



# 行政院國家科學委員會專題研究計畫成果報告

## Putrecine對玉米子粒發育及萌芽的影響及其作用機制之研究： putrecine 對玉米種子萌芽的影響

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### 一、中文摘要

臺農1號玉米種子胚及胚乳的PUT及SPD含量在萌芽36小時達到最高隨後降低，胚乳的PUT與SPD含量遠小於胚的含量。胚乳的 $\alpha$ -amylase活性在萌芽初期很低，但在萌芽48小時起大幅增加。利用PUT合成抑制劑D-arginine (D-ARG) 處理萌芽中的玉米種子，會顯著降低胚的鮮重並抑制胚及胚乳的PUT與SPD含量，亦會降低胚乳 $\alpha$ -amylase活性。D-ARG處理下添加PUT，可增加胚的鮮重、胚及胚乳的PUT含量及其胚乳的 $\alpha$ -amylase活性。

玉米種子以PEG(水分滲透調節劑)、NaCl、CdCl(重金屬)或低溫處理，均會抑制胚與胚乳的PUT含量、增加或抑制SPD含量，並抑制胚乳的 $\alpha$ -amylase活性。但以酸鹼度處理的改變鮮重，似與種子內多元胺含量及胚乳的 $\alpha$ -amylase活性變化無關。

經由以上的結果，我們認為玉米種子萌芽時PUT及SPD含量可能與 $\alpha$ -amylase活性有關。環境壓力下 $\alpha$ -amylase活性降低，可能受到PUT與SPD含量的增減所調控。

### 二、英文摘要

**Study on the effects and mechanisms of putrescine on kernel development and seeds germination of maize : The effects of putrecine on seeds germination of maize**

The contents of PUT and SPD of germinating seeds of maize of Taninung No.1 reached the maximum at the 36<sup>th</sup> hour of germination and then decreased. The contents of polyamines in embryo are much more than in endosperm. The activity of  $\alpha$ -amylase at early stage of germination was low and increased significantly at the 48<sup>th</sup> hour of germination. Treated with D-arginine (D-ARG), an inhibitor of PUT synthesis, results that decreased the fresh weight, the contents of PUT and SPD of embryo and endosperm, and the activity of  $\alpha$ -amylase of endosperm during germination. In the mean times, treated with D-ARG and PUT increased the fresh weight, the contents PUT and SPD, and the activity of  $\alpha$ -amylase.

Germinating seeds treated with PEG(an osmotic regulator), NaCl, CaCl<sub>2</sub>(a heavy mental) or low temperature decreased the contents of PUT, increased or decreased the contents of SPD in embryo and endosperm, and decreased the activity of  $\alpha$ -amylase in endosperm. However, the changes of fresh weight by pH treatment seemed not correlation with the contents of PUT, SPD and the activity of  $\alpha$ -amylase in seeds.

For those results, we suggest that the contents of PUT and SPD correlate to the

activity of  $\alpha$ -amylase during germination of maize under stress.

### 三、計畫緣起與目的

果實或種子為植物體在生殖三長期之最主要的積儲器官，但在萌芽時卻轉變成最主要的供源器官 (source organ)，而幼胚則成為最主要的積儲器官 (sink organ)。近年來許多報告指出，就分子生物學的觀點而言，植物體積儲器官的積儲活性可能藉由一些植物荷爾蒙如 cytokinins、auxins、gibberellins 等的調控，經由誘導一些與澱粉合成或分解有關的酵素活性而達致 (余, 1995; Kuiper, 1995; Sonnewald & Willmitzer, 1992; Sonnewald *et al.*, 1994; Thomas & Rodriguez, 1994)。多元胺是否亦有調節積儲器官的積儲之能力？本研究室即擬以過去的研究為基礎，探討 putrescine 與玉米種子萌芽的關係，擬藉由改變 PUT 含量來探討各種環境下其對種子萌芽的影響，期能釐清 PUT 在種子萌芽所扮演的角色。

### 四、結果與討論

臺農1號玉米種子胚及胚乳的PUT及SPD含量在萌芽36小時達到最高隨後降低，胚乳的PUT與SPD含量遠小於胚的含量。胚乳的 $\alpha$ -amylase活性在萌芽初期很低，但在萌芽48小時起大幅增加。利用PUT合成抑制劑D-arginine (D-ARG) 處理萌芽中的玉米種子，會顯著降低胚的鮮重並抑制胚及胚乳的PUT與SPD含量，亦會降低胚乳 $\alpha$ -amylase活性。D-ARG處理下添加PUT，可增加胚的鮮重、胚及胚乳的PUT含量及其胚乳的 $\alpha$ -amylase活性。顯示抑制劑D-ARG的抑制PUT合成，會抑制玉米子粒的發育及其相關的澱粉合成酵素之活性，亦會抑制萌芽中的玉米胚之生長及

澱粉分解酵素之活性，表現出PUT與糖類酵素活性之關聯。

玉米種子以PEG(水分滲透調節劑)、NaCl、CdCl(重金屬)或低溫處理，均會抑制胚與胚乳的PUT含量、增加或抑制SPD含量，並抑制胚乳的 $\alpha$ -amylase活性。但以酸鹼度處理的改變鮮重似與種子內多元胺含量及胚乳的 $\alpha$ -amylase活性變化無關。

經由以上的結果，抑制劑D-ARG處理下添加低濃度PUT可增加玉米種子萌芽期間胚乳的 $\alpha$ -amylase活性，意味著PUT可能參與了GAs的調控 $\alpha$ -amylase的活性之過程。我們認為玉米種子萌芽時PUT及SPD含量可能與 $\alpha$ -amylase活性有關。環境壓力下 $\alpha$ -amylase活性降低，可能受到PUT與SPD含量的增減所調控。設若多元胺確實會影響 $\alpha$ -amylase之活性，其對供源器官與積儲器官的糖類酵素活性之差異性調控方式是可能的，唯需進一步的驗證。

### 五、計畫成果自評

根據本研究結果，我們認為玉米種子萌芽時PUT及SPD含量可能與 $\alpha$ -amylase活性有關。水分及鹽分壓力下 $\alpha$ -amylase活性降低，可能受到PUT與SPD含量的增減所調控。此結果符合我們先前的假設：植物體積儲器官的積儲活性可能藉由一些植物生長調節劑的調控，經由誘導一些與澱粉合成或分解有關的酵素活性而達致。未來應進一步以PUT與SPD的合成抑制劑處理水分及鹽分壓力下的玉米種子，以驗證降低或增加PUT與SPD的含量會對 $\alpha$ -amylase活性有所影響。此外並應探討多元胺與植物荷爾蒙，如gibberellins及abscisic acid，彼此之間的關聯性。

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