Food ingredients and additives

Dr Ciara McDonnell
Outline

• Introduction to encapsulation
• Active ingredients
• Carrier ingredients
• Labelling considerations
• Practical session
The science of ingredients

Definition of encapsulation

Encapsulation is a process to entrap active material within a carrier material (protective layer)

Technology has been in place for over 60 years

Used as a food ingredient, the process can

✓ Make materials easier to handle (solid vs. liquid)
✓ Enhance nutritive value
✓ Enhance shelf-life i.e. protection against the environment
Benefits of encapsulation in food

- Increase the vitality of ingredients (heat, oxygen, light, etc.)
- Immobility and improved distribution of ingredients within food matrix
- Extended shelf-life (active ingredient will not deplete so quickly)
- Off-taste masking
- Controlled release
- Safety: improved stability of volatiles or flammable oils
Industry benefits

• Reduced complexity of production process (dry ingredients)
• Reduced cost (storage, labour, supply chain)
• Improved product quality = competitive advantage
• Extended shelf-life = improved processing and storage
Encapsulation

• A very specific science of two interaction ingredients

We must first understand food products and functional ingredients before encapsulating.
1. Active Component - Food Ingredients

1. Techno-functional
   - Difference between an ingredient and an additive
   - Additive database
     - Categories
     - Labelling
     - Additives to be encapsulated

2. Flavour
   - Flavours
     - Flavour legislation
     - Encapsulated flavours

3. Nutritive
Techno-functional ingredient

Additive as defined by Regulation 1333/2008/EC:

A ‘food additive’ shall mean any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food, whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in the manufacture, processing, preparation, treatment, packaging, transport or storage of such food results, or may be reasonably expected to result, in it or its by-products becoming directly or indirectly a component of such foods.
Food ingredient vs. additive

• An ingredient is a component of a food product which does not serve a technological function

• An additive is a component of a food product which serves a technological function in the food product as defined by functional categories in Regulation 1333/2008/EC
‘Functional class’ shall mean one of the categories set out in Annex I based on the technological function a food additive exerts in the foodstuff.

Table 1.1. Functional classes of food additives

<table>
<thead>
<tr>
<th>Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid</td>
<td>Emulsifier</td>
</tr>
<tr>
<td>Acidity Regulator</td>
<td>Emulsifying salt</td>
</tr>
<tr>
<td>Anti-caking agent</td>
<td>Firming agent</td>
</tr>
<tr>
<td>Anti-foaming agent</td>
<td>Flavour enhancer</td>
</tr>
<tr>
<td>Antioxidants</td>
<td>Glazing agent</td>
</tr>
<tr>
<td>Bulking agent</td>
<td>Foaming agent</td>
</tr>
<tr>
<td>Colour</td>
<td>Gelling agent</td>
</tr>
<tr>
<td></td>
<td>Humectant</td>
</tr>
</tbody>
</table>
Labelling encapsulated ingredients

- Labelling legislation for additives
  - Additive functional class and specific name or E-number

- The following are not considered functional and as a result there is no requirement to label them as such*:
  - Carry-over additives
  - Processing aids
  - Substances used in the quantities strictly necessary as solvents for flavoring

* Unless those components contain an allergen

Encapsulated ingredients only name the active ingredient (and allergen if present)
Labelling

Ingredients in descending order
Active ingredients presented by class (name or E-Number)

Example: Ice Cream

Partially Reconstituted Skimmed Milk Concentrate, Sugar, Whey Powder (Milk), Palm Stearin, Palm Oil, Dextrose, Palm Kernel Oil, Emulsifier (Mono- and Di-Glycerides of Fatty Acids), Flavouring, Stabilisers (Guar Gum, Sodium Alginate), Colours (Beetroot Red, Beta-Carotene)
Additive database

# Additive database

## Search criteria

- **E No.**
- **Additive name or synonym**

## Results (387 additives found)

<table>
<thead>
<tr>
<th>E No.</th>
<th>INS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Group I, Additives</td>
</tr>
<tr>
<td>2</td>
<td>Group II, Food colours authorised at <em>quantum satis</em></td>
</tr>
<tr>
<td>3</td>
<td>Group III, Food colours with combined maximum limit</td>
</tr>
<tr>
<td>4</td>
<td>Group IV, Polyols</td>
</tr>
<tr>
<td>5</td>
<td>E 100, Curcumin</td>
</tr>
<tr>
<td>6</td>
<td>E 101, Riboflavins</td>
</tr>
<tr>
<td>7</td>
<td>E 102, Tartrazine</td>
</tr>
<tr>
<td>8</td>
<td>E 104, Quinoline Yellow</td>
</tr>
<tr>
<td>9</td>
<td>E 110, Sunset Yellow FCF/Orange Yellow S</td>
</tr>
<tr>
<td>10</td>
<td>E 120, Cochineal, Carminic acid, Carmines</td>
</tr>
<tr>
<td>11</td>
<td>E 122, Azorubine, Carmoisine</td>
</tr>
<tr>
<td>12</td>
<td>E 123, Amaranth</td>
</tr>
<tr>
<td>13</td>
<td>E 124, Ponceau 4R, Cochineal Red A</td>
</tr>
<tr>
<td>14</td>
<td>E 127, Erythrosine</td>
</tr>
<tr>
<td>15</td>
<td>E 129, Allura Red AC</td>
</tr>
<tr>
<td>16</td>
<td>E 131, Patent Blue V</td>
</tr>
<tr>
<td>17</td>
<td>E 132, Indigotine, Indigo Carmine</td>
</tr>
</tbody>
</table>
### Use of additives

**Categories (dairy, meat, confectionary....)**

**Meat Category: permitted additives and maximum limits**

<table>
<thead>
<tr>
<th>E No.</th>
<th>Additive name</th>
<th>Maximum limit, restrictions / exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Group 1, Additives</td>
<td>exception foie gras, foie gras entier, blocs de foie gras, Libamaj, libamaj ésésben, libamaj ésésben, E 4125 ML = 10000 mg/kg; E 620 to E 625, ML = 10000 or in combination, expressed as glutamic acid; E 626 to E 635, ML = 500 mg/kg individually, expressed as guanylic acid.</td>
</tr>
<tr>
<td>E 100</td>
<td>Curcumin</td>
<td>ML = 20 mg/kg, only sausages, patés and terrines</td>
</tr>
<tr>
<td>E 120</td>
<td>Cochineal, Carmine, Carmines</td>
<td>ML = 100 mg/kg, only sausages, patés and terrines</td>
</tr>
<tr>
<td>E 129</td>
<td>Allura Red AC</td>
<td>ML = 25 mg/kg, only <em>lunchmeat</em></td>
</tr>
<tr>
<td>E 150a-d</td>
<td>Caramels</td>
<td>quantum satis only sausages, patés and terrines</td>
</tr>
<tr>
<td>E 160a</td>
<td>Carotenes</td>
<td>ML = 20 mg/kg, only sausages, patés and terrines</td>
</tr>
<tr>
<td>E 160c</td>
<td>Paprika extract, capsanthin, capsorubin</td>
<td>ML = 10 mg/kg, only sausages, patés and terrines</td>
</tr>
</tbody>
</table>
Understanding legislation-example of phosphates in meat

Phosphates serves many techno-functional properties in meat

✓ Bind to Ca$^{2+}$ in the meat cell
✓ Dissociate acto-myosin complex (open cell)
✓ Alkaline leading to increase in pH and movement from IEP
✓ Increase protein solubilisation
✓ Greater intracellular immobilised water = ↑ WHC, ↑ Juiciness, ↑ Yield
✓ Chelating agents = ↓ Oxidative Rancidity
Phosphates in meat

<table>
<thead>
<tr>
<th>Name</th>
<th>E-Number</th>
<th>pH</th>
<th>P₂O₅ Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Tripolyphosphate</td>
<td>E451</td>
<td>9.9</td>
<td>57.2</td>
</tr>
<tr>
<td>Tetra Sodium Diphosphate</td>
<td>E450</td>
<td>10.5</td>
<td>53.5</td>
</tr>
<tr>
<td>Sodium Hexametaphosphate</td>
<td>E452</td>
<td>6.7</td>
<td>68.5</td>
</tr>
<tr>
<td>Sodium Acid Pyrophosphate</td>
<td>E450</td>
<td>4.2</td>
<td>63.5</td>
</tr>
<tr>
<td>Potassium Pyrophosphate</td>
<td>E450</td>
<td>10.4</td>
<td>43</td>
</tr>
<tr>
<td>Potassium Tripolyphosphate</td>
<td>E451</td>
<td>10.1</td>
<td>47.8</td>
</tr>
</tbody>
</table>

Maximum limit for category heat treated processed meats is:

**Individual restriction(s)**
ML = 5000 mg/kg, except foie gras, foie gras entier, blocs de foie gras, Libamáj, libamáj egészen, libamáj tömbben

**Footnotes**
1. The additives may be added individually or in combination
4. The maximum level is expressed as P₂O₅

*Important to check the small print on any additive before considering it for encapsulation in a food!*
Emerging: encapsulated phosphates

Studies have shown
Phosphate encapsulated in vegetable oil
✓ Reduces oxidation
✓ Retains colour
when applied to chicken
Further studies are required on the benefits of encapsulating other additives.

B. Kılıç, A. Şimşek, J.R. Claus, E. Atılğan (2014)
Commercial example of an encapsulated additive

Sorbic acid encapsulated in palm oil

- Sorbic acid is a strong preservative for baked products
- Historically not used due to interference with yeast
- By encapsulating sorbic acid in palm oil (melting point (52-58°C), the yeast can function for leavening and volumes
- After the yeast has functioned, during cooking sorbic acid is released
- Case: Bakery in Africa increased shelf-life from 8 to 14 days
- Declaration: Preservative (Sorbic acid or E200)
Flavours

• Flavours are very volatile compounds
• Very prone to evaporation and oxidation
• Over-time, there is a loss in perceived aroma/flavour
• For this reason, encapsulation has been widely applied in the food industry
Flavours legislation

• Specific legislation: Regulation (EC) No 1334/2008
• EU legislation defines different types of flavourings, such as:
  • flavouring substances
  • flavouring preparations
  • thermal process flavourings
  • smoke flavourings
  • flavour precursors
  • other flavouring
Encapsulated flavours

- Prolonged sweetness from chewing gum
- Artificial sweetness e.g. aspartame in gum acacia

![Graph showing intensity vs. chewing time]

Fig. 1 Demonstrates the benefit of combined release sweeteners
Flavour masking

Used widely in sports nutrition

• Mask bitter tones of protein, such as soya, pea and whey

• Mask bitter tastes and odors from supplements such as vitamins, minerals and caffeine
Flavour masking & time-release

- Sports drink
  - Caffeine encapsulated in cellulose
  - When a 16 fl.oz. bottle is consumed, Zum Energy Drink releases 60mg of caffeine immediately and then gradually releases 140mg over an extended period.
  - Time released in small intestine

- Instant Soup
  - Flavors encapsulated in starch
  - Starch releases flavor when hot water added
Encapsulation for nutrition

• Nutrition
  • Encapsulation of sensitive fatty acids
  • EPA stabilised for use in powder drinks/formulas
  • Arachidonic acid (ARA) and docosahexaenoic acid (DHA) in hypoallergenic infant formulae which enables eye and brain developments
  • Probiotic encapsulation for delivery to the gut
  • Bioactive peptide delivery
2. Carrier material

- Should be *food grade* and able to *form a barrier* for the active agent and its surroundings

- Important to choose a carrier material which does not contain an allergen for declaration

- Depending on the application, either hydrophilic or hydrophobic coating
## Carrier material for encapsulation

<table>
<thead>
<tr>
<th>Origin</th>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Lipid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td>Gluten (corn)</td>
<td>Fatty acid/alcohols</td>
<td></td>
</tr>
<tr>
<td>Cellulose</td>
<td>Isolates (pea, soy)</td>
<td>Glycerides</td>
<td></td>
</tr>
<tr>
<td>Plant exudates</td>
<td></td>
<td>Waxes</td>
<td></td>
</tr>
<tr>
<td>Plant extracts</td>
<td></td>
<td>Phospholipids</td>
<td></td>
</tr>
<tr>
<td>Polysaccharide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrageenan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alginate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microbial/animal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xanthan</td>
<td>Casein</td>
<td>Fatty acids/alcohols</td>
<td></td>
</tr>
<tr>
<td>Gellan</td>
<td>Whey</td>
<td>Glycerides</td>
<td></td>
</tr>
<tr>
<td>Dextran</td>
<td>Gelatin</td>
<td>Waxes</td>
<td></td>
</tr>
<tr>
<td>Chitosan</td>
<td></td>
<td>Phospholipids</td>
<td>(shellac)</td>
</tr>
</tbody>
</table>
Carbohydrate

• Starch
• Maltodextrin
• Corn Syrup Solids
• Dextran
• Modified Starch
• Sucrose
• Cylodextrin
Starch

- Comprised of amylose and amylopectin
- Amylose
  - 20–30%
  - Linear $\alpha(1\rightarrow4)$-linked D-glucose units
  - Higher amylose = reduced gel strength
- Amylopectin
  - 70–80%
  - Side chains of about 30 D-glucose units bonded with $\alpha-(1\rightarrow6)$ linkages approx. every 20-30 glucose units
- Varies with the source of the starch
Starch cont.

• Normally white, odourless and tasteless
• Insoluble in cold water and ethanol
• Swelling behaviour dependent on
  • Shape (spherical or lentil)
  • Grain size (5-900 µm)

<table>
<thead>
<tr>
<th>Starch</th>
<th>Granule Size (µm)</th>
<th>Shape</th>
<th>Gelatinization (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>15-100</td>
<td>Oval</td>
<td>56-66</td>
</tr>
<tr>
<td>Wheat</td>
<td>2-35</td>
<td>Flat &amp; elliptic</td>
<td>52-63</td>
</tr>
<tr>
<td>Rice</td>
<td>3-8</td>
<td>Polygonal</td>
<td>61-77.5</td>
</tr>
<tr>
<td>Corn</td>
<td>5-25</td>
<td>Polygonal</td>
<td>62-75</td>
</tr>
</tbody>
</table>
Starch for encapsulation

- Suited to products where active material release is required upon heating or by enzymes (amylase in saliva)
- Depending on the process, modified starched may be useful
- Modified starches
  - have cross-linkage to replace hydrogen bonds
  - Higher shear and heat stability
  - Increased shelf-life
  - Tolerance to temperature fluctuations
  - Hydrolysis by acids or enzymes (chemical) or by temperature/pressure (physical)
- Suited to flavours and aromas
Cyclodextrin

- Commonly used modified starch for encapsulation
- Dextrin refers to product obtained by hydrolysis of starch
- Cyclodextrin = enzymatic hydrolysis
- Six to eight glucose monomer
- Cavity of 0.7-0.8 nm
- Used for food, pharmaceutical, drug delivery...
- Lipid soluble vitamins & hormones
- Soluble in 25 °C water (degree of solubility depends on no. of glucose molecules)
- Not absorbed in digestive tract
- Metabolised by gut micro-flora

<table>
<thead>
<tr>
<th>Cyclodextrin</th>
<th>Glucose number</th>
<th>Solubility (g/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>6</td>
<td>1.85</td>
</tr>
<tr>
<td>β</td>
<td>7</td>
<td>14.5</td>
</tr>
<tr>
<td>γ</td>
<td>8</td>
<td>23.2</td>
</tr>
</tbody>
</table>
Proteins

- Gluten
- Casein
- Gelatine
- Albumin
- Haemoglobin
- Peptides
Casein

- Originates from bovine milk (3-3.6% protein)
- Casein and whey are the two major proteins
- Caseins vary in net charge, hydrophilicity and metal binding
- Extremely heat stable
- Acid caseins are soluble at pH <3.5 and >5.5
- Rennet caseins soluble at pH >9
- Good fat emulsifiers
- For example, encapsulated fat soluble Vitamin D for fortified milk
- Allergenic- suited to dairy products
Gelatine

- Heterogeneous mixture of single or multi-stranded polypeptides (300-4000 amino acids)
- Derived from animal skin, bones and connective tissue
- Melt when heated and solidify when cooled
- Soluble in most solvents
- Amphiphilic so great emulsifying properties
- Mammalian gelatin can be manufactured to have ‘melt in mouth’ properties (35-40°C) - flavour release
- Cold fish gelatin can gelate as low as 5°C which can have applications for ingredient encapsulation in refrigerated products

**FOOD**

Innovative Food Product Development Cycle: Frame for Stepping Up Research Excellence of FINS
Gum

- Mostly water soluble
- Viscous colloidal solution
- Gel network under temperature
- Emulsion stabiliser, crystal formation protector

<table>
<thead>
<tr>
<th>Gum</th>
<th>Properties</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia</td>
<td>High solubility, emulsifier, low viscosity</td>
<td>Flavours</td>
</tr>
<tr>
<td>Karaya</td>
<td>High solubility, colloidal stabiliser</td>
<td>Sauce &amp; Ice cream</td>
</tr>
<tr>
<td>Carrageenan</td>
<td>Gelling agent, viscosity control, stabiliser</td>
<td>Meat or juice stock encapsulation</td>
</tr>
</tbody>
</table>
Gum Acacia (also gum arabic)

- Originates from tree *Acacia senegal* grown in Africa
- Complex mixture of arabinogalactan oligosaccharides, polysaccharides and glycoproteins
- Branched neutral or slight acidic substance
- Natural substance so prone to variability (source climate, season, age of tree, rainfall, exudation)
- Odourless, tasteless and colourless
Gum Acacia cont.

• Highly soluble in hot and cold water (up to 50% wt.)
• Colloidal stabiliser and emulsifier
• Effect on viscosity varies with type
• The hydrophobic polypeptides anchor polysaccharides to active surface
• Hydrophilic carbohydrate chains prevent aggregation by forming thick charged later
• This unique property means it is greatly suited to encapsulating oil droplets, flavours and prebiotics
Lipid

- Phospholipids
- Glycerides
- Wax
- Paraffin
- Beeswax
- Tristearic acid
- Oils
- Fats
- Hardened oils
Phospholipids

- Commercially isolated from egg, soybean oil or buttermilk (lecithin)
- Two long chain fatty acids, third hydroxyl group of glycerol is modified with phosphoric
- Hydrophilic head, hydrophobic tail
- Excellent emulsifier due to amphiphilic character
- When mixed with water, they self-assemble into bilayers
- With energy, this can form a liposome with an aqueous centre
Phospholipid uses and structure

- Used to encapsulate rennet enzymes for less losses during cheese manufacture
- Aqueous centre also environment for flavour masking or nutrient delivery
- Permeability can be modified during manufacture so it can be created to have high pH stability and various permeation across a temperature range
- For this reason ideal for nutrient delivery in the gastrointestinal tract.
- Widely used in food and pharmaceutical industry
Glycerides

- Most natural fats contain high level of glycerides (animal and plant)
- Tri-, di-, mono- glycerides depending on number of glycerol molecules on the fatty acid chain
- Melting points depend on chemical nature (increased with number of carbons in hydrocarbon chain)
- Mainly used for drug delivery in lipid matrices
Consideration when choosing carrier material

• What are the characteristics of the active?
• What are the processing conditions during food manufacture?
• What are the storage conditions?
• What triggers or mechanisms for release are in place?
• Are there legal issues (e.g. food grade allergen free?)
Allergens

• An allergen is a type of antigen that produces an immune response to fight off a perceived threat that would otherwise be harmless to the body.

• Such reactions are called allergies.

• The EU recognizes 14 allergens and these must be declared on food packaging.
Allergens in EU

1. **Cereals containing gluten**, namely: wheat, rye, barley, oats
2. **Crustaceans**
3. **Eggs**
4. **Fish**
5. **Peanuts**
6. **Soybeans**
7. **Milk**
8. **Nuts**, namely: almonds, hazelnuts, walnuts, cashews, pecan nuts, Brazil nuts, pistachio nuts, macadamia
9. **Celery**
10. **Mustard**
11. **Sesame seeds**
12. **Sulphur dioxide and sulphites**
13. **Lupin**
14. **Molluscs**
Labelling of allergens

• List established since 2003
• Regulation (EU) No. 1169/2011 in effect since December 2014
• No longer permitted to state ‘may contain…..’
• Allergens must be emphasised the ingredient list
• Ingredients: Flour (wheat), sugar, Eggs, Milk, cocoa powder
• As per previous slides, only active material needs to be declared for encapsulated ingredients unless the carrier material contains an allergen
What We Know

• Many ‘active’ ingredients can be encapsulated
  • Techno-functional
  • Flavour
  • Nutrition

• The choice of carrier material depends on many process factors and targeted delivery

• Encapsulation has many advantages (protection and delivery)

• Controlled release can be generated

• The carrier material does not need to be declared but any associated allergens do
Practical session

• You have been asked to develop an instant soup (just add hot water)
• Must release flavour/aroma when water is added
• Must gradually release flavour over temperature
• The colour must be protected from oxidation
• What is the ingredient declaration
## What is the ingredient declaration?

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
<th>Functional Class</th>
<th>E-Number</th>
<th>Allergen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potatoes</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onions</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>27.3</td>
<td></td>
<td></td>
<td>Gluten</td>
</tr>
<tr>
<td>Salt</td>
<td>9.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef powder</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize Starch</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caramel (encapsulated in lecithin which could have egg traces)</td>
<td>1.5</td>
<td>Colour</td>
<td>E150</td>
<td>Egg</td>
</tr>
<tr>
<td>Palm Fat</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>0.6</td>
<td>Antioxidant</td>
<td>E304</td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green beans</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paprika</td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yeast Extract</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato Powder</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flavouring (encapsulated in starch)</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosemary Extract</td>
<td>0.4</td>
<td>Antioxidant</td>
<td>E392</td>
<td></td>
</tr>
</tbody>
</table>

100
**Answer**

<table>
<thead>
<tr>
<th>Starch, Wheat Flour</th>
<th>Salt, Sugar, Palm Fat, Yeast Extract, Potatoes, Green Beans, Colour (Caramel)</th>
<th>Egg, Peas, Carrots, Onions, Tomato Powder, Beef powder, Flavouring, Antioxidant (Ascorbic Acid, Rosemary Extract), Paprika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Or</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bibliography


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