageing.

We are failing to meet the need for food products to support healthy ageing.

One third of adults over 50 years consume less than protein intake recommendations.

BBSRC, MRC, EPSRC and ESRC [Grant No: BB/P023886/1].
Clear benefits to industry for effective reformulation & new product development: designing foods for ‘ageing well’

• There are now more people in the UK aged >60 than are under 18.5 years

• The number of people aged 65+ is projected to rise by over 40 per cent in the next 17 years to over 16 million

• Opportunities for food sector
Protein and snacking

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Top 10 protein sources in the UK (NDNS)

1. Chicken and Turkey dishes  20.3%
2. Beef and Veal dishes 15.5%
3. Baked Beans 7.0%
4. Eggs 6.7%;
5. Bacon and Ham 6.6%
6. Meat Pies and Pastries 6.3%
7. Oily Fish 5.4%
8. Sausages 4.2%
9. Pork and Pork dishes 3.9%
10. White Fish coated and/or fried 3.9%

Snack food sources

<table>
<thead>
<tr>
<th>Food category</th>
<th>% snack energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biscuits</td>
<td>17</td>
</tr>
<tr>
<td>Milk</td>
<td>13</td>
</tr>
<tr>
<td>Cakes &amp; puddings</td>
<td>7</td>
</tr>
<tr>
<td>Bread</td>
<td>5</td>
</tr>
<tr>
<td>Chocolate</td>
<td>4</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>3</td>
</tr>
<tr>
<td>Crisps</td>
<td>2</td>
</tr>
<tr>
<td>“Sweets”</td>
<td>1</td>
</tr>
<tr>
<td>Others (inc. fruit)</td>
<td>48</td>
</tr>
</tbody>
</table>

(Summerbell, 1995)

Percentage contribution (%) of food groups to average daily protein intake in the UK in 2013/2014: adults aged 19-64 and ≥65 y (NDNS)
The consumption of meat based products is still largely regarded as pleasurable and socially desirable.

Current global meat consumption impacts on the environment, and yet consumption is rising in many developing nations.

Consumers see protein as a part of a healthier living lifestyle.

‘High-protein’ is moving from niches to mainstream in supermarkets.

More consumers become a “Flexitarian”
  • A semi-vegetarian or flexitarian diet is one that is plant-based with the occasional inclusion of meat.

Applied to more product categories for its health benefits.

“High Protein” product front of pack claim is increasing (nutrition)
  • But a EFSA approved health claim is still illusive.
Plant protein (non-meat source)

Legumes - a plant in the family Fabaceae, or the fruit or seed of such a plant (e.g. peas, lentils and beans, chickpea, soybeans, nuts)

Nuts and seeds (e.g. peanut, pecan, almond, pumpkin, flax, hemp, chia, flax)

Grains - Ancient grains, sprouted grains, multi-grains
*spelt, Khorasan wheat (Kamut), millet, barley, teff, oats, freekeh, bulgur, sorghum, farro, einkorn, and emmer; and the pseudocereals quinoa, amaranth, buckwheat, and chia.

Non-dairy milk
*Almond, coconut, rice, soy,

Supplements : alage (spirulina, chlorella)
Industry insights: challenges and opportunities

- Sustainability
- Non-allergen
- Non GMO
- Availability
- Affordability

- Functionality
  - Taste
  - Nutrition
  - Food matrix
  - Digestibility

- Absorption
  - Amino Acid mix
  - High protein ‘label’
  - Impact on satiety
  - Consumer acceptability

- Animal-based foods have complete composition of essential amino acids, with high digestibility (>90%) and bioavailability.

- Solutions to maximise essential amino-acids content of plant foods include amino-acid complementation and consuming higher amounts of plant-based products on a more frequent basis.

https://research.ncl.ac.uk/proteinforlife/outputs/workpackage4/
Industry insights: challenges and opportunities for NPD

- Adding high amounts of protein can alter the final taste and texture of a product
  - knowledge of the physico-chemical properties of a protein ingredient (e.g. its solubility, viscosity, gelation, hydrophobicity, water-binding and emulsifying properties)

- Advances in protein fractions (concentrates, isolates, hydrolates) can provide numerous formulation solutions
  - but may not be suitable ingredients for certain product categories including short shelf-life chilled ‘to-go’ foods/fresh prepared meals, and products marketed as ‘natural’ and unprocessed

- Animal-based foods have complete composition of essential amino acids, with high digestibility (>90%) and bioavailability
  - Solutions to maximise essential amino-acids content of plant foods include: amino-acid complementation and consuming higher amounts of plant-based products on a more frequent basis
Industry insights: challenges and opportunities for NPD

- **Cost** is the main limiting factor for product development
- A **reliable and scalable supply chain**
- Favouring plant-based proteins over animal proteins difficult due to the **lower protein content**
- The industry perceived **protein quantity to be of greater value** than protein quality for the consumer,
- **Consumer knowledge** – lack of consumer awareness
- **Consumer acceptance** of ‘functional’ protein products could be a barrier to product success
- **Labelling requirements** for protein claims could be improved
- The industry is proactive, well equipped, and will be **highly successful** at overcoming the recognised and emerging formulation challenges specific to plant-based protein ingredients.
Industry insights: challenges and opportunities

- A report was commissioned to discuss the insights and ideas generated from discussion with industry partners.
- Current food industry trends including Sustainability, Healthy Eating, and Clean Eating suggest there is scope for plant-based high-protein products for healthy ageing.
- Plant proteins contain less protein per gram compared to animal proteins, and plant protein quality, palatability, availability, and cost (particularly for novel proteins) can present additional challenges.
- Adding high amounts of protein can alter the final taste and texture of a product; knowledge of the physico-chemical properties of a protein ingredient (e.g., its solubility, viscosity, gelation, hydrophobicity, water-binding, and emulsifying properties) can aid product developers.

Advances in protein fractions (concentrates, isolates, hydrolates) can provide numerous formulation solutions however fractions may not be suitable ingredients for certain product categories including short shelf-life chilled ‘to-go’ foods/fresh prepared meals, and products marketed as ‘natural’ and unprocessed.

This work is a part of the ‘Protein for life: onwards focussed dietary framework for healthy ageing’ project, funded by the ‘Priming Food Partnership’ initiative supported by four UK’s councils: BBSRC, MRC, EPSRC, and ESRC [Grant No: BB/P023886/1].
Seventh decade, 60-70 years – and beyond
‘Ageing well' is a public health message for an ageing UK population

Foods designed and marketed to support healthy ageing e.g.
protein-rich snack foods for older adults

**DISTRIBUTION:** Consumption of two to three meals a day, each containing around 25-30 g of protein to support health outcomes (muscle mass, weight wellness)

https://research.ncl.ac.uk/proteinforlife/outputs/
Clear potential benefits to industry for effective reformulation & new product development
The older adults group is highly heterogeneous, and its members do not always meet their recommended protein intake.

Mealtime functionality as a basis for tailoring protein-enriched meal concepts to two senior consumer segments:

1) ‘cosy socialisers’, who eat mainly for cosiness and social interaction

2) ‘physical nutritioners’, who eat mainly for nutrients and physical needs
The Future for Satiety Enhancing Foods

Key messages on challenges and opportunities for the food sector

Reformulation: reduction of meat protein and substitution of plant protein

New product development: to meet specific consumer sectors (demands)

Educating consumers: about provenance / health
One diet approach does not fit all people - public health advice and food strategies need to be tailored for specific phenotypes to generate a sustainable & healthy approach for appetite control.

Research and innovation – reformulation for ‘health by stealth’ or substitution for ‘reformulation’

Latest R&D driving innovation in new product development

Protein as a functional food – the future for snackification

Preparation of protein isolates for food industry
Targeted marketing (evidence base)
Gluten free or free from growth
Lifestyle choice – target ageing population

‘One diet approach’ does not fit all people - public health advice and food strategies need to be tailored for specific phenotypes to generate a sustainable & healthy approach for appetite control.

Identify barriers to acceptance (consumers/industry)
Further reading

Sustainable protein: Meeting future needs

Proteins
Gratefully acknowledge
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• Rowett colleagues
• Collaborators

Scientist & Nutritionist – funded by Scottish Executive

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Twitter: Dr_A_Johnstone

https://www.futurelearn.com/courses/nutrition-wellbeing
Many studies on NUTS – most studies indicate that nuts appear to promote satiety when eaten as a snack.

- A review by Tan & Mattes found that tree nuts and peanuts have *high satiety values*, as well as many other positive energy-balance attributes, when consumed as snacks.

- A different review article concluded that pistachios also have satiety and satiation effects when consumed as a snack.

- A 4-wk randomized parallel-arm study, when consumed as snacks, almonds *reduced hunger and desire to eat* during an acute-feeding session, suggest that almonds may be a healthful snack option.

- Alper & Mattes - despite being energy-dense, peanuts have a *high satiety value* and chronic ingestion evokes strong dietary compensation and little change in energy balance.

- Comparing almonds V’s cereal bars on hunger Vs control (who were not provided with snacks and were asked to continue with their habitual eating pattern), the almond snack group had a significantly higher eating frequency, although this did not result in higher energy intake, body weight, or percentage of body fat. However, there was no difference in hunger ratings across the 3 groups.