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利用毛細管電泳鑑別燕窩

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摘要

利用毛細管電泳分析胺基酸組成鑑別燕窩真偽，燕窩檢體經酸及鹼水解後，以 dansyl chloride 衍生化，再以毛細管電泳分析。胺基酸之回收率(包括 NH₃ 在內)為 102.30%，檢出限量為 0.01~0.03 pmole。另就全省各中藥店及超級市場所購得之十件燕窩藥材及二十件冰糖燕窩製品，進行分析。燕窩藥材之粗蛋白質為 47.05~58.91%。冰糖燕窩製品之固形物含量為 2.29~54.45%，粗蛋白質為 1.44~58.45%。於 UV 365 nm 下，燕窩藥材多半呈淡藍白色螢光，冰糖燕窩製品較難判定。由胺基酸分析圖譜發現燕窩真品具相同之胺基酸 profile，而冰糖燕窩製品中，一件疑為白木耳及其他物質之混合加工品，五件因未檢出胺基酸可能是以洋菜、燕石或海藻酸鈉製成之替代品，另有一件檢出 hydroxyproline 疑係以豬皮加工製成。

關鍵詞: 燕窩，鑑別，毛細管電泳，胺基酸。

前言

燕窩係金絲燕屬之幾種鳥類，於吞食海中
小魚或其他蠶螺、海藻等小生物後，用吐出之
唾液凝結於懸崖峭壁所成之窩巢。燕窩之形狀
為黃白色或灰白色半月形，長約 6.5~10 cm，
寬約 3~5 cm，陷成凹狀，全體由分泌物層疊
積累成，質硬而脆，斷面微似角質⁽¹⁾。商品有
白燕、毛燕及血燕之分，以白燕品質最佳⁽²⁾。
燕窩含蛋白質 49.85%，主要的胺基酸組成
為 histidine 2.7%，arginine 2.7%，cystine 2.4%，
tryptophan 1.4%，tyrosine 5.6%；另含碳水化
合物 30.55% 及鈣、磷、鉀、硫等成分，燕窩於
365 nm 呈淡藍白色螢光^(1,2)。其鑑別方法以性
狀、理化及顯微鏡鑑定等，而其中理化鑑定則
包括 ninhydrin、稀鹽酸、碘、bromothymol
blue、螢光及酒石酸銅等反應。

本研究就市售燕窩檢體進行粗蛋白、螢光
反應及胺基酸分析，同時對於可能之取代品如
豬皮(pork skin)、燕石〔一種天然樹膠(natural

plant gum)、海藻酸鈉(sodium alginate)及白木
耳(jelly fungus)等，亦一併探討，以資比對。

胺基酸之分析係以與各種生色團(chro-
mophores)作用而產生之有色物質或螢光物進
行檢測，利用胺基酸分析儀(amino acid analyz-
er)之傳統後置式 ninhydrin 衍生化(post-column
ninhydrin derivatization)離子交換層析法(IEC)
⁽³⁻⁶⁾，或將胺基酸經前置反應衍生化(pre-column
derivatization)後，再利用逆相層析管分析之高
效液相層析法(HPLC)⁽⁶⁻¹⁵⁾。

毛細管電泳(Capillary Electrophoresis, CE)
是最近發展之分析方法，已廣泛應用於蛋白
質、胺基酸及藥物等之分離⁽¹⁶⁻²¹⁾。CE 之效率
高，速度快，中空管柱清洗容易，換液迅速，
幾乎不消耗溶媒，且樣品用量僅為 HPLC 之幾
百分之一⁽²⁰⁾是其優點。

材料與方法

一、燕窩檢體

於民國84年10月至85年1月間在全省各中藥店及超級市場購燕窩藥材十件及製成飲品形態之冰糖燕窩產品二十件(檢體編號1~20)。

二、試藥

十七種胺基酸及 $(\text{NH}_4)_2\text{SO}_4$ 之混合標準溶液購自Pierce Chem. Co. (Ill., USA)。胺基酸、L-norleucine (Nle)(內部標準品)、tryptophan (Trp)、hydroxyproline (Hyp)及dansyl chloride (Dns-Cl)購自Sigma Chem. Co.。Sodium tetraborate, sodium dihydrogen phosphate及sodium dodecyl sulfate (SDS)為試藥特級,購自Nacal Tesque Inc. (Kyoto, Japan)。

三、實驗方法

(一)不溶性固形物重

將冰糖燕窩檢體過濾,水洗去糖分,濾乾後稱重。

(二)螢光反應

將冰糖燕窩檢體之不溶性固形物經 100°C 乾燥後,於365 nm觀察其螢光反應;燕窩藥材則直接於365 nm觀察。

(三)粗蛋白

冰糖燕窩檢體經濾乾後,於 100°C 乾燥至恆重後磨碎,取約200 mg依照Kjeldahl method⁽²²⁾進行粗蛋白測定,氮係數以6.25計。燕窩藥材則直接磨碎,取同量依Kjeldahl method進行粗蛋白測定。

(四)胺基酸分析

1.蛋白質水解

取磨碎之檢體約20~100 mg(依粗蛋白多寡而定),置於先經 $\text{H}_2\text{SO}_4/\text{HNO}_3$ (3/1)洗滌,再用水沖洗乾淨並烘乾之分解瓶中,加入2 ml之6N HCl,以真空幫浦抽去氣泡,於 $110 \pm 1^\circ\text{C}$ 酸水解24小時,過濾後供作衍生化用檢液。Trp之分析則另取磨碎之檢體約50~100 mg置於分解瓶中,加入3ml之4.2N NaOH,以真空幫浦抽去氣泡,於 $110 \pm 1^\circ\text{C}$ 鹼水解24小時,

以6N HCl中和後,加水定容至10 ml,離心後供作衍生化用檢液。

2. Dansyl-Cl衍生化反應

參考Negro *et al.*方法⁽¹⁰⁾,取酸水解所得之衍生化用檢液10 μl ,置於樣品瓶中,加入10 μl 之內部標準溶液(2.5 $\mu\text{mole/ml}$),置於含NaOH之乾燥器中,抽真空乾燥。將HCl完全去除後,殘留物加水100 μl 溶解,加0.5M NaHCO_3 100 μl 及0.02M Dns-Cl/acetone 100 μl (臨用時調製)。以vortex mixer混合均勻,於 65°C 加熱40分鐘衍生化後,進行CE分析。另取Trp衍生化用檢液100 μl 置於樣品瓶中,加0.5M NaHCO_3 100 μl ,按照上述方法進行衍生化反應,供做CE分析用檢液。

3. Capillary electrophoresis分析

取CE分析用檢液50 μl ,加水150 μl 及pH 9.0之CE緩衝液50 μl ,混合均勻,進行CE之胺基酸分析。

毛細管電泳分析儀: Beckman P/ACE 5500 capillary electrophoresis system with UV detector。分析條件:毛細管柱為Beckman eCap capillary tubing, 57 cm total length/50 cm effective length, 50 μm i.d.;分析混合標準溶液之緩衝液為pH 9.0之0.02M borate/phosphate(含0.1M SDS);甲醇=9:1;分析Trp時,緩衝液為pH 9.0之0.02M borate/phosphate(含0.1M SDS);檢測波長214 nm;操作溫度 25°C ;電泳電壓27 KV;檢液注入時間5秒鐘。

(五)標準曲線之製作

取2.5 $\mu\text{mole/ml}$ 之混合標準溶液3、5、10、20、30、40及50 μl (相當於含各胺基酸7.5、12.5、25、50、75、100及125 nmole,唯Cys含量為前述之半),分別加入與混合標準溶液相同容量之2.5 $\mu\text{mole/ml}$ Hyp溶液,再加入2.5 $\mu\text{mole/ml}$ 之內部標準溶液10 μl ,經乾燥並衍生化後,以CE分析三次。

另取2.5 $\mu\text{mole/ml}$ 之Trp水溶液3、5、10、20、30、40及50 μl ,加水至100 μl ,衍生化後,以CE分析三次。

以各種胺基酸之Dns-衍生物的波峰面積(Dns-Trp除外)除內部標準品之Dns-衍生物的波峰面積,得到各胺基酸在不同濃度之relative response factors,對含量(nmole)作圖。各胺基酸於7.5~50 nmole之標準曲線均呈線性,其

迴歸係數(r)均為0.999。

(六)回收試驗

參考 AOAC⁽⁴⁾以 CE 分析所得之各種胺基酸中氮之含量總和與 Kjeldahl method 所得檢體總氮量之比值做為回收率，其計算式如下：

$$\% \text{ Recovery} = \frac{\sum \text{aa} - N_{\text{CE}}}{\text{Total } N_{\text{Kj}}} \times 100\%$$

式中， $\sum \text{aa} - N_{\text{CE}}$ 為 CE 分析所得每種胺基酸含氮之總量， $\text{Total } N_{\text{Kj}}$ 為以 Kjeldahl method 所得之檢體總氮量。

結果與討論

一、固形物重及粗蛋白質含量

Table 1. Comparison of crude protein contents and prices of dried bird's nest

Origin	Price (NTD/3.75 g)	Crude protein ^a (%,dry basis)
Hong Kong	430	53.47 ± 0.01
Indonesia	350	58.91 ± 0.27
Indonesia	380	51.90 ± 0.16
Indonesia	180	53.24 ± 0.64
Thailand	470	54.31 ± 0.16
Thailand	350	56.33 ± 0.43
Vietnam	412	49.45 ± 1.32
Unknown	190	54.51 ± 0.57
Unknown	390	47.05 ± 0.17
Unknown	400	53.43 ± 1.36
Average		53.26 ± 3.32

a: mean ± standard deviation, n = 3.

Table 2. Total solids, crude protein contents, prices and authenticity of bird's nest in rock sugar syrup

Sample No.	Labelled content ^a (%)	Price (NTD/bottle)	Total solids ^b (%)	Crude protein ^b (%, dry basis)	Authenticity ^d
1	50	250	54.45 ± 1.95	58.45 ± 2.47	+
2	30	167	20.33 ± 3.27	26.92 ± 1.80	+
3	30	200	14.19 ± 2.45	38.61 ± 2.34	+
4	25	115	16.22 ± 3.88	13.53 ± 0.06	+
5	22	150	14.47 ± 2.64	26.86 ± 2.36	+
6	12.5	100	5.55 ± 4.27	2.11 ± 0.00	— (1)
7	10.6	191	35.92 ± 3.66	13.57 ± 0.83	+
8	— c	148	20.95 ± 2.36	30.26 ± 0.35	+
9	—	190	8.16 ± 0.18	44.35 ± 1.29	+
10	—	193	2.70 ± 0.98	5.95 ± 0.68	— (2)
11	—	158	25.99 ± 1.44	14.59 ± 1.62	+
12	—	149	34.57 ± 0.78	2.21 ± 0.07	— (3)
13	—	115	3.55 ± 0.59	44.91 ± 2.10	+
14	—	190	5.61 ± 0.12	3.47 ± 0.59	— (4)
15	—	150	10.39 ± 1.28	25.46 ± 1.30	+
16	—	65	2.29 ± 1.35	3.24 ± 0.32	— (5)
17	—	120	25.70 ± 0.43	9.78 ± 0.71	— (6)
18	—	120	33.18 ± 1.51	43.36 ± 1.57	+
19	—	160	14.70 ± 3.61	1.44 ± 0.12	— (7)
20	—	92	3.56 ± 0.08	9.94 ± 0.11	+

a: labelled content of bird's nest.

b: mean ± standard deviation, n=3.

c: not labelled.

d: sample was identified using CE electrophoresis as (2) jelly fungus, (6) pork skin, (1),(3),(4),(5) and (7) natural plant gum possibly sodium alginate or agar.

Table 3. Capillary electrophoretic migration times of Dansyl chloride derivatives of amino acids

Amino acid	Migration time ^a (min)
Hydroxyproline (Hyp)	7.94 ± 0.03
Threonine (Thr)	8.44 ± 0.03
Serine (Ser)	8.44 ± 0.03
Alanine (Ala)	8.91 ± 0.03
Glycine (Gly)	9.34 ± 0.02
Valine (Val)	9.71 ± 0.02
Proline (Pro)	10.24 ± 0.02
Methionine (Met)	10.46 ± 0.02
Glutamic acid (Glu)	11.40 ± 0.03
Isoleucine (Ile)	11.59 ± 0.03
Aspartic acid (Asp)	11.84 ± 0.04
Leucine (Leu)	12.27 ± 0.04
Norleucine (Nle) ^b	13.22 ± 0.04
Phenylalanine (Phe)	13.67 ± 0.04
Cystine (Cys)	15.29 ± 0.04
Arginine (Arg)	22.08 ± 0.06
Lysine (Lys)	25.98 ± 0.10
Histidine (His)	27.10 ± 0.12
Tyrosine (Tyr)	27.50 ± 0.11

a: mean ± standard deviation, n=3.

b: internal standard.

市售燕窩藥材均為乾品，粗蛋白質含量介於47.05~58.91%，平均為53.26% (表一)，與前人所述含蛋白質49.85%相當接近^(1,2)。冰糖燕窩製品之不溶性固形物介於2.29~54.45%，粗蛋白質含1.44~58.45%，每瓶售價由65至250元不等(表二)，差異甚大。冰糖燕窩檢體中有七件標示燕窩含量(表二)，由固形物重之標示量對檢出量之比值可以了解燕窩含量狀況，除No.1檢體為0.92與標示相符外，No.7檢體偏低(0.30)，應攙有非燕窩之物質，該品標示另添加0.7%海藻酸鈉，其餘五件之比值皆大於1，表示不足標示量。粗蛋白質含量與燕窩真偽之相關性見表二，顯示粗蛋白質含量低於4%以下者應可判定為燕窩未檢出。相較於燕窩藥材之粗蛋白質含量，冰糖燕窩製品中粗蛋白質含量低於45%，二十件中僅一件蛋白質含量高達58.45 ± 2.47%。

二、螢光反應

燕窩藥材除了血燕呈深褐色無螢光外，其他幾乎都具典型之微藍白色螢光反應。冰糖燕窩製品可能受加工過程及攙雜其他物質之影響，有些檢體較難判定。

三、胺基酸分析

各種胺基酸之縮寫、CE分析之遷移時間(migration time, tm)及再現性整理於表三。CE電泳之遷移順序(migration order)是陰離子、中性分子及陽離子。利用儀器本身之spike功能，分析時將單一之胺基酸添加至混合標準溶液予以鑑別，其中Thr及Ser之tm同為8.44分無法分離，其餘分離效果均相當不錯，再現性亦佳。

AOAC⁽⁴⁾認為蛋白質經水解成胺基酸後，其回收率之合理數值應介於86~105%之間。以本研究所建立之方法，取燕窩藥材約20 mg及50 mg分別進行12、24及36小時之酸及鹼水解，按照前述方法以CE分析，燕窩含17種胺基酸。Dns-Thr及Dns-Ser因無法分離，另以pH 9.0之0.02M borate/phosphate (含0.1M SDS)再分析，所得可溶性氮含量總和(包括ammonia在內)分別為8.11、8.71及8.59% (表四)。Thr、Ser及Cys因酸水解過程中會遭到部分破壞，使所得的分析值偏低⁽⁶⁾。括號內數值即為依水解時間之結果外插校正後所得之數據，分別為8.19、8.89及8.85%，為Kjeldahl method (8.69%)之95.25、102.30及101.84%，顯示水解24小時已可達最高之回收情形，故本研究採用之水解時間為24小時。

本方法以CE分析各胺基酸之最低檢出限量為0.01~0.03 pmole，相較Negro *et al.*⁽¹⁰⁾及Marquez *et al.*⁽¹¹⁾之HPLC方法分別為0.04~0.1 nmole及25 pmole以下，靈敏度提高很多。

胺基酸組成方面，燕窩藥材之profile幾乎一致，且均未檢出Met (圖一之peak 8)，為其特徵。圖一(A)是燕窩藥材之CE分析圖譜，overscale之波峰是反應過剩的Dns-Cl。燕窩中具代表性之Val、Pro、Phe及Tyr含量除以粗蛋白質含量所得aa/crude protein百分比(表五)，Val 5.57~7.25% (平均6.77%)，Pro 7.01~10.14% (8.64%)，Phe 5.41~8.10% (7.35%)及Tyr 4.92~9.71% (7.25%)。其中血燕為5.57、7.01、5.41及4.92%，稍微偏低。

攙偽之冰糖燕窩製品多以豬皮、魚皮、白木耳、洋菜、燕石或海藻酸鈉等冒充。其中洋

Table 4. Amounts of amino nitrogen of bird's nest sample after different hydrolysis time

Amino acid	Nitrogen content ^a (%)		
	12 hr	24 hr	36 hr
Thr	(0.42) ^b 0.40 ± 0.01	(0.42) 0.36 ± 0.06	(0.42) 0.34 ± 0.02
Ser	(0.54) 0.50 ± 0.01	(0.54) 0.46 ± 0.10	(0.54) 0.42 ± 0.02
Ala	0.33 ± 0.00	0.32 ± 0.01	0.33 ± 0.01
Gly	0.47 ± 0.02	0.46 ± 0.01	0.46 ± 0.01
Val	0.31 ± 0.02	0.42 ± 0.00	0.45 ± 0.00
Pro	0.51 ± 0.01	0.56 ± 0.01	0.53 ± 0.00
Glu	0.44 ± 0.01	0.45 ± 0.01	0.44 ± 0.01
Ile	0.11 ± 0.00	0.17 ± 0.00	0.18 ± 0.01
Asp	0.61 ± 0.05	0.65 ± 0.00	0.65 ± 0.01
Leu	0.41 ± 0.01	0.46 ± 0.01	0.45 ± 0.01
Phe	0.29 ± 0.02	0.37 ± 0.03	0.36 ± 0.01
Cys	(0.15) 0.13 ± 0.01	(0.15) 0.12 ± 0.01	(0.15) 0.09 ± 0.01
Arg	1.19 ± 0.05	1.35 ± 0.04	1.32 ± 0.03
Lys	0.34 ± 0.00	0.41 ± 0.01	0.42 ± 0.00
His	0.52 ± 0.03	0.58 ± 0.02	0.59 ± 0.01
Tyr	0.28 ± 0.01	0.27 ± 0.00	0.26 ± 0.01
Trp	0.13 ± 0.05	0.15 ± 0.01	0.14 ± 0.03
NH ₃	1.14 ± 0.14	1.16 ± 0.09	1.16 ± 0.04
Total	(8.19) 8.11	(8.89) 8.71	(8.85) 8.59

a: mean ± standard deviation, n=3.

b: the numbers in the parentheses denote corrected values obtained by extrapolation to zero-time hydrolysis.

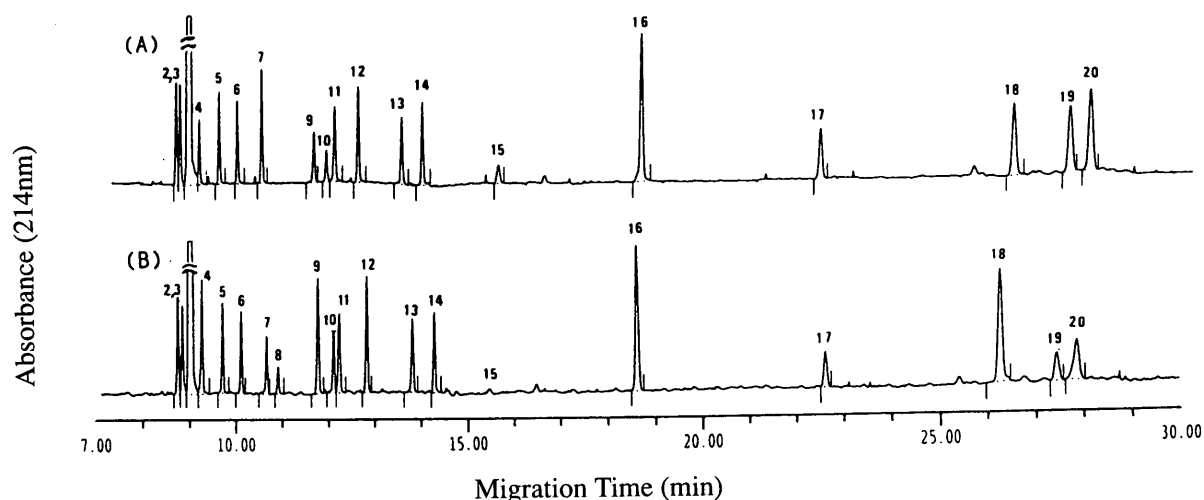


Figure 1. Electropherograms of dansyl-amino acid derivatives of the hydrolysate of (A) bird's nest sample (B) bird's nest in rock sugar syrup sample No.1.

Peaks identification: 2, Thr; 3, Ser; 4, Ala; 5, Gly; 6, Val; 7, Pro; 8, Met; 9, Glu; 10, Ile; 11, Asp; 12, Leu; 13, Nle (internal standard), 14, Phe; 15, Cys; 16, NH₃; 17, Arg; 18, Lys; 19, His; 20, Tyr.

Table 5. The ratio of Val, Pro, Phe, Tyr and Hyp to crude protein contents in dried bird's nest, jelly fungus and pork skin

Sample	a.a /crude protein ^a (%)				
	Val	Pro	Phe	Tyr	Hyp
Bird's nest	6.77 ± 0.48 (5.57 ~ 7.25) ^b	8.64 ± 0.81 (7.01 ~ 10.14)	7.35 ± 0.80 (5.41 ~ 8.10)	7.25 ± 1.19 (4.92 ~ 9.71)	N.D. ^c
Jelly fungus	3.51	3.92	3.01	1.86	N.D.
Pork skin	2.88	12.42	2.27	0.77	9.92

a: average of duplicate analyses.

b: range limit.

c: not detected.

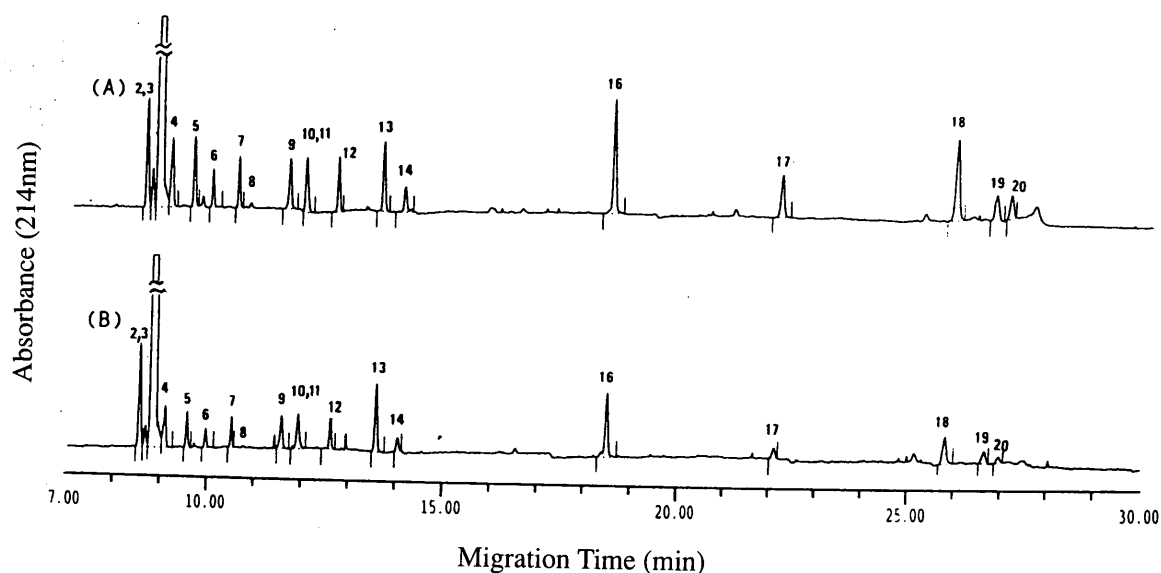


Figure 2. Electropherograms of dansyl-amino acid derivatives of the hydrolysate of (A) jelly fungus and (B) bird's nest in rock sugar syrup sample No. 10. See figure 1 for peak numbering.

菜、燕石及海藻酸鈉等不含蛋白質，而一般市售豬皮及白木耳之粗蛋白含量經檢測結果分別為64.7及8.7%。圖二、三及四分別是白木耳、洋菜、海藻酸鈉及豬皮之CE分析圖譜，其中豬皮含明膠(gelatin)特有之Hyp，且Ala、Gly及Pro也特別高⁽²³⁾。白木耳中四種aa/crude protein百分比為3.51、3.92、3.01及1.86% (表五)，皆較燕窩低；豬皮為2.88、12.42、2.27及0.77%，Pro特別高，另含Hyp 9.92% (表五)，顯示攙偽品之aa/crude protein百分比皆與燕窩真品有異。

冰糖燕窩檢體中，No.1 (圖一(B))、2及18三件之CE分析圖譜相當近似，但稍異於燕窩

藥材(圖一(A))。這三件均檢出Met，且Pro、His及Tyr含量較低，為其特徵。故由CE分析結果燕窩可歸納為圖一(A)及(B)兩種形態之胺基酸profile。No.10之CE分析圖譜與白木耳相似，但吸收峰較低(見圖二，檢體取量皆約100mg)，故No.10檢體疑為白木耳及其他物質之混合加工品。No.6、12、14、16及19等五件檢體因未檢出胺基酸，可能是洋菜、燕石或海藻酸鈉之假冒品。圖三是洋菜、海藻酸鈉及No.6和No.12兩件檢體之CE對照圖譜。No.17檢體之CE分析圖譜與豬皮一致(參見圖四)檢出Hyp，且Ala、Gly及Pro也特別高，因此該檢體疑係以豬皮加工製成。其餘檢體比對結果均

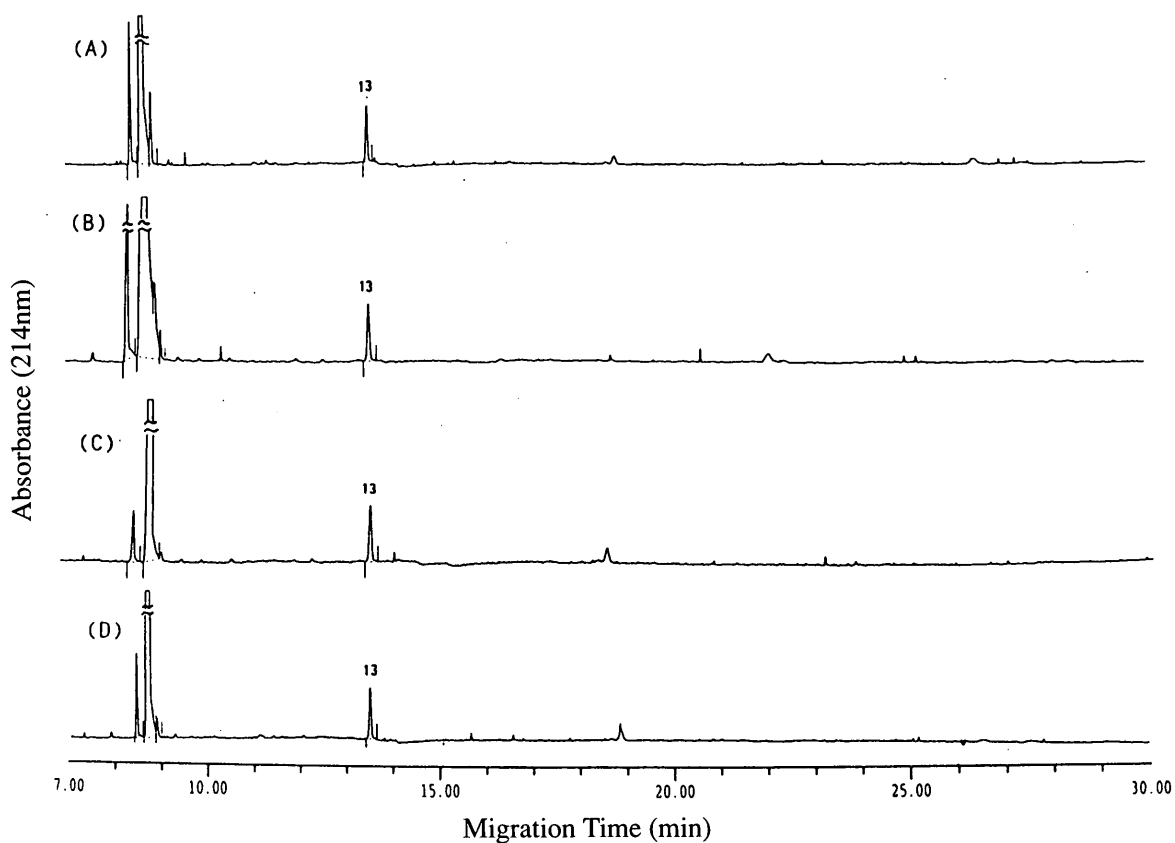


Figure 3. Electropherograms of dansyl-amino acid derivatives of the hydrolysate of (A) agar, (B) sodium alginate, (C) bird's nest in rock sugar syrup sample No. 6 and (D) No. 12. See figure 1 for peak numbering.

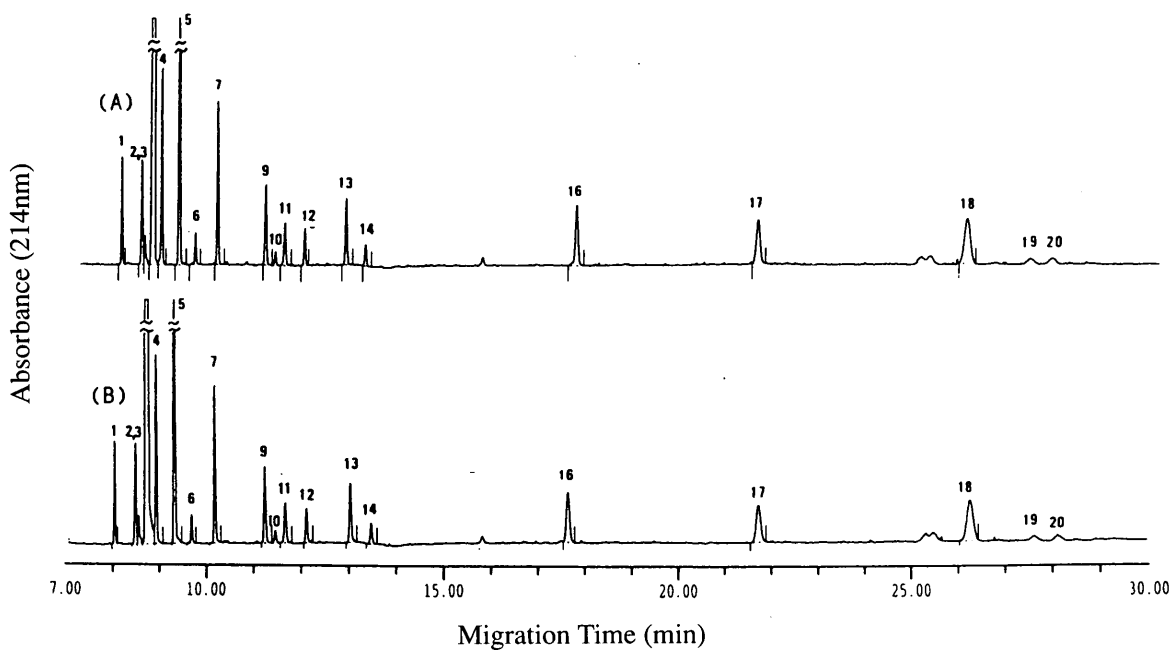


Figure 4. Electropherograms of dansyl-amino acid derivatives of the hydrolysate of (A) pork skin and (B) bird's nest in rock sugar syrup sample No. 17. See figure 1 for peak numbering, except peak 1 for Hyp.

Table 6. The ratio of Val, Pro, Phe, Tyr and Hyp to crude protein contents and authenticity of bird's nest in rock sugar syrup

Sample No.	a.a /crude protein ^a (%)					Authenticity ^c
	Val	Pro	Phe	Tyr	Hyp	
1	6.21	3.66	6.84	3.70	N.D. ^b	+
2	5.79	4.23	7.24	1.04	N.D.	+
3	4.74	5.54	3.81	2.69	N.D.	+
4	4.21	5.25	4.43	1.55	N.D.	+
5	4.80	6.11	5.70	2.57	N.D.	+
6	N.D	N.D.	N.D.	N.D.	N.D.	- (1)
7	4.94	6.56	5.31	2.36	N.D.	+
8	5.02	5.98	5.88	4.99	N.D.	+
9	5.91	7.87	5.98	6.29	N.D.	+
10	2.86	3.03	2.18	0.67	N.D.	- (2)
11	4.80	5.62	4.73	0.69	N.D.	+
12	N.D.	N.D.	N.D.	N.D.	N.D.	- (3)
13	5.52	6.61	5.83	4.83	N.D.	+
14	N.D.	N.D.	N.D.	N.D.	N.D.	- (4)
15	4.56	5.81	5.30	2.16	N.D.	+
16	N.D.	N.D.	N.D.	N.D.	N.D.	- (5)
17	2.15	12.99	2.04	0.82	10.33	- (6)
18	6.97	3.69	7.03	3.95	N.D.	+
19	N.D.	N.D.	N.D.	N.D.	N.D.	- (7)
20	3.92	5.33	4.53	0.81	N.D.	+

a: average of duplicate analyses.

b: not detected.

c: sample was identified using CE electrophoresis as (2) jelly fungus, (6) pork skin, (1), (3), (4), (5) and (7) natural plant gum, ie sodium alginate or agar.

為燕窩真品。

冰糖燕窩檢體之四種aa / crude protein百分比整理如表六。其中No.6、12、14、16及19等五件檢體皆未檢出胺基酸。No.10之四種aa/ crude protein百分比為2.86、3.03、2.18及0.67%，與白木耳(3.51、3.92、3.01及1.86%)比較，除了Tyr較低外，其餘均相當近似。至於No.17之aa/crude protein百分比為2.15、12.99、2.04及0.82%，與豬皮(2.88、12.42、2.27及0.77%)幾乎一致，且Hyp 10.33% (豬皮9.92%)亦相近。其餘檢體則為3.92~6.97% (平均5.18%)、3.66~7.87% (5.56%)、3.81~7.24% (5.59%)及0.81~6.29% (2.89%)，其中No.1、2及18三件之Pro及Tyr偏低，係屬另一種形態之胺基酸組成。另外No.11及20二件檢體之

Tyr含量較低(約1%)，與白木耳(0.67%)及豬皮(0.82%)差異不大，但配合Val、Pro及Phe一起比對，仍具差異性。整體而言冰糖燕窩之aa/crude protein百分比較燕窩藥材為低，且範圍較大，原因何在尚待進一步探討。

結 論

粗蛋白質含量可以初步作為鑑定燕窩真偽之參考，低於4%時判定為非燕窩。利用CE分析所得之胺基酸profile可鑑別燕窩及其攙偽品。攙偽品中洋菜、燕石或海藻酸鈉均未檢出胺基酸；豬皮含明膠特有之Hyp，且Ala、Gly及Pro特別高；白木耳之Phe及Tyr均較低。分析結果顯示冰糖燕窩製品之品質良莠不齊，以

代替品假冒燕窩者計有七件。

誌 謝

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Application of Capillary Electrophoresis for Identification of the Authenticity of Bird's Nests

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ABSTRACT

A method using capillary electrophoresis (CE) to determine amino acid profile was developed to identify the authenticity of bird's nest. Bird's nest samples were hydrolyzed in acid and alkali, respectively. The protein hydrolysates were then derivatized with dansyl chloride, and analyzed by CE. The average recovery of amino acids was 102.30%. The detection limits were between 0.01 and 0.03 pmole.

Ten bird's nest samples and twenty bird's nest in rock sugar syrup were analyzed. The bird's nest samples were found to contain 47.05~58.91% crude protein, while bird's nest in rock sugar syrup were found to contain 1.44~58.45%. All the bird's nest samples were identified to be authentic based on amino acid profile matching. Among 20 bird's nest in rock sugar syrup, seven were considered to be substituted with agar, natural gum or pork skin. CE analysis of amino acid profile was found to be an efficient and sensitive technique for identifying the authenticity of bird's nests.

Key words: bird's nest, identification, capillary electrophoresis (CE), amino acid(s).