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論文名稱(英)	Stability of aspartame-encapsulated submicron particles and the kinetic studies of its controlled release
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摘要(中)	阿斯巴甜甜味劑在水溶液中加工或貯存時不安定，容易受水活性、pH 值、溫度及光照的影響，尤其在受熱時會裂解而失去甜味。故研究目的在於製備熱穩定膠囊化阿斯巴甜，以減緩高溫烤焙時的熱破壞。而高度熱穩定之膠囊，其包覆壁材質對熱穩定性之要求甚高，且需仰賴其分子間具有強的交互作用。由相分離研究 κ-紅藻膠與動物膠分子之交互作用發現，在 pH 3.6、25℃及 κ-紅藻膠固定在 0.5% 時，動物膠 (type B) 濃度在 2.5-4.0% 或是鹼處理動物膠濃度 2.0-4.0%，兩分子呈現強的交互作用。另以物性分析 κ-紅藻膠及刺槐豆膠之混合膠體發現，在固定 1.5% (w/v) 動物膠及 pH 3.5 條件下，κ-紅藻膠及刺槐豆膠濃度分別為 1.6% (w/v) 及 1.2-1.6% (w/v) 時，有最高的膠體硬度。在此條件下，混合膠體的膠性及咀嚼性也最好。另以流變性分析發現，當固定動物膠濃度為 1.5% (w/v) 且 κ-紅藻膠和刺槐豆膠的比例為 1.48% : 1.4% 時，有較強的交互作用。以上述最適條件製備超微膠囊，再以示差掃描熱分析發現，其熱穩定性可達到 120℃，而所配製超微膠囊的平均粒徑為 197 nm。超微膠囊化阿斯巴甜於 pH 3.5 經冷凍解凍循環之熱安定性高，然而在鹼性環境 (pH 7.4) 很不安定。以高效率液相層析定量阿斯巴甜及其裂解產物也發現，在 pH 7.4 比在 pH 3.5 的安定性差。在 pH 7.4、70℃時阿斯巴甜由超微膠囊中釋出之速率常數為 1.17±0.08 h-1，釋出之阿斯巴甜會裂解，而總裂解速率常數為 6.24±0.26 h-1，這比在 pH 3.5、70℃的總裂解速率常數(0.011±0.001 h-1) 高 567 倍。進一步分析釋出後阿斯巴甜遇到鹼及熱的各別裂解反應，阿斯巴甜 (A) 降解成 3,6-dioxo-5-phenylmethyl-2-peperazineacetic acid (DKP) 的反應速率常數為 5.94±0.48 h-1，而反應 A? N-L-α-aspartyl-L-phenyalanine (AP) 的速率常數為 0.3 h-1，比較兩反應速率常數可了解阿斯巴甜在 pH 7.4、70℃加熱之主要降解途徑為 A?DKP。此外於 70℃阿斯巴甜在 pH 3.5 裂解成 DKP 的反應速率常數 (0.0072±0.0015 h-1) 比在 pH 7.4 者下降 825 倍。由此可知阿斯巴甜在微鹼性溶液中加熱的裂解速率非常的快，因此超微膠囊之所以可以減緩阿斯巴甜在 pH 7.4 及 70℃環境中裂解，主要靠緩慢的釋出控制。
摘要(英)	Aspartame, a dipeptide sweetener, is unstable during storage or heating in an aqueous solution. Its instability can be affected by water activity, pH, temperature and illumination. For instance, aspartame may decompose under heating and lose its sweetness. Therefore, it is our purpose to develop heat-stable encapsulated aspartame strongly depends on the heat stability of coating materials, which was governed by the interaction formed during preparation. Studies of phase separation indicated that strong intermolecular interaction between κ-carrageenan and gelatin was observed at pH 3.6 and 25℃ when 2.5-4.0%gelatin (type B) or 2.0-4.0% alkali-treated gelatin was added into 0.5% κ-carrageenan. Furthermore, rheometric results showed that maximum hardness of the mixed gel were obtained by mixing 1.6% (w/v) κ-carrageenan with 1.2-1.6% (w/v) locust bean gum in presence of 1.5% (w/v) gelatin

	at pH 3.6. Gumminess and chewiness of the mixed gel also reached the highest value at the same condition. Based on the finding of rheological analysis, strong interaction was also found for the mixed gel at concentration of 1.48% κ-carrageenan, 1.4% locust bean gum and 1.5% gelatin. Heat-stable submicron particles were prepared based on the above optimal conditions. Differential Scanning Calorimetry revealed that the micron particles with particle size of 197 nm had heat stability up to 120℃. At pH 3.5, the aspartame-encapsulated submicron particles were very stable upon freeze-thawing as compared to its instability at pH 7.4. Quantitative analysis of high performance liquid chromatography also showed that aspartame was more stable at pH 3.5 than pH 7.4. When encapsulated release from submicron particles was 1.17±0.08 h-1. The released aspartame was instantaneously degraded with the overall reaction rate constant of 6.24±0.26 h-1, which was 567 times higher than the heating of aspartame at pH 7.4 and 70℃. Further studies on the degradation reaction of aspartame in an aqueous solution indicated that the rate constant for degradation of aspartame (A) to 3,6-dioxo-5-phenylmethyl-2-peperazineacetic acid (DKP) was 5.94±0.48 h-1, whereas the rate constant for reaction A? N-L-α-aspartyl-L-phenyalanine (AP) was estimated to be 0.3 h-1. As we carefully examined the above two heating reactions, it was noted that the major reaction route for aspartame degradation at pH 7.4 and 70℃ was A?DKP. Besides, the reaction rate constant (0.0072±0.0015 h-1) for aspartame degradation at pH 3.5 was 825-folds lower than that at pH 7.4. Thus, aspartame degraded rapidly at a slight alkaline solution. Reduction on aspartame loss during heating can only be achieved by lowering the controlled release rate of submicron particles at pH 7.4 and 70℃.
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