Effective Learning and Teaching of Home Economics / Technology and Living Series: Food Preparation and Cooking Skills with Meal Planning in Basic Food Science
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Topics

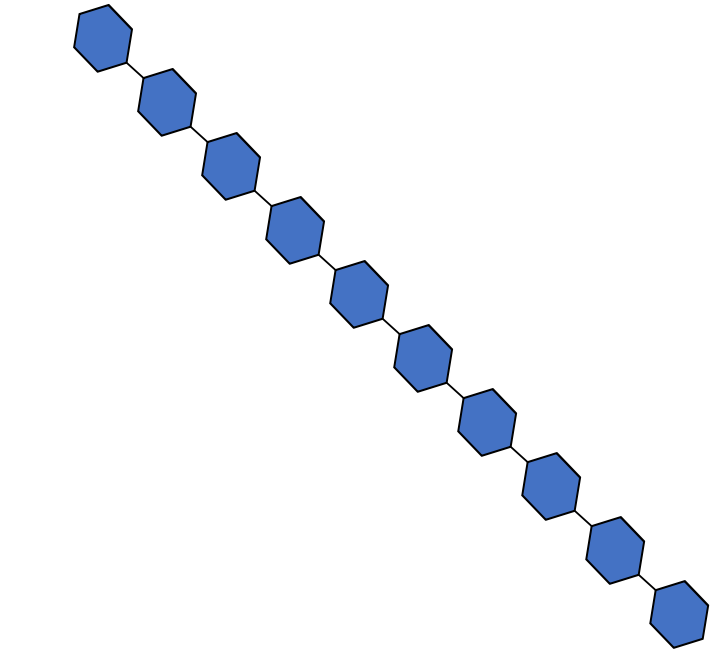
- Gelatinisation of starch
- Dextrinisation of starch
- Denaturation of protein (gluten) in wheat flour
- Raising agents in flour dough

Gelatinisation of Starch

- Takes place under moist heat
- Starch granule swells
- Loss of amylose from the swelling granule
- Gelatinisation temperature depends on the type of starch
- Produces a thick cooked paste
- e.g. thickener for sauces

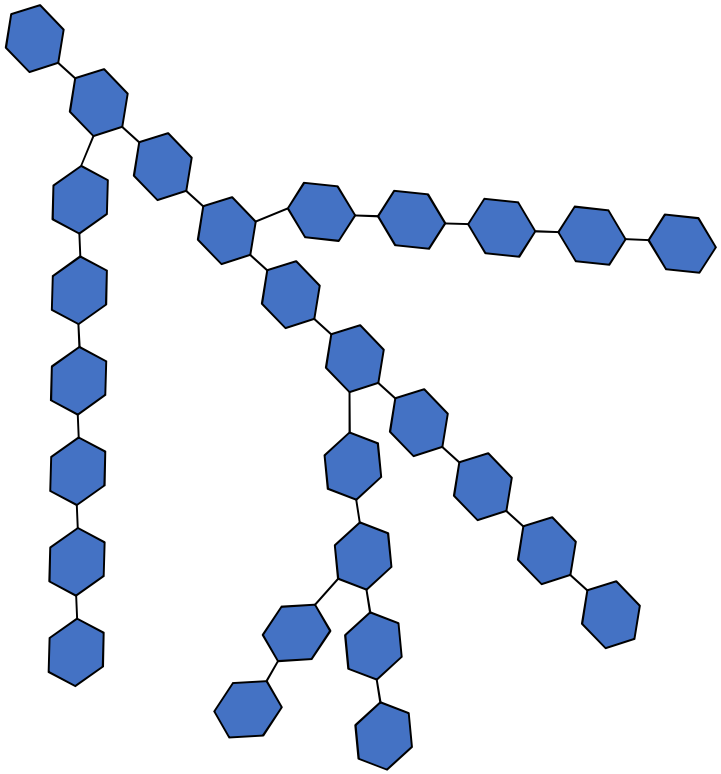
Gelatinisation of Starch

- Amylose molecule



D-glucose

- Amylopectin molecule



Gelatinisation of Starch

- Swelling and disorganisation of starch granules heated in water
- Measures of gelatinisation
  - Swelling of granules
  - Increased viscosity (thickness or stickiness)
  - Increased translucency
  - Increased solubility

Gelatinisation of Starch

- Factors affecting gelatinisation
  - Ratio of amylose to amylopectin
  - Amount of water
  - Heating time
  - Presence of other substances

Dextrinisation of Starch

- Takes place under dry heat
- Thermal degradation of starch
- Browning occurs
- Different from Maillard reaction in which amino acid is involved
- Such starches produce thin cooked pastes
- Little thickening power, e.g. brown gravy
- Example: toast a slice of bread in toaster

Denaturation of Protein (Gluten) in Wheat Flour

- Proteins are amino acid polymers
- Denaturation is a process in which proteins lose the quaternary structure (three-dimensional structure of multiple polypeptides), tertiary structure (three-dimensional structure) and secondary structure (hydrogen bonds between peptide group chains) which are present in their native state
- Primary structure (linear structure of amino acids) is intact
- Protein can be denatured by:
  - Application of some external stress
  - Compound such as a strong acid or base
  - Concentrated inorganic salt
  - Organic solvent (e.g. alcohol or chloroform)
  - Radiation
  - Heat

Denaturation of Protein (Gluten) in Wheat Flour

- Flour does not contain gluten
- Flour contains two proteins (glutenin and gliadin)
- When water is added to flour, gluten is formed
- Gluten requires mixing to form a strong continuous network
- Fully developed dough should form a uniformly thin, smooth film without tearing

Denaturation of Protein (Gluten) in Wheat Flour

- When batters and doughs are baked, most of the moisture evaporates or is absorbed by gelatinising starch granules.
- Loss of moisture, presence of heat, gluten sets into a firm and rigid yet porous structure that holds its shape
- Egg protein, when heated, also set into a firm, rigid structure

Raising Agents in Flour Dough

- Raising agents, also known as leavening agents, cause baked goods to rise
- Providing lightness and volume to baked goods
- Leavened baked goods are more porous and tender
- During baking, heat causes matter to change from one physical form to another
  - Solid to liquid (butter melts)
  - liquid to gas (water to vapour)
- Molecules move faster and spread farther apart
- This expansion is the basis for leavening

Raising Agents in Flour Dough

- There are three main leavening gases in baked goods:
  - Steam
  - Air
  - Carbon dioxide

Raising Agents in Flour Dough

Steam (water vapour), gaseous form of water

- A physical leavener
- Forms when water, milk, eggs, syrups, or any other moisture-containing ingredient is heated
- e.g. choux pastry is leavened almost exclusively by steam

Raising Agents in Flour Dough

Air

- A physical leavener
- Added to batters and doughs by physical means, by:
  - Creaming
  - Whipping
  - Sifting
  - Folding
  - Kneading
  - Stirring
- Sponge cake and angel food cake contain eggs that are whipped, and this adds volumes of air to the batter.

Raising Agents in Flour Dough

Carbon dioxide

- Although it is present in air, in trace amounts only
- It is formed from two sources:
  - Yeast fermentation, which is a biological leavener
  - Chemical leavening agents
    - Baking powder
    - Baking soda
- When carbon dioxide is warmed from the heat of the oven, it moves into existing air bubbles, causing them to expand.
- Breads and cookies are examples of baked products that rely on carbon dioxide to raise

Raising Agents in Flour Dough

- Yeast are usually applied in baked goods with presence of wheat (gluten), so that porous and rigid structure can be formed

Raising Agents in Flour Dough

Baking powder

- Acidic
- Made by combining soda and a dry acid, such as cream of tartar
- Milder by 2-3 times

Baking soda

- Alkaline
- Stronger
- Reacts with acid to produce bubbles
- Usually used in products containing buttermilk, brown sugar, yoghurt, lemon juice, cocoa powder, etc.
- Overuse produces metallic aftertaste

Q&A

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課題

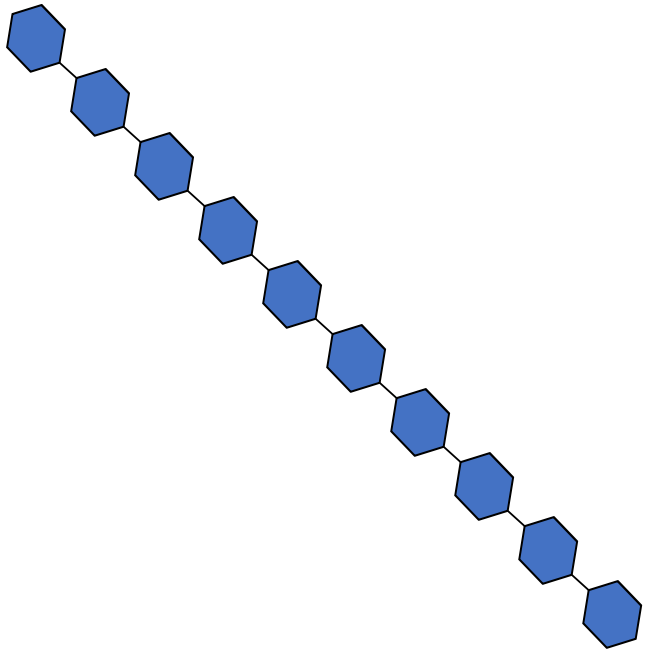
- 澱粉的糊化作用
- 澱粉的糊精作用
- 小麥粉中的蛋白質變性（麵筋）
- 粉糰的發麵劑

澱粉的糊化作用

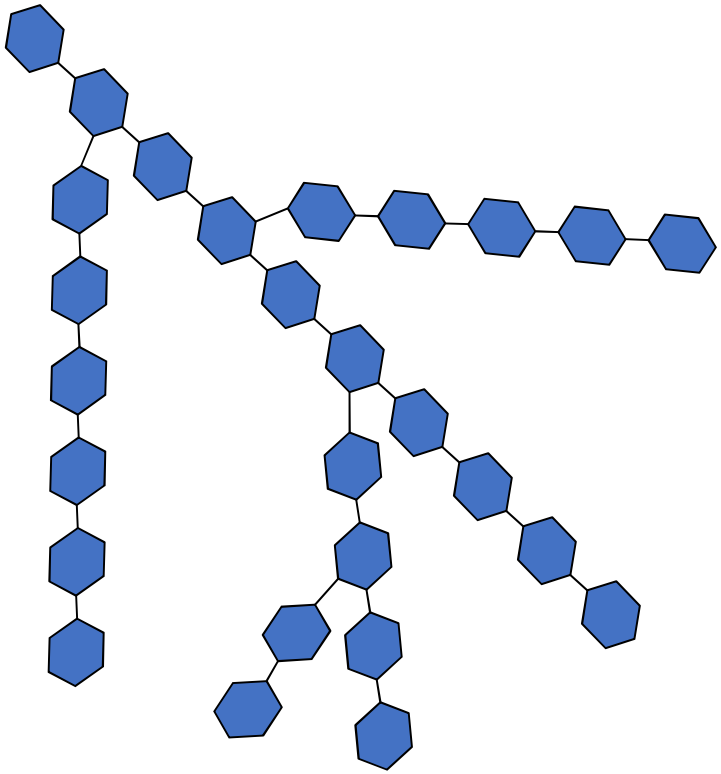
- 在潮濕的熱力下發生
- 澱粉的顆粒膨脹
- 直鏈澱粉從膨脹顆粒流失
- 糊化溫度取決於澱粉的種類
- 產生濃稠的糊
- 例如：醬汁的增稠劑

澱粉的糊化作用

- 直鏈澱粉分子



- 支鏈澱粉分子



D-葡萄糖

澱粉的糊化作用

- 澱粉顆粒在水中受熱，膨脹，並解體
- 測量糊化
  - 顆粒膨脹
  - 粘度增加（稠度或粘性）
  - 透明度增加
  - 溶解度增加

澱粉的糊化作用

- 影響糊化的因素
  - 直鏈澱粉與支鏈澱粉的比例
  - 水的份量
  - 加熱時間
  - 其他存在的物質

澱粉的糊精作用

- 在乾熱下發生
- 澱粉熱降解
- 澱粉變褐色
- 有別於涉及氨基酸的梅納反應
- 這種澱粉產生稀薄的糊
- 稠化能力較弱，例如肉汁
- 例子：烘麵包器烤烘麵包

小麥粉中的蛋白質變性（麵筋）

- 蛋白質是氨基酸聚合物
- 變性是一個過程，其中蛋白質失去四級結構（三維多肽的結構），三級結構（立體結構）和二級結構（肽基鏈之間的氫鍵），其存在於它們的天然狀態
- 一級結構（氨基酸線性結構）是完整的
- 蛋白質變性原因：
  - 使用一些外加壓力
  - 化合物，如強酸或強鹼
  - 濃縮的無機鹽
  - 有機溶劑（例如，醇或氯仿）
  - 輻射
  - 熱力

小麥粉中的蛋白質變性（麵筋）

- 麵粉不含有麵筋
- 麵粉中含有兩種蛋白質（谷蛋白和醇溶蛋白）
- 麵粉加入水後，產生麵筋
- 麵筋需要經過混合來形成一個強大的連續網絡
- 充分混合的粉糰應該形成一個均勻、薄、光滑的膜並且沒有撕裂

小麥粉中的蛋白質變性（麵筋）

- 當麵粉糊和粉糰被烤焗時，大部份的水份被蒸發或由糊化澱粉顆粒吸收。
- 當麵筋流失水份，且有熱力的存在時，形成一個硬而堅固但多孔的結構，能夠保持形狀
- 當雞蛋中的蛋白質遇熱，也形成一個堅固的結構

粉糰中的發麵劑

- 發麵劑，又被稱為膨鬆劑，可令烘焙食品膨脹
- 為烘焙食品提供鬆軟度和增加體積
- 膨鬆了的烘焙食品比沒有膨鬆的較多孔和鬆軟
- 在烘焙時，熱力使物質從一種物理形態改變為另外一種
  - 固體變為液體（牛油溶解）
  - 液體變為氣體（水變為水蒸汽）
- 分子活動較快，彼此之間的距離也較遠
- 這種擴張，就是膨鬆的原理

粉糰中的發麵劑

- 在烘焙食品中，有三種令食物膨鬆的氣體：
  - 蒸汽
  - 空氣
  - 二氧化碳

粉糰中的發麵劑

蒸汽（水蒸汽）是水的氣態形式

- 是一物理性膨脹劑
- 當水、牛奶、雞蛋、糖漿或任何其他含水的成分被加熱時便形成
- 例如：蛋油鬆皮，幾乎完全是透過蒸汽令批皮膨鬆

粉糰中的發麵劑

空氣

- 是一物理性膨脹劑
- 以物理形式被添加到麵粉糊和粉糰內：
  - 擂油
  - 打起
  - 篩
  - 拌入
  - 搓
  - 攪勻
- 海綿蛋糕和天使蛋糕包含打起了的雞蛋，增加了麵粉糊的空氣含量

粉糰中的發麵劑

二氧化碳

- 雖然存在於空氣，但只佔微量
- 從兩個來源形成：
  - 酵母發酵，是一種生物膨鬆劑
  - 化學膨鬆劑
    - 發粉
    - 食用梳打粉（碳酸氫鈉）
- 當焗爐的溫度上升時，二氧化碳變暖，並移動到已存在的氣泡中，使氣泡膨脹
- 麵包和曲奇是依靠二氧化碳而膨脹的烘焙產品例子

粉糰中的發麵劑

- 酵母通常應用於含有小麥（麵筋）的焙烤食品中，它讓多孔和堅固結構可形成

粉糰中的發麵劑

發粉

- 酸性
- 由梳打粉及乾酸，如撻撻粉組合而成
- 溫和了2-3倍

食用梳打粉

- 鹼性
- 較強
- 與酸產生反應，產生氣泡
- 通常用於含酪乳漿、黃糖、酸奶酪、檸檬汁、可可粉等的產品
- 過度使用會產生金屬後味

問與答