

The Effect of Two Triethylamine Compound on Carotenoid Synthesis and Quality of Flue-cured Tobacco Leaves

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Introduction

What's the triethylamine compound?

- ◆ The triethylamine compound was a kind of carotenoid synthetic inducer.
- ◆ Firstly proved could affect the biosynthesis of carotenoid in 1970 by Coggins in SCIENCE.
- ◆ In the following years, a lot of researchers had used triethylamine compound to change carotenoid content and improve quality of different plant.
- ◆ Up to now, the mostly used triethylamine compound was 2-(4-chlorobenzene-sulfury)-triethylamine (CPTA) and 2-(4-methy-phenoxy)-triethylamine (MPTA).

Introduction

- **Valadon (1982)** used CPTA in the mung bean seedlings, and found that the carotenoid content increased 17% after 8 days, and a new carotenoid (lycopene) was generated.
- **Ishida (1998)** added CPTA to the culture medium, and found that the Lycopene (a kind of carotenoid) and volatile flavor compound derived from carotenoid of tomato fruit and calyx significantly increased.
- **Similar conclusions was made by Hayman(1977) and TAO(2002)** used MPTA in orange.
- **Used in tobacco :** LIAO (2002) used MPTA solution to soak the tobacco leaves, and found that the carotenoid content significantly increased, but a polyethylene bag must be used in his experiment to keep the leaves, which made his method not practical.

Introduction

What's the means of carotenoid to tobacco ?

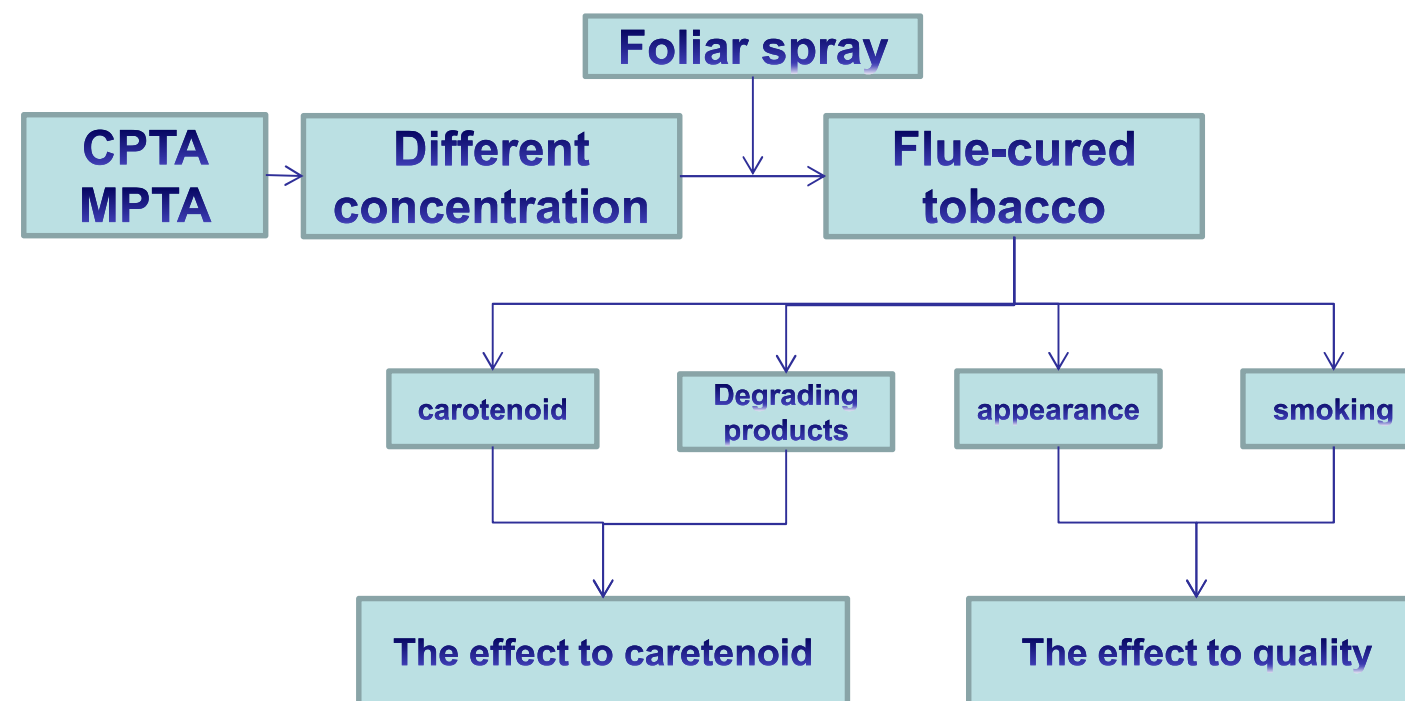
- ◆ The carotenoid is an important aroma precursor and chromogenic substance, which greatly affect the smoking quality and appearance quality of flue-cured tobacco leaves.
- Enzell (1990) found that about **80 kinds** of aroma substances degraded from carotenoid. Such as megastigmatrienone has a Cocoa flavor, and β -damascenone could generate a sense of rose fragrance.
- Weeks (1985) found that with the tobacco quality increased, the carotenoid degrading products obviously increased.
- GUO(2010) found that the appearance quality and smoking quality of flue-cured tobacco leaves enhanced with the increase of carotenoid content in a certain range.

Introduction

- ◆ Carotenoid is an anti aging and free radical substance.
- [Huang\(2002\)](#) found that adding carotenoid in cigarette or cigarette holder significantly reduced the oxidative damage of smoking to mice.
- Carotenoid not only plays a role in quality of flue-cured tobacco leaves, but also has something to do with the healthy problem of smoking.

Introduction

- Therefore, could the triethylamine compound be used in flue-cured tobacco to change the carotenoid content and quality? This is the problem to be solved in this paper.



Materials and Methods

◆ Materials

- Experiment Location: Henan province, in central China.
- Cultivar: ZhongYan NO.100(mainly cultivated in Henan province).
- The two triethylamine compound CPTA and MPTA was supplied by HuaZhong agricultural University.

Materials and Methods

◆ Methods

➤ Experimental design:

- CK: Deionized water;
- T1: 0.05%MPTA; T2: 0.1%MPTA; T3: 0.2%MPTA;
- T4: 0.05%CPTA; T5: 0.1%CPTA; T6: 0.2%CPTA;
- After about 10 days of topping, different treatment (solution) was foliar sprayed on the middle leaves (about 9~12 leaf position from bottom to top).
- Every treatment repeated 3 times and randomized block arrangement was made.



Materials and Methods

◆ Methods

➤ Sampling methods:

● Fresh leaves



Sampling volume : About 20 leaves every block.

Sampling time : Before treatment; Treatment after 25 days (harvest).

● Flue-cured leaves



Sampling volume : About 40 leaves every block.

Sampling time : After flue-curing.

Materials and Methods

◆ Methods

➤ Analyzing method:

- **Carotenoid** : HPLC; Fresh leaves including Neoxanthin, Violaxanthin, lutein and β -carotene; Flue-cured leaves including lutein and β -carotene.
- **Carotenoid degrading products**: GS-MS; Indices including β -damascenone, megastigmatrienone and so on.
- **Appearance quality**: Including color, maturity, leaf structure, body, oil and color density. A quantitative method was used which has a 1~10 score range of every index from poor to excellent.
- **Smoking quality**: Including aroma quality, aroma quantity and so on.

Results

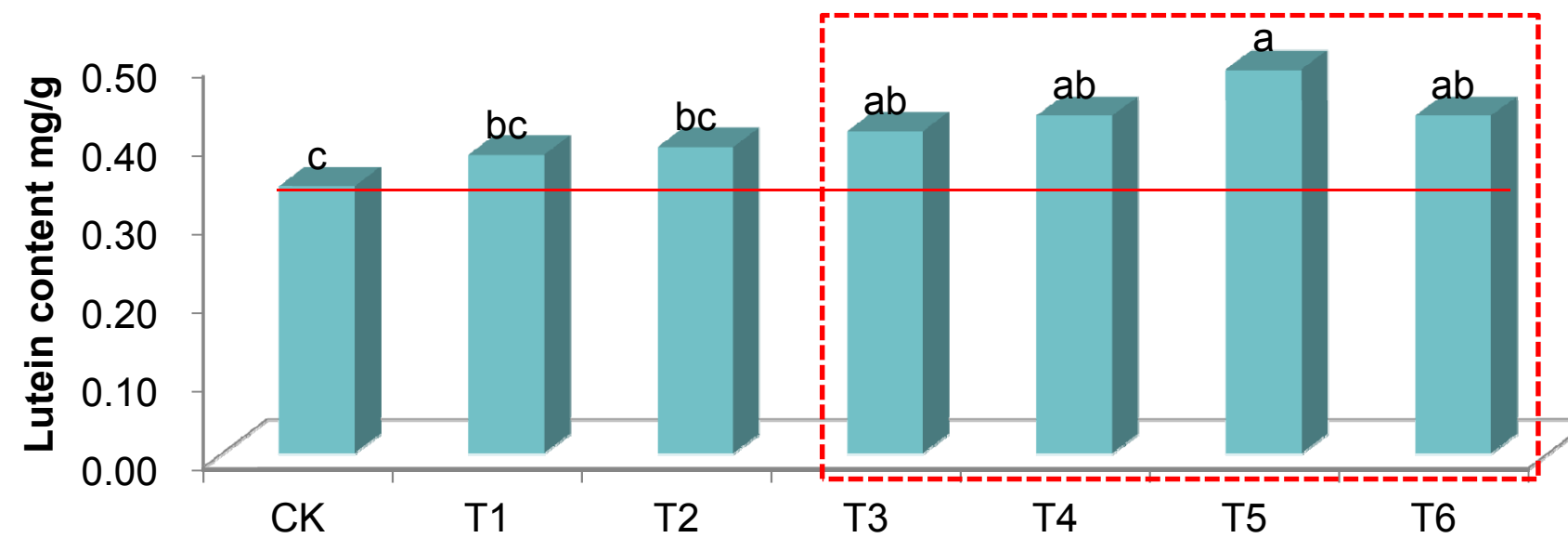
- The effect of triethylamine to carotenoid of fresh leaves
- The effect of triethylamine to carotenoid of flue-cured leaves
- The decrement of carotenoid during flue-curing of different treatment
- The effect of triethylamine to appearance and smoking quality

Results

- The effect of triethylamine to carotenoid of fresh leaves
- The effect of triethylamine to carotenoid of flue-cured leaves
- The decrement of carotenoid during flue-curing of different treatment
- The effect of triethylamine to appearance and smoking quality

Results

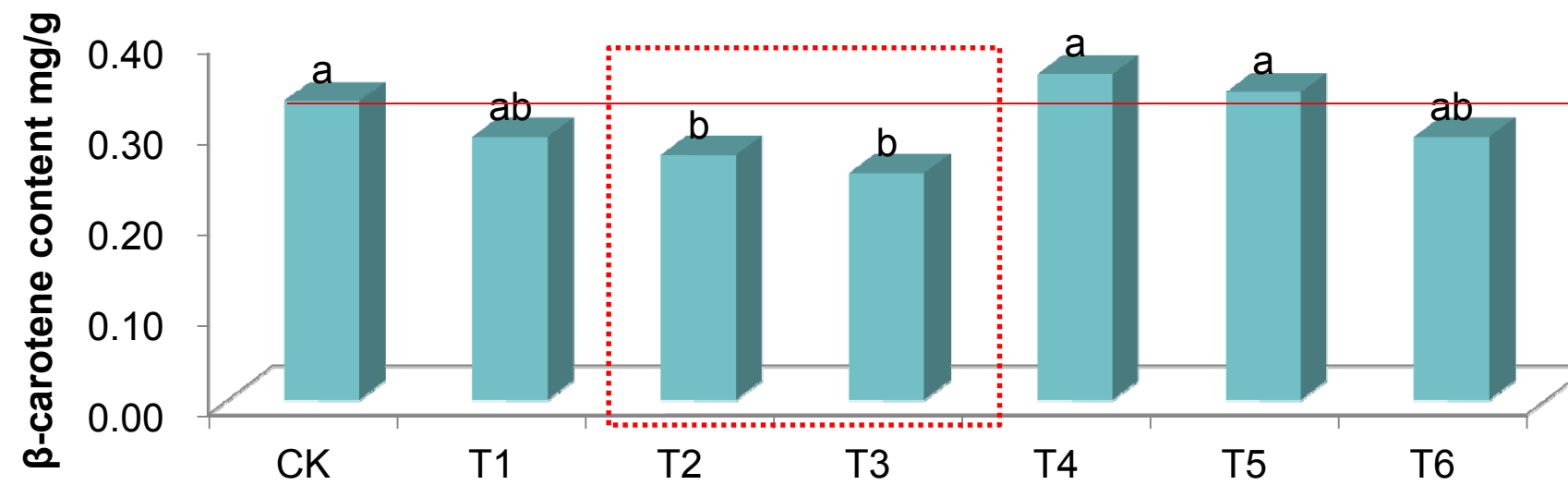
➤ Lutein content of fresh leaves after treatment



- The triethylamine compound had a positive influence on lutein content.
- 0.2% MPTA (T3) and 0.05~0.2% CPTA (T4~T6) treatment was significantly higher than control.

Results

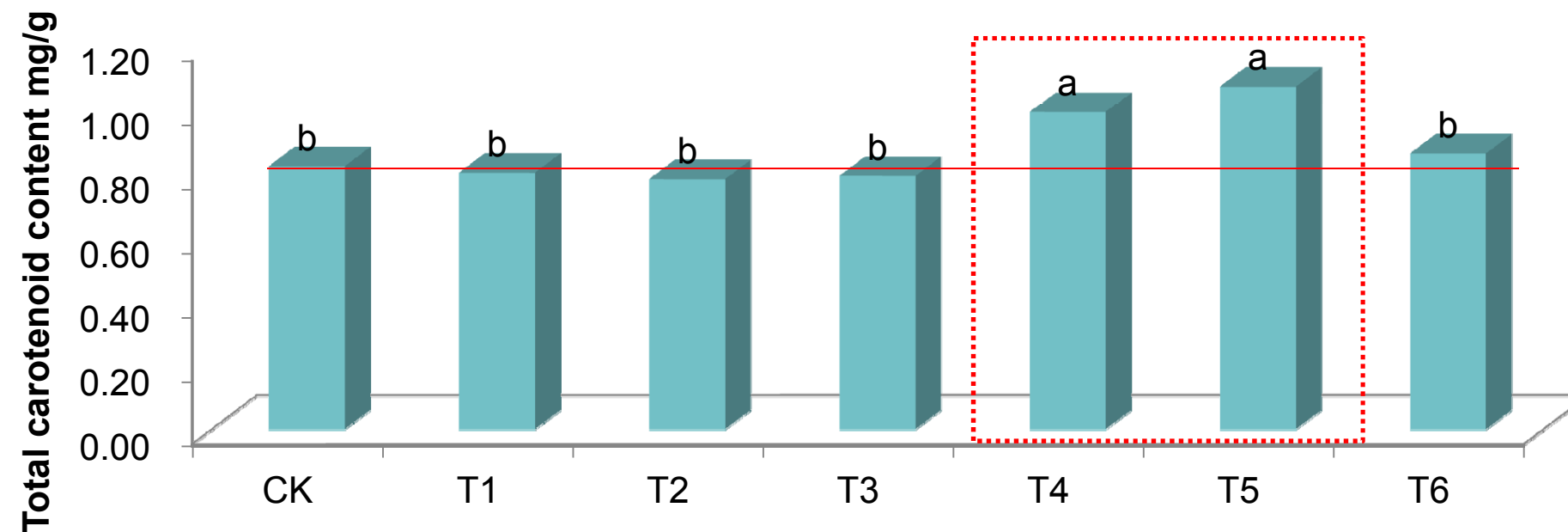
➤ β -carotene content of fresh leaves after treatment



- The triethylamine compound had little or negative influence on β -carotene content.
- 0.1~0.2% MPTA (T2~T3) treatment significantly lower than control.

Results

➤ Total carotenoid content of fresh leaves after treatment



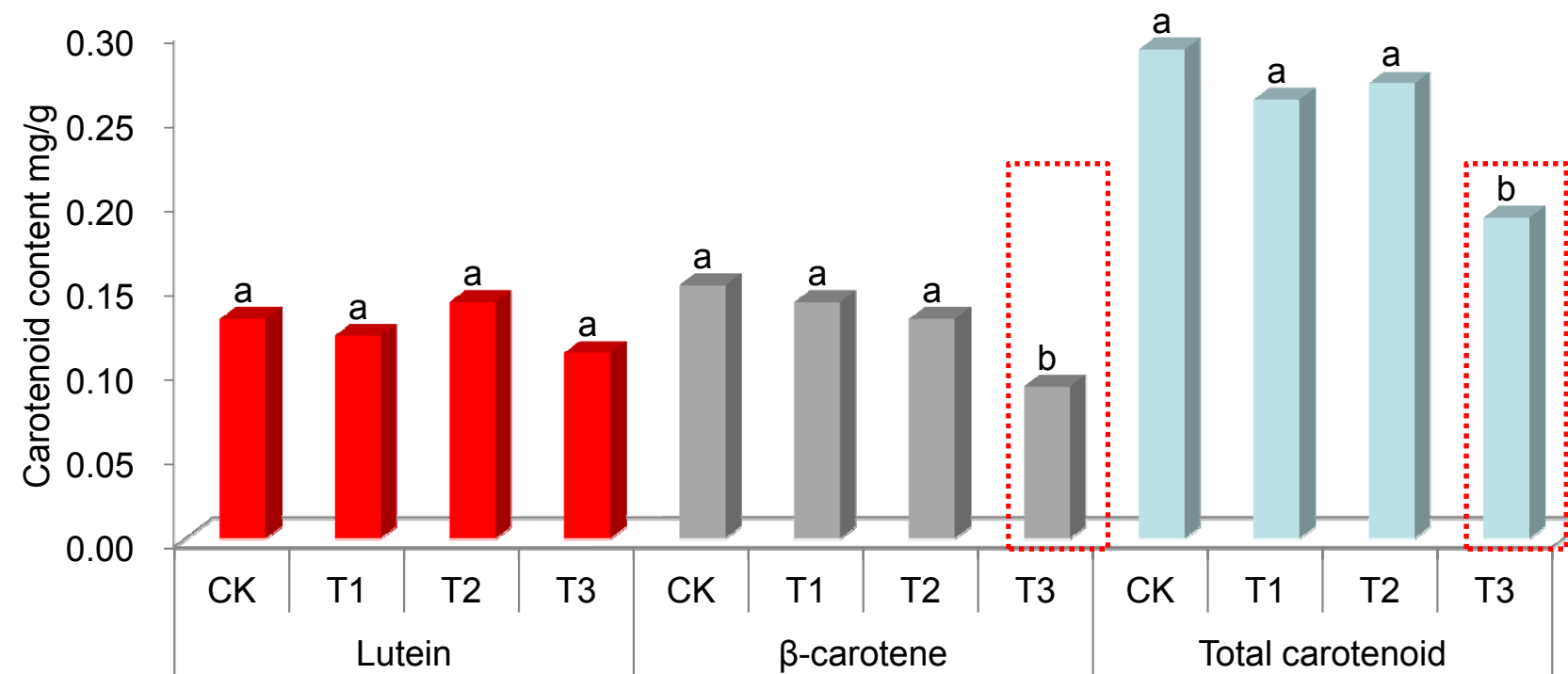
- The total carotenoid was more influenced by CPTA than MPTA in fresh leaves.
- 0.05~0.1% (T4~T5) CPTA treatment significantly higher than control.

Results

- The effect of triethylamine to carotenoid of fresh leaves
- **The effect of triethylamine to carotenoid of flue-cured leaves**
- The decrement of carotenoid during flue-curing of different treatment
- The effect of triethylamine to appearance and smoking quality

Results

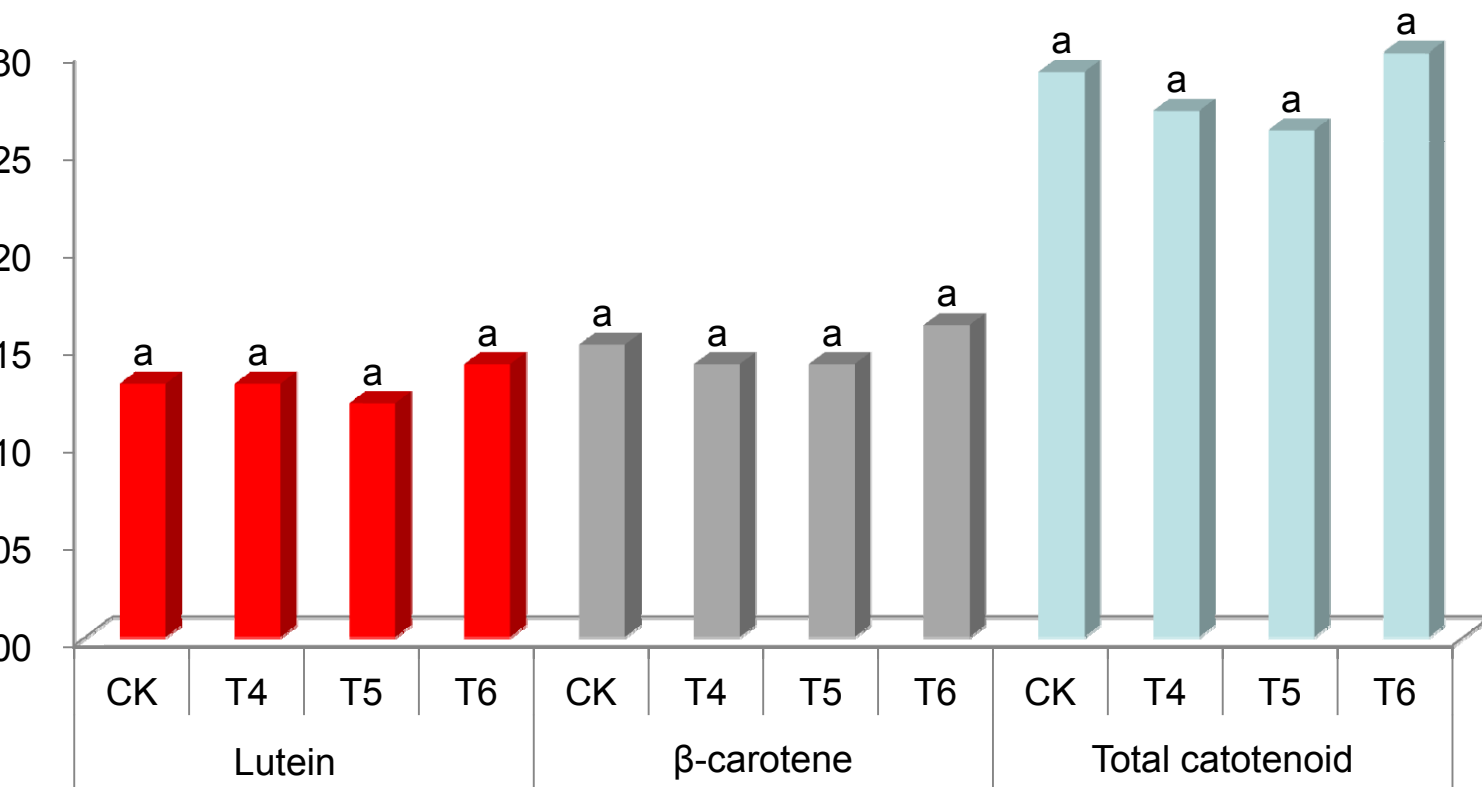
➤ Carotenoid content of flue-cured leaves of MPTA treatment



➤ β-carotene and total carotenoid content of 0.2% MPTA (T3) treatment was significantly lower.

Results

Carotenoid content of flue-cured leaves of CPTA treatment



No significantly difference was found between CPTA treatment and control.

Results

effect of triethylamine to carotenoid of fresh leaves

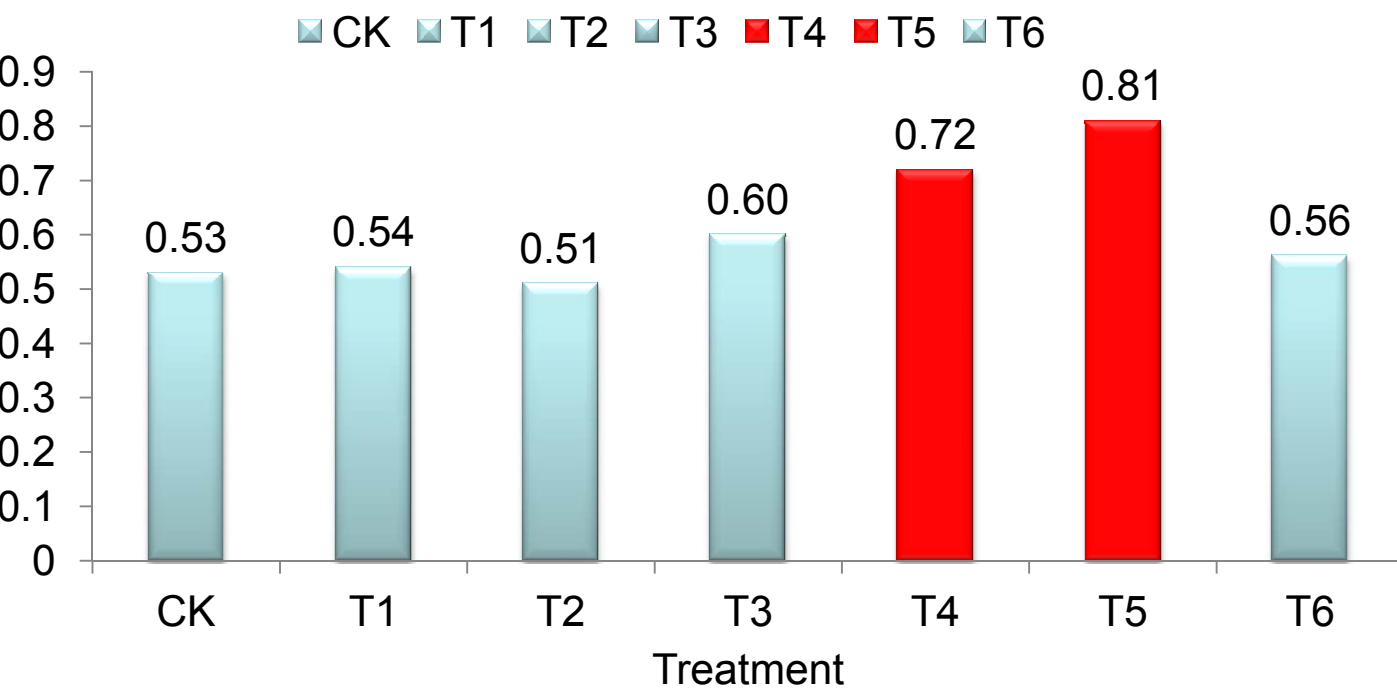
effect of triethylamine to carotenoid of flue-cured leaves

decrement of carotenoid during flue-curing of different treatment

effect of triethylamine to appearance and smoking quality

Results

decrement of carotenoid during flue-curing



decrement of carotenoid of 0.05~0.1% CPTA (T4~T5) treatment was obviously higher than control, which means the degrading products of carotenoid might be different.

Results

effect of CPTA to the degrading products of carotenoid

Degrading products of carotenoid	CK	T4	T5
Dihydroactinidiolide	1.87 b	1.98 b	2.33 a
Geranyl acetone	0.80	0.85	0.83
6-methyl-5-hepten-2-one	0.31	0.31	0.33
β -Damascenone	9.42 b	10.71 a	11.55 a
Megastigmatrienone A	0.39	0.41	0.39
Megastigmatrienone B	1.56 b	1.63 b	1.96 a
Megastigmatrienone C	0.61 b	0.63 b	0.91 a
Megastigmatrienone D	1.73 b	1.79 b	2.21 a
Total degradation products of carotenoid	16.68 b	18.30 ab	20.51 a

The total degrading products of carotenoid of 0.1% CPTA (T5) was significantly higher than control.

Results

effect of triethylamine to carotenoid of fresh leaves

effect of triethylamine to carotenoid of flue-cured leaves

decrement of carotenoid during flue-curing of different treatment

effect of triethylamine to appearance and smoking quality

Results

effect of MPTA and CPTA to appearance quality

nt	Color	Maturity	Leaf structure	Body	Oil	Color density	Total score
	8.0 b	7.2 a	7.5 a	7.7 a	8.1 a	7.8 a	76.9 b
	8.2 ab	7.2 a	7.4 a	7.9 a	8.2 a	8.0 ab	77.8 ab
	8.3 a	7.1 a	7.5 a	7.7 a	8.0 a	8.1 ab	77.6 ab
	8.1 b	7.1 a	7.5 a	7.7 a	8.0 a	8.1 ab	77.0 ab
	8.4 a	7.1 a	7.5 a	7.7 a	7.9 a	8.2 a	78.1 a
	8.5 a	7.2 a	7.4 a	7.8 a	8.0 a	8.3 a	78.7 a
	7.9 b	7.2 a	7.3 a	7.7 a	8.1 a	7.9 ab	76.3 ab

reatment, the color of flue-cured leaves had a trend to changing deeper, and the maturation and gloss was better, especially for the 0.05~0.1% (T4~T5) CPTA ent.

Results

effect of CPTA and MPTA to smoking quality

Sample	Aroma quality	Aroma quantity	Offensive	Irritancy	After taste	Total score
Control	5.8	5.8	5.8	6.0	6.0	65.1
0.05% CPTA (T4)	5.8	5.8	5.8	6.0	6.0	65.1
0.05% CPTA (T5)	5.8	6.0	6.0	5.8	6.0	65.7
0.1% CPTA (T6)	5.9	5.7	6.0	5.5	6.0	64.5
0.2% MPTA (T7)	6.0	6.2	6.0	5.8	6.0	67.0
0.2% CPTA (T8)	6.0	6.0	6.0	6.0	6.0	66.7
0.2% MPTA (T9)	5.7	5.8	6.0	5.5	5.5	63.2

Smoking quality of 0.05~0.1% CPTA (T4~T5) treatment were obviously higher than control.

Smoking quality of high concentration treatment (0.2% MPTA and 0.2% CPTA) were relatively low, especially for the irritancy and after taste score.

Conclusions

triethylamine compound could enhanced the lutein content and had
or negative influence on β -carotene content of fresh leaves when
spraying in the maturing stage.

carotenoid was more influenced by CPTA than MPTA in the field.

appropriate triethylamine compound to change total carotenoid
content in the field was CPTA, and the concentration was between
~0.1%.

carotenoid of flue-cured leaves was less influenced by triethylamine
compound than fresh leaves.

Conclusions

Field spraying 0.05~0.1% CPTA after topping in the field could significantly increase the carotenoid degraded aroma components, and improved the appearance and smoking quality of flue-cured leaves.

The application of CPTA in flue-cured tobacco for carotenoid adjustment and quality improvement is of good applying value and prospect.

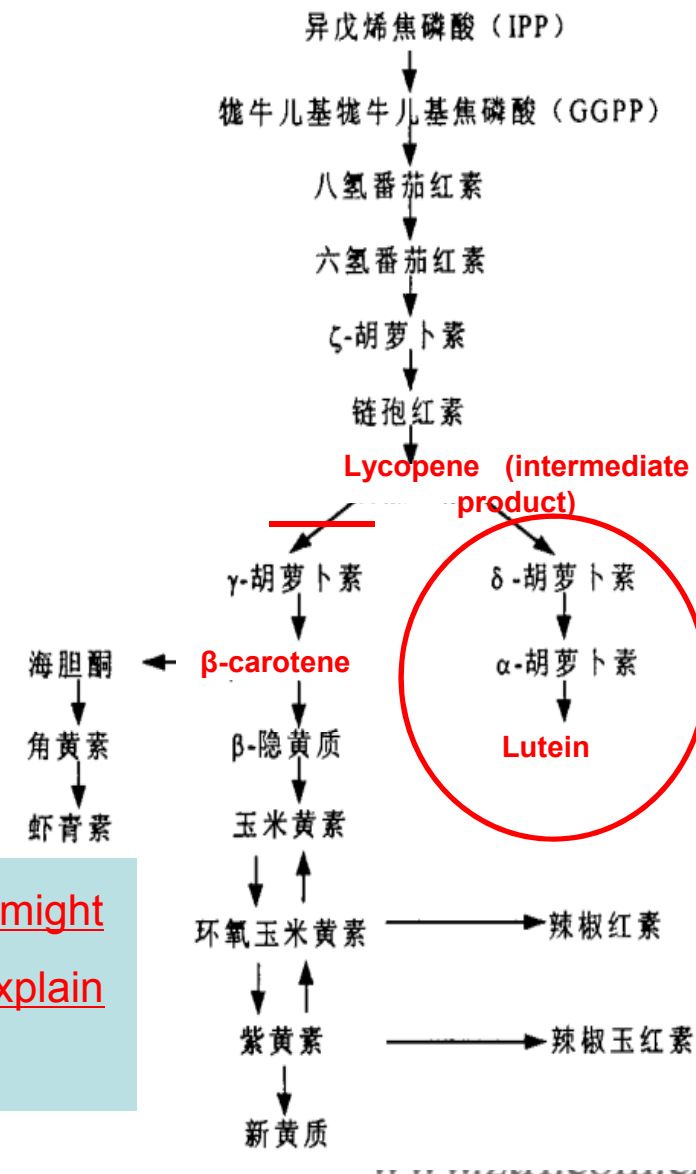
Future emphasis on

(1970) firstly found the CPTA could promote the accumulation of Lycopene in tomato, orange.

(1991), Bouier (1997) and Cunningham (1994) found CPTA and MPTA could inhibit the activity of β -LYC, block the transformation of Lycopene to β -carotene, as in accordance with triethylamine had little or no effect on β -carotene content in this paper.

(2002) speculated that MPTA not only inhibit the β -carotene synthesis but also improved the biosynthesis of Lycopene or other synthesis pathway of carotenoid.

Lycopene which was accumulated by CPTA or MPTA might be converted to β -carotene from the other pathway in tobacco leaves could explain why β -carotene content increased by CPTA or MPTA treatment.



Future emphasis on

What's the regulation mechanism of triethylamine compound to carotenoid (especially for lutein) in flue-cured tobacco ?

How to further validate the effect of triethylamine compound on flue-cured tobacco quality in different area.

Because of the importance of carotenoid to photosynthesis,

whether could we use the triethylamine compound in earlier stage

tobacco growth to promoting development ?

Thank you for your
attention!

