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Effect of Drying Method on Fresh Flue-cured Leaves Morphology, Colour and Chemical Components

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Introduction

The alkaloids, polyphenols and aroma contents are very important for tobacco quality, especially in the security of cigarette products for smokers.

Tobacco leaves were needed to dry before detecting these substances.

A lot of research results have shown that other crops had a different chemical compositions, biological activity by different drying methods.

The drying methods of other crops mainly focus on :

- *Hot air drying*
- *Sun-dried*
- *Air-dried*
- *Browning during different temperature and time*
- *Microwave-vacuum drying*
- *Freeze-drying*

The results showed that freeze-drying is a better way to maintain inherent chemical components contents and keep the highest activity.

- However, most of the studies about tobacco used kill-enzyme torrefaction to dry fresh tobacco leaves to detect the alkaloids, polyphenols and other chemical components contents.

- ***Question:*** whether there were difference between freeze-drying and kill-enzyme torrefaction?

We are interested in the difference of morphology and chemical components between fresh tobacco leaves dried by kill-enzyme torrefaction and freeze-drying.

Experimental design

Freeze-drying

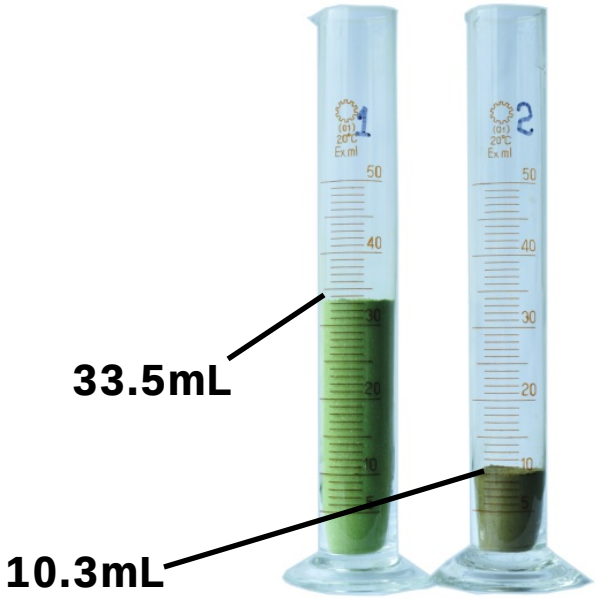
One half leaves preserved in liquid nitrogen, and then dried in the freeze dryer .
Vacuum:10MPa
Temperature and time conditions:
(1)Pre-freezing: - 20 ℃,3h;
(2) The first sublimation-drying: 0 ℃,15 h;
(3) the second sublimation-drying: 20 ℃, drying to constant weight.

kill-enzyme torrefaction

Put a another half leaves into the oven to dry.
Temperature and time conditions:
105 ℃,30min;and then under the 70 ℃ drying to constant weight.

Results and Discussion

The volume of tobacco leaves by freeze-drying was 3.25 times of that by kill-enzyme torrefaction with the same weight.



1: Freeze-drying
2: Kill-enzyme torrefaction

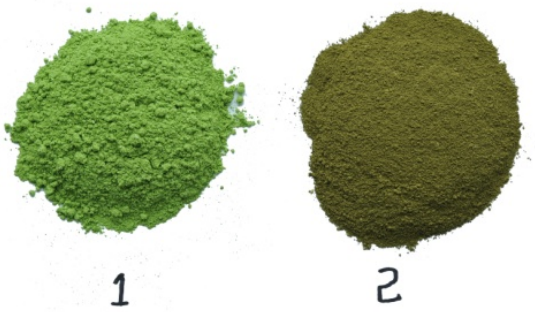


Fig. 1 Effect of drying method on colour and volume of fresh flue-cured tobacco leaves with the same weight (5g)

5 polyphenols contents of tobacco leaves by freeze-drying were significant higher than that of by kill-enzyme torrefaction.

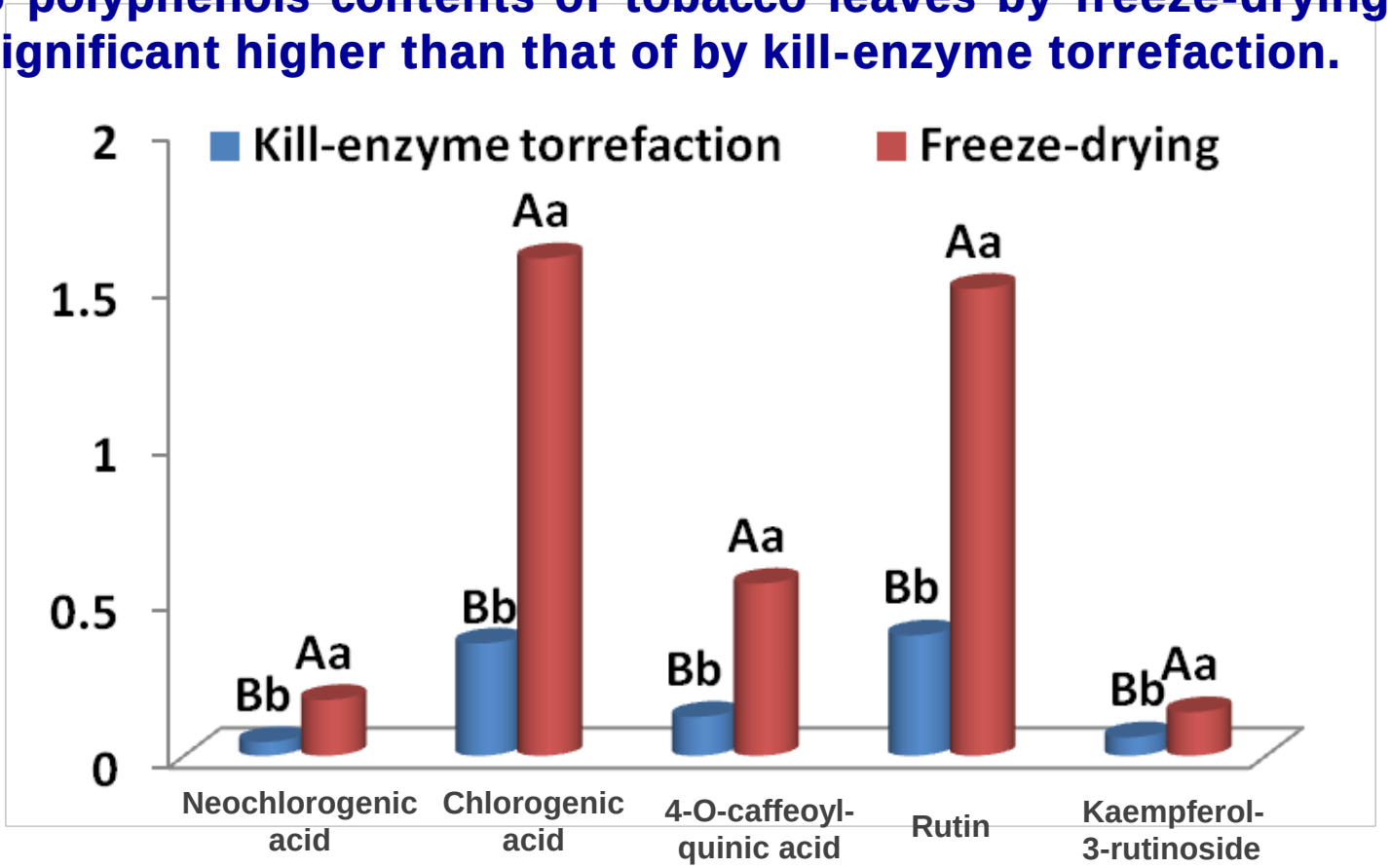


Fig. 2 Effect of drying method on fresh flue-cured tobacco leaves polyphenols contents (mg/g)

Notes: Data are the mean of three independent experiments. Statistical analysis by Tukey's test ;The capital letters denote a very significant difference from drying mathods ($P<0.01$); The lowercase letters denote a significant difference from drying mathods ($P<0.05$).The same as below.

There were significant differences of neutral aroma components between freeze-drying and kill-enzyme torrefaction. Both drying methods we detect 11 kinds of neutral aroma components; 9 kinds of neutral aroma components of fresh tobacco leaves were unique by freeze drying leaves while 21 kinds of neutral aroma components were unique by kill-enzyme torrefaction leaves.

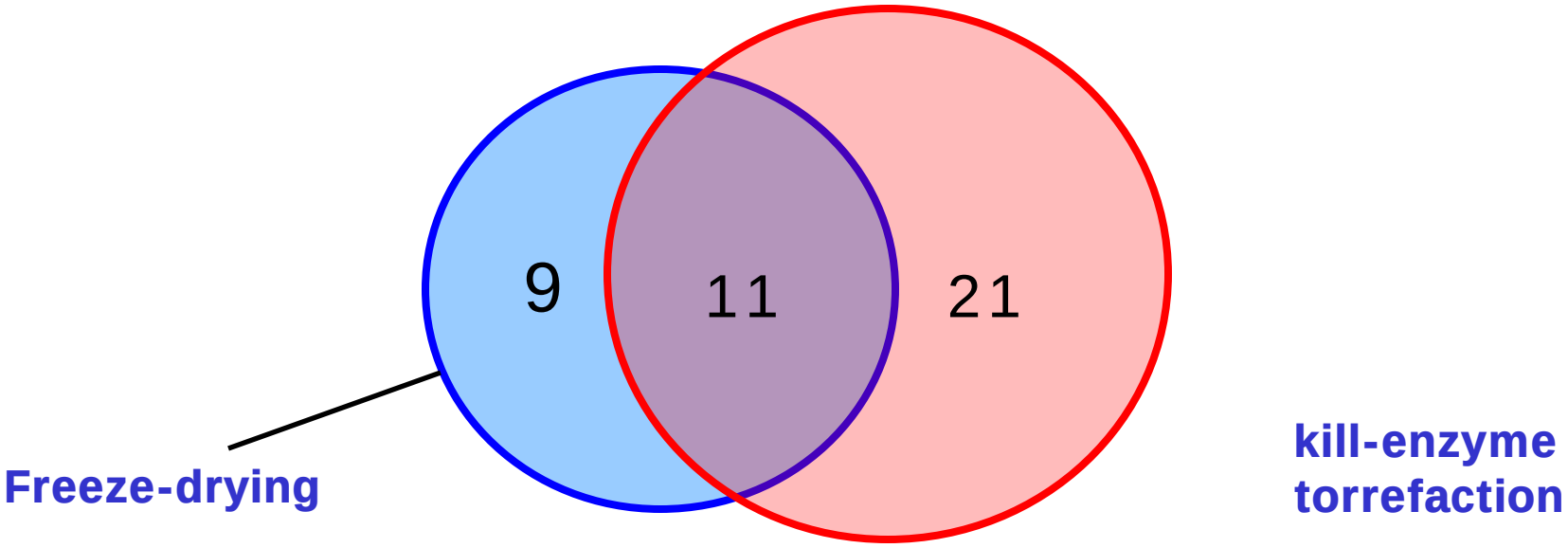


Fig. 3 Effect of drying methods on kinds of neutral aroma components of fresh flue-cured tobacco leaves

4 kinds of aroma components of tobacco leaves by freeze-drying were significantly higher than that of by kill-enzyme torrefaction. But one kind of aroma components of tobacco leaves was lower.

Tab.1 The differences of common aroma components contents to both drying methods（ng/g）

Number	Flavour precursors	Compounds	Freeze-drying	Kill-enzyme torrefaction
1	Browning reaction products	Furfural	185.36±135.79 Aa	234.16±64.18 Aa
2		Indole	18.51±0.86 Aa	24.43±14.64 Aa
3	Phenylalanine degradation products	Benzaldehyde	164.46±28.55 Aa	12.87±2.04 Bb
4		Phenethyl alcohol	194.43±54.80 Aa	13.52±1.90 Bb
5	Cembratriendid compounds degradation products	Lnalool	8.46±5.57 Aa	8.71±3.67 Aa
6		Norsolandione	82.90±24.01 Aa	121.37±109.25 Aa
7	Cartenoids degradation products	Damascone	293.36±15.34 Aa	213.00±94.87 Aa
8		β-Ionone	0.79±0.37 Ab	2.43±1.01 Aa
9		Farnesylacetone	26.08±3.33 Aa	2.32±1.88 Bb
10	Others	Neophytadiene	1955.03±166.38 Aa	1326.02±608.99 Aa
11		2-Butenal	486.59±31.12 Aa	1.26±0.12 Bb

11 kinds of small molecular aromatic components were only found in freeze drying leaves.

Tab.2 The aroma components only found in freeze drying leaves (ng/g）

Number	Flavour precursors	Compounds	Freeze-drying	Kill-enzyme torrefaction
1	Others	3- pentenol	32.46±1.45	N/A
2		3-methyl-2-butanol	64.17±13.71	N/A
3		3 - Methyl - butene-2-ol	32.93±7.16	N/A
4		3-Pentenal	20.00±9.85	N/A
5		4-Vinylguaiacol	27.52±1.84	N/A
6		Phenol	540.31±174.08	N/A
7		Benzophenone	409.82±51.15	N/A
8		Hexanal	24.68±1.95	N/A
9		Nonanal	4.78±0.11	N/A

Notes: N/A indicates that the content is very small amount and it couldn't be detected; The same as below.

9 kinds of browning reaction products and one kind of phenylalanine degradation product were only found in Kill-enzyme torrefaction leaves.

Tab.3 The unique aroma components in kill-enzyme torrefaction leaves (ng/g）

Number	Flavour precursors	Compounds	Freeze-drying	Kill-enzyme torrefaction
1	Browning reaction products	2 - Methyl - 3（2H） - furanone	N/A	3.24±1.19
2		2-Methylpyrazine	N/A	8.54±2.39
3		2-Acetylpyrrole	N/A	18.42±19.45
4		2-Acetyl furan	N/A	15.17±3.76
5		5,6-Dimethyl-2-benzimidazolinone	N/A	61.15±61.97
6		5-Methylfurfural	N/A	27.23±7.75
7		6-Methyl-3,5-heptadien-2-one	N/A	3.55±2.32
8		Pyridine	N/A	6.76±3.54
9		Furfuryl alcohol	N/A	46.18±38.60
10	Phenylalanine degradation product	Benzeneacetaldehyde	N/A	321.76±75.76

In the process of kill-enzyme torrefaction, polyphenols degraded mostely and produced 9 kinds of bronwning reaction production. This may explain why the tobaocco leaves colour was yellow brown after kill-enzyme torrefaction drying.

1:Vacuum freeze-drying

2 :Kill-enzyme torrefaction

Fig. 4 The colour difference of tobacco leaves with different drying methods

In addition, 8 kinds of the cartenoids degradation products and one kind of cembratriendid compounds degradation product were unique in Kill-enzyme torrefaction leaves.

Continued Tab.3 The unique aroma components in kill-enzyme torrefaction leaves (ng/g)

Number	Flavour precursors	Compounds	Freeze-drying	Kill-enzyme torrefaction
11	Cembratriendid compounds degradation product	solanone	N/A	413.72±205.80
12	Cartenoids degradation products	dihydroactinidiolide	N/A	46.33±43.49
13		Megastigmatrienone B	N/A	10.98±8.70
14		Megastigmatrienone C	N/A	9.43±7.56
15		Geranyl acetone	N/A	15.52±4.36
16		Isophorone oxide	N/A	2.16±2.45
17		Isophorone	N/A	2.24±2.17
18		Safranal	N/A	6.85±5.20
19		dihydrosafranal	N/A	5.92±4.37
20	Others	2-Methyl-1-butanol	N/A	1.04±0.08
21		1,3,5-Heptenal	N/A	14.20±2.26

The weight of dry product tobacco leaves from freeze-drying was higher than kill-enzyme torrefaction for 4.37%.

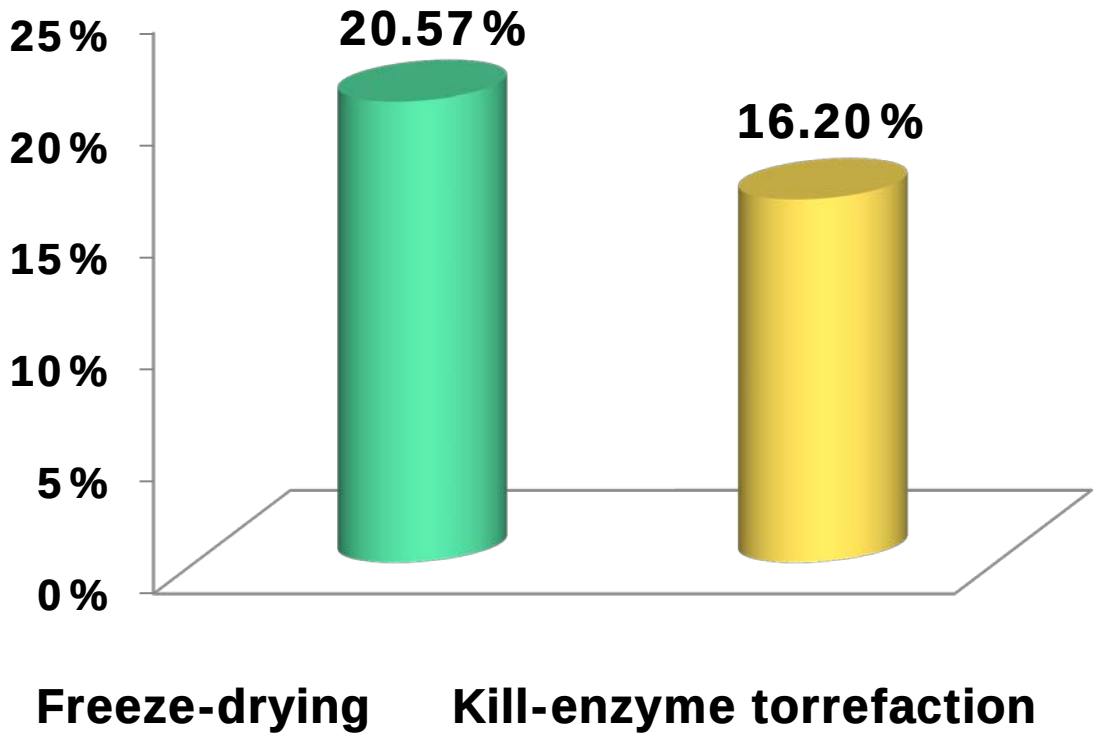


Fig. 5 Effect of drying method on the dry product weight of fresh flue-cured tobacco leaves

Conclusions

- The polyphenols, carotenoids were degraded and some small molecular aromatic components were lost during kill-enzyme torrefaction, which may result in the dry product weight of fresh tobacco leaves reduced by 4.37% .

- Freeze-drying is a better way to detect chemical components accurately, meanwhile, it could keep inherent colour, structure and inclusions of fresh flue-cured tobacco leaves.

Acknowledgements

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Thank you!