INNOVATING ALMONDS FOR NEW PLANT PROTEIN FORMULATIONS

ROOM 314  |  DECEMBER 4, 2018
AGENDA

- Harbinder Maan, Almond Board of California, moderator
- Craig Duerr, Campos Brothers
- Swati Kalgaonkar, Almond Board of California
- Chris Marinangeli, Pulse Canada
- Tom Velthuis, Log5
- Craig Duerr, Campos Brothers
Creating Opportunities for Pulses and Almonds: Leveraging Protein

Christopher Marinangeli PhD, RD

The Almond Conference

December 4, 2018
1. Almonds and pulses: Both contributing to healthy and sustainable dietary patterns.

2. Regulatory frameworks for protein in North America: A barrier to promoting pulses and other plant-based protein in food innovation?

3. **Moving forward**

   Almonds and pulses as complementary protein sources for claims and nutrient density.
1. Almonds and pulses: Both contributing to healthy and sustainable dietary patterns.
Protein: A Trending Functional Food Ingredient in Europe

Global demand for protein ingredients has greatly increased due to protein’s efficiency and high nutritional value.

‘Protein is the hottest functional food ingredient trend in the United States’: Packaged Facts

By Stephen DANIELLS ©, 23-Dec-2014

Protein trends: Saturation point or just the tip of the iceberg?
A little something about pulses....
Origin of the Words Denoting Some of the Most Ancient Old World Pulse Crops and Their Diversity in Modern European Languages

Aleksandar Mikić
Institute of Field and Vegetable Crops, Novi Sad, Serbia

Figure 1. Some of the oldest archaeobotanical evidence related to the first domesticated pulse crops in Europe and its neighbouring regions.
<table>
<thead>
<tr>
<th>Pulse Type</th>
<th>Protein (g)</th>
<th>Fibre (g)</th>
<th>Folate (mcg)</th>
<th>Iron (mg)</th>
<th>Potassium (mg)</th>
<th>Magnesium (mg)</th>
<th>Zinc (mg)</th>
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<tbody>
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<td>Barley</td>
<td>2.3</td>
<td>2.5</td>
<td>16</td>
<td>1.3</td>
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<td>31</td>
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<tr>
<td>Quinoa</td>
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<td><strong>64</strong></td>
<td><strong>1.09</strong></td>
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<tr>
<td>Beans</td>
<td><strong>8.4</strong></td>
<td>7.9</td>
<td>124</td>
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<td>412</td>
<td>54</td>
<td>1.04</td>
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<tr>
<td>Lentils</td>
<td><strong>9.0</strong></td>
<td>7.9</td>
<td>181</td>
<td>3.33</td>
<td>369</td>
<td>36</td>
<td>1.27</td>
</tr>
<tr>
<td>Chickpeas</td>
<td><strong>8.9</strong></td>
<td>7.6</td>
<td>172</td>
<td>2.89</td>
<td>291</td>
<td>48</td>
<td>1.53</td>
</tr>
<tr>
<td>Peas</td>
<td><strong>8.3</strong></td>
<td><strong>8.3</strong></td>
<td>65</td>
<td><strong>1.29</strong></td>
<td><strong>362</strong></td>
<td><strong>36</strong></td>
<td><strong>1.00</strong></td>
</tr>
</tbody>
</table>

*per 100 g (cooked)*
A similar story for almonds ...
Remains of domesticated almonds: ~3200 bp

Prunus dulcis

A. Californian  B. Mediterranean  A. Asiatic

(19,000 BP)

<table>
<thead>
<tr>
<th>Pulse Type</th>
<th>Protein (g)</th>
<th>Fibre (g)</th>
<th>Folate (mcg)</th>
<th>Iron (mg)</th>
<th>Potassium (mg)</th>
<th>Magnesium (mg)</th>
<th>Zinc (mg)</th>
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</thead>
<tbody>
<tr>
<td>Beans</td>
<td>8.4</td>
<td>7.9</td>
<td>124</td>
<td>2.2</td>
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<td>54</td>
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<td>362</td>
<td>36</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**per 100 g (cooked)**

<table>
<thead>
<tr>
<th>Pulse Type</th>
<th>Protein (g)</th>
<th>Mono + poly FA (g)</th>
<th>Potassium (mg)</th>
<th>Magnesium (mg)</th>
<th>Zinc (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds</td>
<td>6.3</td>
<td>3.75</td>
<td>13.16</td>
<td>1.13</td>
<td>81</td>
</tr>
</tbody>
</table>
# Match Made in Heaven?

![Image of dietary interventions]

<table>
<thead>
<tr>
<th>Dietary interventions</th>
<th>A1C</th>
<th>CV benefit</th>
<th>Other advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary patterns of specific foods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dietary pulses/legumes</td>
<td>↓(176)</td>
<td>↓CVD (181)</td>
<td>↓Weight (179), ↓LDL-C (177), ↓BP (178)</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>↓(183,184)</td>
<td>↓CVD (79)</td>
<td>↓BP (186,187)</td>
</tr>
<tr>
<td>Nuts</td>
<td>↓(188)</td>
<td>↓CVD (143,181)</td>
<td>↓LDL-C (190), ↓TG, ↓FPG (189)</td>
</tr>
<tr>
<td>Whole grains</td>
<td>↓(oats) (194)</td>
<td>↓CHD (99)</td>
<td>↓LDL-C, FPG (oats, barley) (57,193)</td>
</tr>
<tr>
<td>Dairy</td>
<td>↔</td>
<td>↓CVD (199,200)</td>
<td>↓BP, ↓TG (when replacing SSBs) (197)</td>
</tr>
</tbody>
</table>

2. Regulatory frameworks for protein nutrient content claims in Canada:
A barrier to promoting pulses and other plant-based protein?
Using Nutrient Content Claims to Transition the Protein Trend into an Opportunity for Consumers

Transitioning the Trend to an Opportunity for Industry and Canada

“Source of ...”
Positioning Plant-based Proteins as “Sources” of Protein in North America

“Source of…”

“Source of” Protein claims on food in Canada in the US are dependent on protein quality

- Regulatory framework of nutrient content claims apply to the labelling and advertising of foods

What is Protein Quality?

- Describes characteristics of a protein in relation to its ability to achieve defined metabolic actions
  1. Supply of indispensable amino acids
  2. Digestibility of indispensable amino acids

11 Indispensable Amino Acids

- Tryptophan
- Methionine + Cysteine
- Phenylalanine + Tyrosine
- Valine
- Histidine
- Threonine
- Lysine
- Leucine
- Isoleucine
Protein Quality of Animal and Plant-based Foods

**Animal –based Protein**

- Levels of protein (g)
- All indispensable amino acids
- Digestibility (>90%)

**Plant-based Protein**

- Levels of protein (g)
- 1 or more indispensable amino acids
- Digestibility (70% to >90%)

In General, plant-based proteins have a lower protein quality compared to animal-based protein.
Limiting Indispensable Amino Acids in Almonds and Pulses (mg/g protein)

<table>
<thead>
<tr>
<th></th>
<th>TRP</th>
<th>THR</th>
<th>LYS</th>
<th>Met + Cys</th>
<th>ILE</th>
<th>Phe + Tyr</th>
<th>HIS</th>
<th>LEU</th>
<th>VAL</th>
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<tbody>
<tr>
<td>Almonds</td>
<td>10.0</td>
<td>28.4</td>
<td>26.9</td>
<td>17.6</td>
<td>35.5</td>
<td>74.8</td>
<td>25.5</td>
<td>69.6</td>
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<tr>
<td>Soybeans</td>
<td>7.9</td>
<td>38.0</td>
<td>72.1</td>
<td>22.6</td>
<td>38.8</td>
<td>76.0</td>
<td>24.1</td>
<td>72.8</td>
<td>43.5</td>
</tr>
<tr>
<td>Lentils</td>
<td>8.0</td>
<td>42.3</td>
<td>81.1</td>
<td>17.9</td>
<td>38.4</td>
<td>84.9</td>
<td>26.6</td>
<td>80.7</td>
<td>43.8</td>
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<tr>
<td>Black beans</td>
<td>6.8</td>
<td>40.6</td>
<td>73.9</td>
<td>26.9</td>
<td>45.6</td>
<td>94.0</td>
<td>29.2</td>
<td>84.4</td>
<td>48.4</td>
</tr>
<tr>
<td>Black beans</td>
<td>10.4</td>
<td>52.6</td>
<td>75.6</td>
<td>19.2</td>
<td>41.8</td>
<td>92.3</td>
<td>30.5</td>
<td>88.5</td>
<td>48.9</td>
</tr>
</tbody>
</table>
Protein Content Claims in Canada and US: Contingent on Protein Quality

**Protein Rating** = Adjusted Protein Efficiency Ratio (PER) x g of protein per Reasonable Daily Intake

- Bioassay
- “Good Source of Protein” = Protein Rating of 20 - 39
- “Excellent Source of Protein” = Protein Rating > 40

**Protein Digestibility Corrected Amino Acid Score (PDCAAS)**

\[
\text{Corrected Protein Level} = \text{PDCAAS}_{\text{Food}} \times \text{Level of protein in the food (g) per RACC}
\]

\[
\% \text{ DV} = \frac{\text{Corrected protein level (g) per RACC}}{50 \text{ g DV protein}}
\]

- If the \%DV is $\geq 10\%$, the Food is a "Good" Source of Protein
- If the \% DV is $\geq 20\%$, the Food is an "Excellent" Source of Protein

DV = 50 g protein/day
## Claims for Whole Pulses and Almonds in Canada Using the PER Method

<table>
<thead>
<tr>
<th>Protein Efficient ratios &amp; protein ratings - Canadian Regulatory System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protein (g/100 g)</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Red kidney beans</td>
</tr>
<tr>
<td>Navy Beans</td>
</tr>
<tr>
<td>Whole green lentils</td>
</tr>
<tr>
<td>Split red lentils</td>
</tr>
<tr>
<td>Split yellow peas</td>
</tr>
<tr>
<td>Split green peas</td>
</tr>
<tr>
<td>Black beans</td>
</tr>
<tr>
<td>Chickpeas</td>
</tr>
<tr>
<td>Pinto beans</td>
</tr>
<tr>
<td>Almonds</td>
</tr>
</tbody>
</table>

*Reasonable daily intake for baked beans is 250 g; Reference amount for all other pulses is 125 ml

If the Protein Rating is ≥ 20, the Food is a "Good Source" of Protein
If the Protein Rating is ≥ 40, the Food is an "Excellent" Source of Protein

Protein Content Claims in Canada and US: Contingent on Protein Quality

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- Rat growth bioassay
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DV = 50 g protein/day
## Claims for Whole Pulses in the US using the PDCAAS Method

**Max PDCAAS = 1.0**

**US DV protein = 50 g/day**

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>PDCAAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>0.41</td>
</tr>
<tr>
<td>Oats</td>
<td>0.64</td>
</tr>
<tr>
<td>Corn</td>
<td>0.43</td>
</tr>
<tr>
<td>Brown rice</td>
<td>0.59</td>
</tr>
<tr>
<td>Barley</td>
<td>0.55</td>
</tr>
<tr>
<td>Red kidney beans</td>
<td>0.55</td>
</tr>
<tr>
<td>Navy beans</td>
<td>0.67</td>
</tr>
<tr>
<td>Whole green lentils</td>
<td>0.63</td>
</tr>
<tr>
<td>Split red lentils</td>
<td>0.54</td>
</tr>
<tr>
<td>Split yellow peas</td>
<td>0.64</td>
</tr>
<tr>
<td>Split green peas</td>
<td>0.50</td>
</tr>
<tr>
<td>Black beans</td>
<td>0.53</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>0.52</td>
</tr>
<tr>
<td>Pinto beans</td>
<td>0.59</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Protein (g/100 g)</th>
<th>PDCAAS</th>
<th>RACC* (g)</th>
<th>Corrected Protein per serving</th>
<th>% DV</th>
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</thead>
<tbody>
<tr>
<td>Red kidney beans</td>
<td>8.27</td>
<td>0.549</td>
<td>130</td>
<td>5.90</td>
<td>11.8%</td>
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<tr>
<td>Navy Beans</td>
<td>8.76</td>
<td>0.667</td>
<td>130</td>
<td>7.60</td>
<td>15.2%</td>
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<tr>
<td>Whole green lentils</td>
<td>6.72</td>
<td>0.628</td>
<td>90</td>
<td>3.80</td>
<td>7.6%</td>
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<td>Split red lentils</td>
<td>7.3</td>
<td>0.538</td>
<td>90</td>
<td>3.53</td>
<td>7.1%</td>
</tr>
<tr>
<td>Split yellow peas</td>
<td>6.81</td>
<td>0.643</td>
<td>90</td>
<td>3.94</td>
<td>7.9%</td>
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<td>Split green peas</td>
<td>7.39</td>
<td>0.5</td>
<td>90</td>
<td>3.33</td>
<td>6.7%</td>
</tr>
<tr>
<td>Black beans</td>
<td>8.39</td>
<td>0.534</td>
<td>130</td>
<td>5.82</td>
<td>11.6%</td>
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<tr>
<td>Chickpeas</td>
<td>7.57</td>
<td>0.519</td>
<td>90</td>
<td>3.54</td>
<td>7.1%</td>
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<tr>
<td>Pinto beans</td>
<td>7.85</td>
<td>0.59</td>
<td>130</td>
<td>6.02</td>
<td>12.0%</td>
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<tr>
<td>Almonds</td>
<td>21.15</td>
<td>0.33</td>
<td>90</td>
<td>2.01</td>
<td>4.1%</td>
</tr>
</tbody>
</table>

* Reference Amount Customarily Consumed (RACC) assumed to be 130 g for beans and 90 g for all other pulses

3. Moving forward

Almonds and pulses as complementary protein sources for claims and nutrient density.
Protein Quality

**Animal-based Protein**

- Levels of protein (g)
- All indispensable amino acids
- Digestibility (>90%)

**Plant-based Protein**

- Levels of protein (g)
- 1 or more indispensable amino acids
  - Digestibility (70% to >90%)

Use “Complimentary Proteins” to **the Protein Quality**

(mix different protein sources together to make up for shortfalls in Indispensable Amino Acids and Digestibility)
Reformulation for Complimentary Protein Quality?

Whole Yellow Pea  +  Split Yellow Pea  +  Whole Green Lentil  +  Chickpeas  +  Black Beans  +  Pinto Beans  +  Navy Beans
Protein Digestibility Corrected Amino Acid Score (PDCAAS) vs % Inclusion of Pulses

- Whole Green Lentil
- Chickpeas
- Split Yellow Pea
- Whole Yellow Pea
- Navy Beans

Marinangeli. 2018. Unpublished
30 g Total Flour

% Inclusion of Pulses (Total Flour = 30 g)

- Almond + Whole Pea
- Almond + Split Pea
- Almond + Green Lentil
- Almond + Chickpea
- Almond + Black Bean
- Almond + Pinto Bean
- Almond + Navy Bean

Corrected Level of Protein (g)

Claim threshold in US: 5 g/RACC

Marinangeli, 2018. Unpublished
40 g Total Flour

- 70% Almonds + 30% pulses (except whole yellow pea) = Protein Claim

Approx. 12 g MUFA/PUFA

Marinangeli. 2018. Unpublished
Almonds and pulses are nutrient dense sources of plant-based protein that contribute to healthy and sustainable dietary patterns.

Regulatory frameworks in North America can be barriers for communicating the presence of protein in whole and manufactured foods that contain pulses.

Combining pulses with almonds as complementary proteins can substantially increase the level of quality protein in food to help meet thresholds that permit foods to be marketed as “sources of protein.”

The opportunity for complimentary proteins can differ depending on inclusion rates of almonds and pulses and the desired outcome.
Thank you

Questions?

Pulse Canada
Low fat ultrafine nut protein enhanced flour

Add value to Nuts & seeds

Almond board conference – Dec 2018
Gerhard Knol
Product group manager Log5
MSc Food process technology

Equipment & processing Solutions

Single machine to processing lines:
- nut/seed pasteurization
- roasting
- Nut butter & spread (Nutella like products).
  Mixing, grinding and refining
- Technology center in the Netherlands

Major industrial customers
Ultrafine low fat protein powder applications

- Confectionary industry: fillings, snacks,
  - Chocolate filling with low oil content (chocolate friendly fat bloom prevention)
  - Add ultrafine coating
- Dairy, include in milk, ice cream, yogurts etc.
- Health bars
- Instant mixes:
  - Shakes, drinks (mixtures with other (protein) sources)
  - High protein suitable for athletes...
  - Instant (pea)nut butter
  - Instant Almond (or tree nut) milk
- Smoothies
- Bakery:
  - Bake stable
  - Gluten free flour, all natural
Product: Ultrafine low fat protein powder

- Calibrate (low) fat content in (tree)nuts & seeds (repeatable)
- Create a dry flour
- Low in fat, high in valuable proteins
  - ≈12% fat, ≈40% protein (Brown, calculation USDA table brown 12061)
  - ≈12% fat, ≈43% protein (Blanched, calculated from USDA 12062)
  - Non-chemical (no Hexane / Alcohol / CO2)
- Ultra fine: very smooth texture – similar to cocoa powder (down to 20 micron)
- “Cold pressed” high quality unrefined oil
Production

- **Ground material**
  - Brown or white almonds
  - Use wholes / pieces / slivers
  - Raw dried (Pasteurized with raw quality)
  - Roasted

- **Product development in our technology center**
Low fat protein powder Technology

Two technologies: different focus

- Pasteurize
- Roast/dry
- Expeller press
- Cake grinding
- Low fat flour

- Pasteurize
- Roast/dry
- Coarse grind
- Hydraulic press
- Cake grinder
- Powder line
- Ultrafine
- Low fat flour (protein quality)
Oil extraction vs Protein flour production

**Expeller press**
- Efficient oil production
- Warm (high friction/shear)
- Infeed solid particles
- Low capital investment
- Wear & tear
- Continuous adjustment
- Cleaning attention point
- **Coarse powders** (impact shear / heat)
  - Issues with solubility
- Variation in oil content
- Upgrade low value by streams

**Hydraulic press**
- Efficient solids production minimal impact
- Cold (no friction/shear)
- Infeed (tree)nut butters (pump able)
- Higher capital investment
- Low maintenance
- Repeatable results
- Sanitary production
- **Ultrafine protein powders** down to 20 micron
  - High solubility /flowability / mixing properties
- Calibrated repeatable oil content (12 – 28%)
- Upgrade “waste” product
>15,000 PSI frictionless force on the product to take the oil out and leave behind the solids

Milled to an exquisitely fine powder
Example of layout Low fat ultrafine nut flour
Sell or create products for:

- Ultrafine natural protein nut flours, for
  - Direct sell to consumers (health industry)
    - Mix with other protein sources for higher value
    - Well flavored high energy shakes
  - Ingredient:
    - Confectionary industry
    - Dairy
    - Health bars
    - Instant mixes
    - Bakery
  - Oil:
    - Cosmetic industry
    - Also interesting for (sweet goods) to bakeries!
    - Salad dressing, other consumables

- Base material for further processing steps
• (Tree)Nut industry : from agro supplier to value addition with technology
• We see increasing demand and interest for solutions for:
  • Health Low fat/oil
  • Natural pasteurization (safe raw food)
    – Non Chemical
    – Gentle processing (Low acrylamide)
  • Versatility Taste / feel / color combinations with other products
  • Product diversity More complex flavors (confectionary industry)
  • Consumer & brand With product and process
  • Decrease ingredients Process “base” product to make it functional

• Protein market
  – Diversification in products
  – Production at origin facility due to allergen concerns
  – Focus still on exploring opportunities
  – Mild processing in order to obtain protein and oil quality
  – Higher protein values
More Information?

For info:
Gerhard Knol
gknol@log5.com
Tom Velthuis
tvelthuis@log5.com
Eating plant-based is becoming mainstream, industry thrives on plants

CONSUMERS MAKE HEALTHIER FOOD CHOICES

- 8 in 10 consumers* have changed their own or family’s diet to try to be healthier (2018) and over 40% of those consumers have increased their consumption of fruit & vegetables in order to be healthier.

*Average of consumers from: UK, US, China, Brazil, France and Germany

“I increased my consumption of fruit & vegetables in order to be healthier“
Almond as a clean and natural source of protein

**NATURAL PROTEIN FROM ALMONDS**

Creative Snacks Almond Clusters Baked With Cranberries and Cacao Nibs

United States, Sep 2018

DESCRIPTION Almond clusters baked with cranberries and cocoa nibs, in a 397g resealable plastic pouch.

CLAIMS **Natural protein from almonds.** No artificial anything. **5g protein per serving.** 7g sugar per serving. 4g fiber per serving. Certified kosher dairy. Real good, feel good snacks...

**ALMOND BUTTER FOR A GOOD SOURCE OF PROTEIN**

**Kind Breakfast Protein Almond Butter Bar**

United States, Oct 2018

CLAIMS Sustained energy from whole grains (20g per serving). **Breakfast protein 8g per serving. Good source of protein.** Gluten free. No genetically engineered ingredients. With 5 super grains (oats, millet, buckwheat, amaranth, quinoa). Certified kosher. Do the kind thing for your taste buds: Treat your taste buds to our Almond Butter breakfast protein bars.
Product Examples: good source for plant protein

Kite Hill Greek Style Artisan Almond Milk Yogurt: Blueberry
United States, Sep 2017
DESCRIPTION Plump blueberries, **10g of almond protein** and live active cultures equals pure deliciousness by the spoonful. Comes in a plastic tray.
CLAIMS Artisan. Contains 10g almond protein. Soy and dairy free. Traditionally cultured.

Maxim Protein Bite With Almond Crunch Flavor
Norway, Sep 2017
DESCRIPTION **Protein bite with almond** and a high content of natural ingredients. It contains a lot of vegan protein and fiber and is also low in sugar. Ideal before, during and after training.
CLAIMS Low sugar. Only 4g coconut sugar.

Rxbar Kids Protein Bar With Chocolate Chip Flavor
United States, Oct 2017
Almond examples:

**Kelloggs Special K Protein Bar With Blackcurrant And Pumpkin Seeds**
Ireland, Feb 2018

- Super-food grains (whole rolled oats, quinoa, puffed amaranth)
- Raw sunflower seeds
- Dried shredded coconut
- Chopped raw almonds
- 15 g protein
Nescafe: plant-based clean energy breakfast product with plant protein

- NESCAFÉ Coffee Protein Smoothie, a delicious plant-based protein coffee smoothie made with real 100% Columbian Arabica coffee, oats and almond butter to reinvent your morning routine.

- The products are expected to hit the US shelves in January 1, 2019.

- Made with 15g of plant protein, these smoothies provide fulfilling and convenient nutrition that gets you going in the morning - all with a non-dairy and no artificial sweetener formula.

- “This product taps into the rise of dairy alternative beverages and plant powered products.”
Thank you
Q and A