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蔗糖與8-HQS對蕾期採收菊花改善品質與延長壽命之研究

Studies on Improving Quality and Prolong Longevity of Bud Cut Chrysanthemum by Sucrose and 8-HQS

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by

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摘要：蕾期採收(花徑 3.0～3.5cm)之冬王與平和台品種菊花，於含有 200 ppm 8-HQS (8-hydroxyqninoline sulfate), 25 ppm 硝酸銀或 50 ppm 醋酸銀等保鮮劑下，觀察 0～30%不同蔗糖濃度對切花品質及壽命之影響。冬王品種，隨蔗糖濃度之增加，均獲得品質之改善與壽命之增長，以含蔗糖 7%最爲理想。夏採之平和台品種，蔗糖濃度 2～10%對瓶插壽命影響不大，但 30%蔗糖處理效果不良。花莖 75cm 者，以5～10%蔗糖濃度最佳，花莖 40cm 者，則以 2%蔗糖最爲理想。含適當蔗糖之保鮮劑，可改善水分平衡，促進花蕾之正常發育與開放，且菊葉硬挺，保持鮮綠不變黃。但濃度過高，會引起葉緣乾枯變黑，甚而捲曲，影響品質。保鮮劑中含有 8-HQS 較單含有硝酸銀者爲理想。

前　言

一般切花之採收適期，以能確保瓶插時充分發育之最早熟度爲採收適期。很多玫瑰品種、唐菖蒲及鳶尾都是蕾期採收。蘭花、香石竹及菊花，蕾期採收插於水時，花朵無法充分發育，以達盛開狀，故在歐美都盛開時採收。近年來適當蔗糖濃度，8-HQS (或8-HQC)* 及硝酸銀或醋酸銀等藥劑之應用，已使蕾期採收不易發育好之切花，能展開的很好 [3,10,12,16,18,24,25,26,35]。有些菊花甚至比在植株上自然展開者爲佳 [7, 13, 19]。這種保鮮劑 (floral preservatives) 處理，使菊花在蕾期採收，可縮短生育時間，增加土地利用率；減少在田間遭受不利環境如陰冷或風吹雨打及病蟲害感染等之損失；且田間一次全面蕾期採收，可節省部分因田間花朵發育較慢，需分次採收所增加之勞力與時間；便於採收後處理、包裝、運輸與貯藏；實爲降低成本提高品質之一經濟可行方法 [7, 14, 18, 26, 26, 27, 33]。

Kofranek 等人[20]把大菊 Albatross 蕾期採收熟度分爲四級，即緊蕾期 (stage Ⅰ)，鬆蕾期 (stage Ⅱ)，外瓣微展期 (stage Ⅲ) 及全花瓣展開期 (stage Ⅳ)。臺灣大菊之採收熟度，依上述分法，都屬蕾期採收。其中內銷之熟度約在 stage Ⅲ 到 stage Ⅳ，外銷日本者，則屬於 stage Ⅰ (圖 1) 或 stage Ⅱ。Kofranek 等人 [19] 認爲大菊應在 stage Ⅱ (花徑

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* 8-HQC: 8-hydroxyquinoline citrate

4.5 cm 以上）熟度採收，Marousky [26] 也認爲花徑應在 5.0～6.0 cm 時採收。若小於上述熟度採收，即使置於保鮮液中，花朵展開較慢，盛開時也較小。故臺灣現行大菊之採收熟度，不祇瓶插時，應置於保鮮液中，使花展開 [3, 12, 18, 19, 26, 33]，且在採收後運輸前應予保鮮液預措[13, 14, 15]，方能確保採收後之品質。菊花保鮮劑中，主要成分爲供應生長與發育之蔗糖和殺菌劑。蔗糖濃度依菊花品種而異[18]，一般在1～5%[12,36]，而殺菌劑則以 8-HQS（或 8 HQC）200ppm 被應用的最爲廣泛[12,25,26,35,36]。然 Kofranek 與 Halevy[18] 認爲 8-HQC 會使菊葉變黃，認爲改用硝酸銀爲殺菌劑 [2,34] 較爲理想。又 Reist 與 Rey 二氏 [32] 認爲 K 配方（含 3.5%蔗糖，30 ppm 硝酸銀及 75 ppm 枸橼酸），較含 2.5%蔗糖及 200 ppm 8-HQS 之保鮮液對多花型（spray type）蕾期採收 Pink Marble 菊花爲佳。而本研究室發現康大配方（cornell solution）[35] 對玫瑰 [1] 及多種省產菊花切花均有良好效果，故本研究之目的，在研究不同蔗糖濃度及 8-HQS 對蕾期採收菊花品質及壽命之影響，供蕾期採收菊花之處理、運輸、貯藏、批發及批發後處理之參考。

材料與方法

供試大花型菊花（standard mums）採取自彰化縣田尾鄉菊花專業區外銷日本之花材。黃色之冬王品種於民國六十七年一月廿一日下午三點採收，熟度分緊蕾（stage Ⅰ）及外瓣略展期（stage Ⅲ）二種。白色之平和台品種於同年八月九日緊蕾期（圖 1）採收，花徑 3.0～3.5cm。平和台採收後於產地立給予三小時不同蔗糖濃度處理。所有切花於當天晚上送達臺大花卉研究室後，立刻重剪花莖，除去莖基部葉片。冬王品種取花莖 50 cm（田間植株高度 90～100 cm），每處理 10 枝。平和台品種產地採收之花莖爲 90cm（田間高度爲 100 cm），吸 3 小時水或保鮮液後到研究室重切爲 75cm花莖，每處理 7 枝，或切爲 40cm 花莖，每處理 3 枝。瓶插室溫爲 25±2°C，光線爲室內自然漫射日光（diffused day light）及由天花板照射下來之 40 瓦特日光燈，白天照 9 小時。相對濕度約爲 60～85%。

冬王品種有二保鮮配方，一爲康大配方[35]，含 200ppm 8-HQS 及 50ppm 醋酸銀，蔗糖則爲變數由2～10%。另一爲K配方[32]，含 30 ppm 硝酸銀及 75 ppm 枸橼酸，蔗糖含2～10%。夏天採收之平和台品種，保鮮劑含 200 ppm 8-HQS 及 25 ppm 硝酸銀，蔗糖濃度爲2～30%。對照爲蒸餾水，所有保鮮液均以蒸餾水配之。於處理時期，每天測鮮重，花徑大小，展開度及葉片劣變萎凋黃化的情形。花莖 40cm 之平和台，置於 500 ml 三角瓶，內盛 500ml 保鮮液，每瓶一枝切花爲一重複，密封瓶口，以防蒸發所造成誤差，每天晨晚隔 12 小時以 Mettler P1210 電動天平測花莖及保鮮液重量變化至 0.01 克，以求花莖之吸水及蒸散量。切花壽命則以外圍三或四層舌狀花失去膨脹度（turgidity），或略呈淺褐色或脫落或腐敗者視爲已失去其切花壽命。

結果與討論

本研究結果顯示，康大配方中各不同蔗糖濃度處理，其鮮重之增加均較K配方爲佳(表1.)。於 stage Ⅲ 熟度採收，11 天後 K 配方之花徑與康大配方相近，但於緊蕾期（stage 1）採收者，則花徑略遜於康大配方，且菊葉下垂（dropping）呈失水狀，而康大配方則無此現象，顯示康大配方中含 8-HQS、醋酸銀及蔗糖，對花莖水分的保持[28,34]較單含硝酸銀及蔗糖者爲強。在不含 8-HQS 之K配方，所有供試 120 枝花莖，在採收後第 8～16 天中（圖 3.），莖葉遭受 Ray Speck 病之病源菌 *Stemphylium* spp. 及 *Alternaria* spp. 之爲害，使花不能獲得水分萎凋而落瓣，致瓶插壽命短暫。在康大配方含 2%蔗糖也有相同腐敗情形，而對照之蒸餾水處

表 1. 保鮮劑種類、蔗糖濃度及採收熟度對冬王菊花鮮重變化之影響。

Table 1. Effect of kind of preservative solutions, sucrose concentration and harvest stage on percent change in fresh weights of Tung-Wong chrysanthemum. [1,2,3]

Sucrose concentration %	% weight changes after					
	6 days		12 days		18 days	
	Bud harvested at stage					
	I	III	I	III	I	III
Control (water)	+26.1	+22.1	+20.9	+16.9	+16.0	+11.5
Cornell solution						
2	+49.1	+43.3	—	—	—	—
5	+55.0	+50.6	+74.1	+58.5	+78.0	+54.6
7	+49.9	+50.6	+71.9	+63.2	+72.5	+59.0
10	+48.7	+47.6	+72.8	+60.5	+76.3	+59.3
K solution						
2	+35.9	+38.5	+30.9	+34.4	—	—
3.5	+44.1	+44.8	+37.8	+34.2	—	—
7	+36.5	+39.0	+36.2	+38.9	—	—
10	+44.1	+44.2	+51.8	+47.3	—	—

1. Cornell solution contained 200 ppm 8-HQS and 50 ppm silver acetate and K solution contained 75 ppm citric acid and 30 ppm $AgNO_3$.
2. Bud stage I: about 3.0~3.5 cm diameter, tight buds with no florets extending. Bud stage III: expanded buds with several outer florets extending.
3. Dash indicates stem discarded before measurements because of stems and foliage decay and wilted florescence caused by chrysanthemum ray speck.

表 2. 康大配方中蔗糖濃度及採收熟度對冬王菊花壽命及花大小之影響。

Table 2. Effect of sucrose concentration in Cornell solution and harvest stage on longevity and flower size of cut Tung-Wong chrysanthemum [1,2,3]

Sucrose concentration %	Longevity days		Flower weight gm		Diameter cm		Thickness mm		Length of central florets mm	
	I	III	I	III	I	III	I	III	I	III
Control (Water)	11.6a	10.3a	10.4	11.1	10.8a	10.6a	33.0a	37.0a	20.2a	27.0a
2	16.3b	14.6b	16.3	14.2	—	—	41.0b	44.2a	30.6b	36.6b
5	20.6c	17.6c	18.8	20.1	13.2b	13.3b	48.6c	54.8b	36.6c	39.6b
7	22.1d	19.6d	20.0	20.7	13.8b	13.9b	51.2cd	56.8b	41.2c	43.6bc
10	22.3d	19.1cd	22.1	21.2	13.4b	13.2b	53.8d	61.0b	42.2c	45.2c

Note: 1. All sucrose solutions contained 200 ppm 8-HQS and 50 ppm silver acetate. Distilled water was used in all treatments.
2. Stem harvested Jan. 21, 1978, the size of flowers were measured at 16 days after harvest.
3. Values in columns followed by different letters are significantly different at the 1 % level by Duncan's multiple range test.

表 3. 蔗糖濃度與花徑長短對蕾期採收平和臺菊花壽命及花大小之影響。

Table 3. Effect of sucrose concentration and stem length on longevity and flower size of bud cut Ping-Huo-Tai chrysanthemum [1-2-3-4]

Sucrose concentration %	Longevity days		Flower weight gm F. W.		Thickness cm		Length of central florets mm		Length of outer florets mm	
	75 cm	40 cm	75 cm	40 cm	75 cm	40 cm	75 cm	40 cm	75 cm	40 cm
Control (water)	3.1a	9.3a	—	7.6a	—	—	—	8.8a	—	43.1a
2	16.4cd	18.7c	13.6a	21.4b	31.8a	26a	16.4a	22.5b	53.8a	57.7b
3.5	15.0bc	18.7c	19.8bc	23.2b	37.4b	51b	21.9a	26.4b	55.8a	58.0b
5	18.1d	18.7c	18.4b	26.7b	38.1b	51b	21.0a	29.6b	57.7a	62.2b
10	18.3d	13.7b	21.6c	—	44.8c	55b	23.6a	—	58.7a	—
30	8.6b	7.7a	—	—	—	—	—	—	—	—

Note 1. All sucrose solutions contained 200 ppm 8-HQS and 25 ppm $AgNO_3$ except 3.5% sucrose conc. which contained 30 ppm $AgNO_3$. Distilled water was used in all treatments.

2. Buds initially 3.0-3.5 cm in diameter. Stems harvest on Aug.9, 1978. The harvesting position for 75 cm and 40 cm stem length were about 25 cm and 60 cm above soil respectively. Stem length = Stem length plus inflorescence cm.

3. Dash indicates stem discarded before measurement because of inflorescence deterioration and wilted foliage.

4. Same as note 3 of table 2. The size of flower measured at 20 and 21 days after harvest for 75 cm and 40 cm stem length respectively.

表 4. 蔗糖濃度與花徑長短對平和臺菊花鮮重變化之影響。

Table 4. Effect of sucrose concentration and stem length on percent changes in fresh weights of Ping-Huo-Tai chrysanthemum [1-2-3].

Sucrose concentration %	% weight changes after			
	6 days		12 days	
	75 cm	40 cm	75 cm	40 cm
Control (water)	−25.0	+14.6	—	+ 1.1
2	+12.5	+25.8	+ 4.8	+42.8
3.5	+17.0	+30.7	+20.2	+47.8
5	+16.8	+35.2	+17.5	+48.4
10	+11.8	+29.2	+16.3	+46.0
30	−12.8	+ 7.5	—	—

Note 1, 2, 3:the same as table 3.

表 5. 蔗糖濃度與花莖長短對蕾期採收平和臺菊花葉片之影響

Table 5. Effect of sucrose concentration and stem length on leaves injury rating of Ping-Huo-Tai chrysanthemum cut at bud stage and opened 12 days in preservative solutions.

Sucrose concentration %	Dropping		Desiccation		Chlorosis	
	75 cm	40 cm	75 cm	40 cm	75 cm	40 cm
Control (water)	4	1	0.0	0.0	1	1
2	1	0	0.5	0.0	0	0
3.5	1	0	0.0	0.0	0	0
5	0	0	0.5	0.5	0	0
10	1	0	1.0	4.0	0	0
30	4	0	4.0	4.0	0	0

Ratings: 0, none; 1 slight; 2, moderate; 3, severe; 4, very severe.

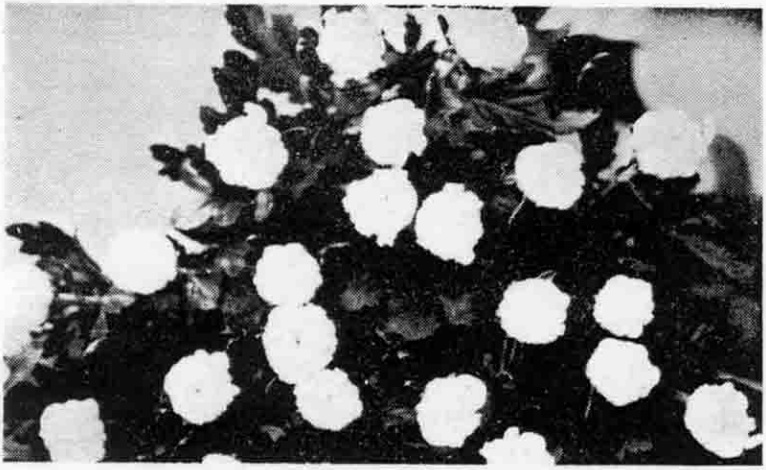

圖 1. 緊蕾期 (stage 1) 採收之平和臺菊花

Fig. 1. Stage 1 of bud-cut Ping-Huo-Tai chrysanthemum harvested on Aug. 9, 1978.

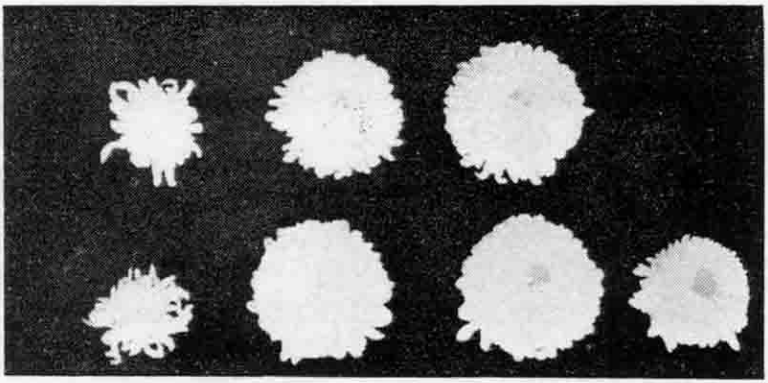

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圖 2. 緊蕾期採收之平和臺菊花，在不同蔗糖濃度 (%) 下，採收後21天花朵之展開度。

Fig. 2. Bud-cut Ping-Huo-Tai chrysanthemum opened in various sucrose concentration, photo. 21 days after harvest.

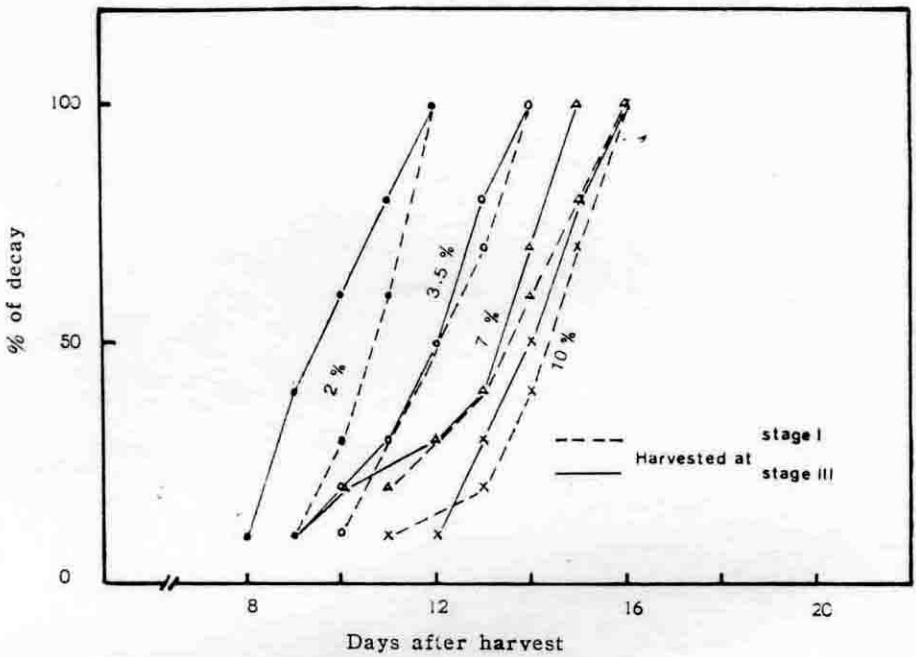

圖 3. K配方中冬王菊花之腐敗率

Fig.3 Decay in K solution of Tung-Wong chrysanthemum.

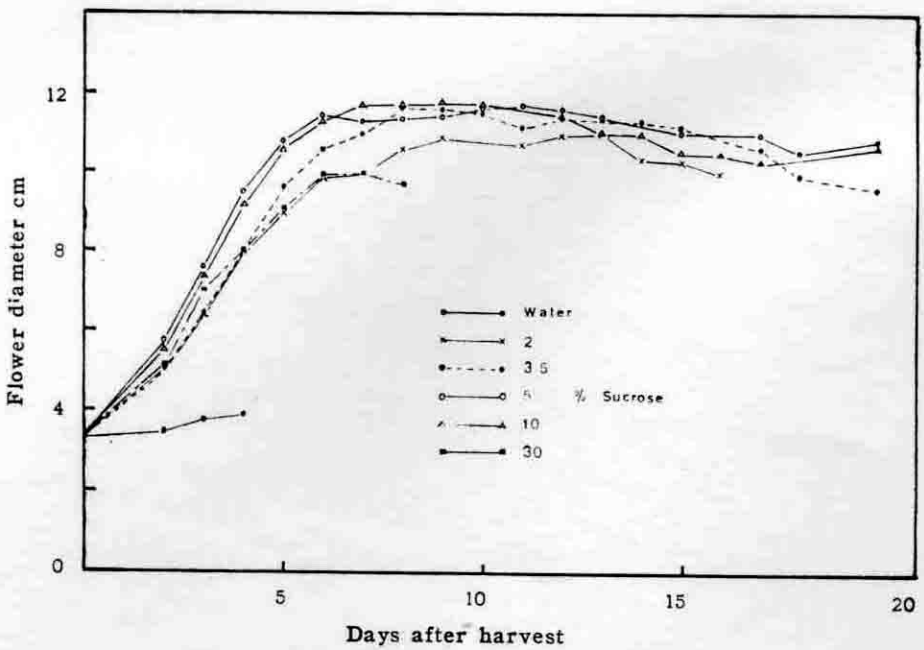

圖 4 蔗糖濃度對 75cm 長平和臺菊花花徑之影響

Fig.4 Effect of sucrose concentration on flower diameter in 75 cm flower stem of Ping-Huo-Tai chrysanthemum.

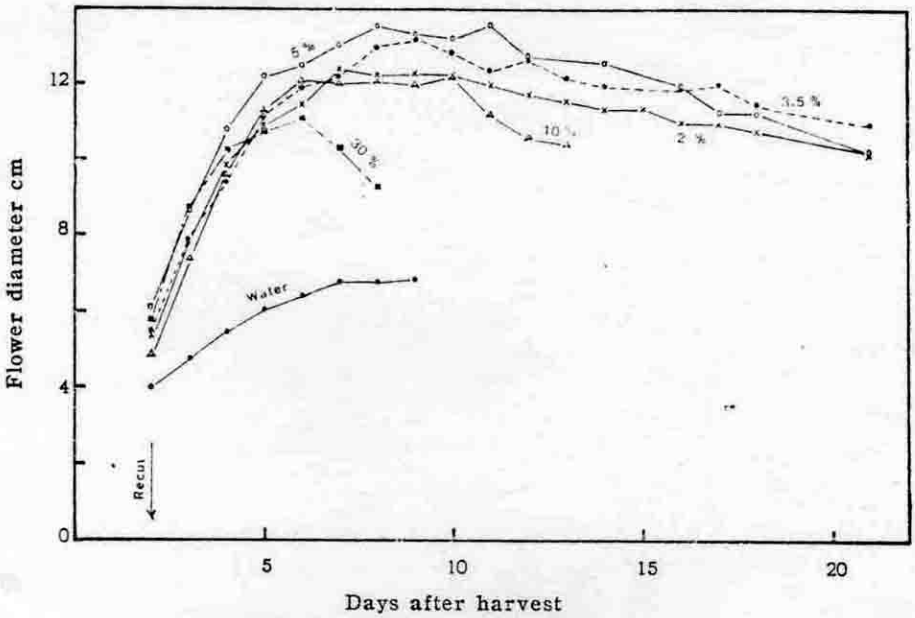

圖 5. 蔗糖濃度對 40cm 長平和臺菊花花徑之影響

Fig. 5 Effect of sucrose concentration on flower diameter in 40cm flower stem of Ping-Huo-Tai chrysanthemum.

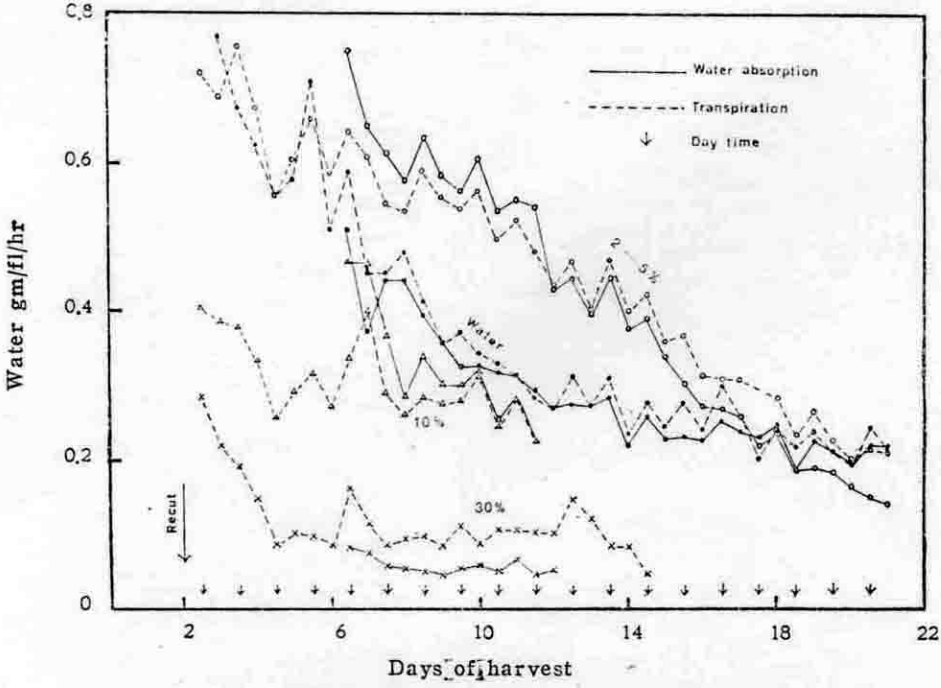

圖 6. 蔗糖濃度對平和臺菊花水分吸收及蒸散之影響

Fig. 6 Effect of sucrose concentration on water absorption and transpiration of Ping-Huo-Tai chrysanthemum.

理者，則完全不見發病，顯示此批切花，植株在田間帶有大量之 Ray Speck 病源菌，在含2%蔗糖下，很容易大量繁殖，致 200 ppm 8-HQS 及 50 ppm 醋酸銀無法達到完全殺菌之效果，而蔗糖 5%以上者，可能因蔗糖濃度的增加，造成水分活性之降低，使微生物增殖發育較慢，200ppm 8-HQS 及 50ppm 醋酸銀足以殺死病菌[23]，故5～10%蔗糖均未有病徵發生。而K配方中，不含 8-HQS，祇靠 30 ppm 硝酸銀殺菌[2,31,34]，其中 75 ppm 之物像酸是酸化保鮮劑之用[13]而已，2～10%蔗糖處理者均罹病腐敗，其發病速度依蔗糖濃度之增加而延緩（圖 3），更清楚地顯示隨蔗糖濃度之增加，降低水分活性，使病源菌增殖發育遲緩而延遲發病。本結果顯示保鮮劑中含有 8-HQS 及醋酸銀者，其殺菌力較强於單施硝酸銀者。然 Kofranek 與 Halevy[19]，在美國加州發現 8-HQC 會使菊葉黃化（chlorosis），改用硝酸銀則無此現象。Marousky[25,26] 在 Florida 州也發現 8-HQC 加蔗糖會使菊葉在採收後 10～18 天後黃化，其程度視品種及季節而異，冬季較春季爲輕。他認爲黃化並非喹啉（guinoline）的關係，而是蔗糖所導致，1977 年 Gay 與 Nichols[11] 也具同樣見解。本研究中之冬王及平和台，在 8-HQS 加蔗糖處理中，均未發現有促進黃化之現象，秋採之月友 10%蔗糖處理，於葉脈間略有黃化（未發表資料）。也許冬王與平和台這二品種較不易受害及其生育環境如光線强度不如佛州之强烈，故較不易造成菊葉積聚過多碳水化合物而黃化[38]。却是於蒸餾水之對照，採收後12天，二品種之葉均部分黃化衰老，顯示 8-HQS 和蔗糖有抗老化作用[6,8,9,17,30,37]。本研究參酌近年來菊花保鮮劑之研究[7,12,18,19,20,21,25]，設計出基本保鮮劑配方爲 200 ppm 8-HQS, 25 ppm 硝酸銀和蔗糖。蔗糖濃度將依菊花品種，季節及花莖長短而有所不同。

冬季元月廿一日採收之冬王大菊，在康大配方，所有蔗糖濃度處理均極顯著地優於以蒸餾水爲對照者。蔗糖 2～10%，不論於緊蕾期之 stage Ⅰ 或外瓣略展之 stage Ⅲ 採收，其切花壽命、鮮重、厚度及花心舌狀花之長度，均隨蔗糖濃度之增加而增加，且花型美好，10% 蔗糖對花徑及壽命略遜於 7%者，故以 7%蔗糖似對蕾期採收之冬王大菊最爲理想(表 2.)。stage Ⅰ採收者較 stage Ⅲ 採收者壽命略長 2～3 天，鮮重%變化較大（表 1.），至採收後 16 天之鮮重，花徑及中心舌狀花長度皆相近，惟花之厚度略小（表 2.）。由此可知冬王在緊蕾期採收，祇要施以適當保鮮劑，壽命較長，品質不遜於 stage Ⅲ採收者（表 2.）。夏季八月九日緊蕾期採收之平和台大菊，在蒸餾水之對照，花莖 75cm 者，花朵完全不展開就萎凋（圖 4.），花莖 40cm 者花瓣略張而已（圖 2 和 5）。在含 200ppm 8-HQS 及 25ppm 硝酸銀之基本配方中，花莖 75cm 者，以 5～10% 蔗糖對切花之壽命及品質最好（表 3. 及 圖 4），在採收後 7 天花朵已展開到最大。花莖 40cm 者，蔗糖 2%最爲適中。雖 3.5 及 5%蔗糖處理者，花朵較 2%，大也較厚，鮮重及壽命相近，可是蔗糖 5%者，於採收後 12 天，葉緣已顯出輕微焦枯現象 (desiccation)(表 5.)，而3.5%者，也在採收後15天出現葉受害情形。若依 Kofranek 等人[21]之法，在花完全盛開（第八天）後，就從保鮮液中移至去雜子水 (deionized water)，必可減少葉受糖分爲害情形，則蔗糖 2～5%應甚爲理想。蔗糖 10%對短花莖者，已造成傷害，致縮短壽命及降低品質，30%蔗糖不論長短花莖危害更甚（表 3. 圖 2. 4 及5）。從上述得知，花莖長短對蔗糖濃度反應有別，長花莖者（75cm），莖基離地面較近（25cm），而短花莖者（40cm），莖基離地面較遠（60 cm），離地面愈遠其組織較嫩而少木質化，有利於水分與糖之吸收[39]，2%蔗糖已可得甚佳效果，10%已明顯受濃度過高之害。故本研究顯示，理想之蔗糖濃度，除受品種[18]及氣候[26,37]影響外，其供試花莖之長短，也是決定因素之一。在實用上 75 cm花莖，代表採收到批發時之長度，而 40 cm 花莖，代表消費者之瓶插花莖。

保鮮劑中蔗糖極顯著地增加切花之鮮重，壽命及品質（表1, 2, 3, 4 及圖 2, 4 和 5），而於蒸餾水之對照，花朵未能展開就凋謝，是因蒸散失水較吸水爲多（圖 6.），水分失去平衡，降低

膨壓而造成水分逆境的結果（表4)。而花蕾之展開，是一種生長過程，這種生長過程(growth process)，細胞必須在充滿膨壓下才能進行。蔗糖處理，可提高花瓣之滲透壓，增加花瓣之吸水能力[13]。是故，2～5%蔗糖，其三濃度平均吸水量與蒸散量均較對照爲高，且在採收 12 天前，吸水量均大於蒸散量（圖6），故花莖鮮重一直在增加中（表4），花徑也一直維持在最大狀態下（圖5.)。但採收 12 天後，吸水量已不如蒸散量，可能是外圍舌狀花先受其影響，花瓣下垂，致最大花徑漸小（圖 4, 5）。蔗糖 10%或 30%，其蒸散量均不如對照，10% 蔗糖處理者，吸水量在採收後 12 天一直較蒸散量爲高，顯示在 10% 蔗糖下，由於保鮮液滲透壓高，吸水量減少，因氣孔開度也減小[31]，使蒸散量降低的比吸收量爲多，而仍維持相當之水分平衡[28,34]。30%蔗糖處理，雖吸水與蒸散量很低，但蒸散量大於吸水量甚多（圖 6），使花缺水不能展開到應有的大小（圖4, 5），使葉乾枯捲曲受害嚴重（表5）。在0～30%蔗糖處理，所有花莖之吸水量與蒸散量，均隨老化而漸減（圖 6），顯示有維管束堵塞現象(vascular blockage)[9]。蔗糖除上述可以改善切花水分平衡外，另外主要功能，可供花朵生長所需之代謝物質及呼吸作用之基質[8,34]，抑制蛋白質之分解[6,22,37]。據最近研究，認爲切花瓶插壽命之結束，並非缺少呼吸基質所致，而是無法維持 mitochondria 膜之完整性，而蔗糖之施用，就可以維持膜之完整性[8,17]。另有研究蔗糖與切花生長素之關係，認爲蔗糖可以增加 cytokinins 效果[30]，減少乙烯之危害[30]，降低玫瑰切花 abscisic acid 之含量[5]，並與 abscisic acid 有頡抗作用[1]。這些都是抗老化作用（antisenescence）也許都能解釋蔗糖可以延長切花壽命之致因。

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Summary

Standard chrysanthemums harvested as buds (3.0-3.5 cm) were opened in sucrose solution from O to 30%. Concentration of 7% for winter cultivars Tung-Wong and 5 to 10% for long stem (75 cm) and 2% for short stem (40 cm) of summer harvested Ping-Huo-Tai.

Buds opened in preservative solution were better quality and greater longevity than those opened in water. Foliage on stems held in 8-HQS plus sucrose and silver nitrate (or silver acetate) could not become chlorotic in Tung-Wong and Ping-Huo-Tai chrysanthemum. However, supraoptimum sucrose concentration were caused leaf damage.

Buds held in sucrose solution contained 200 ppm 8-hydroxyquinoline sulfate (8-HQS) and silver acetate (50 ppm) resulted in better water balance and decay control than silver nitrate (30 ppm) and citric acid (75 ppm).