Artemisia annua L.

Drying and Storage

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Aims:

1-Effect of drying temperatures on the artemisinin content

2-Effect of temperatures during the storage on the artemisinin content

Recommendations for *Artemisia annua* GACP

Basic information for the farm trials
Dried leaves stored

~2.5 t

Fresh plant in the field

H₂O leaves

H₂O stems

Dry matter stems

Dry matter leaves

~22%

~37%

~5%

~27%

~9%

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artemisinin
1-Effect of drying temperatures on the artemisinin content

11-Leaves, constant temperatures 20, 30, 40, 50, 70 or 90°C
12-Leaves, drying 1h30 at 40, 50, 70, or 90°C then end of the drying at 30°C
13-Leaves, drying at 30°C (78, 72, 64, 45% moist. content) then drying at 40, 50, 70 or 90°C
14-Stems+leaves (4 cm or «crushed»), drying at 30, 40 or 50°C
15- Stems+leaves (4 cm or «crushed»), storage 4h at 30°C then drying at 30, 40 or 50°C
- Artemis F1 110 days old imported from Kenya
- ovens with air ventilation

-Moisture content analysis (oven at 105°C)
-Artemisinin content analysis (TLC + densitometer)
-3 replications per treatment
Leaves

Stems+leaves «crushed»

Stems+leaves cut ~4 cm

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Drying dynamic

**moisture content (%) vs. time (hour)**

- **R²** values:
  - 0.973
  - 0.976
  - 0.982
  - 0.983
  - 0.996

**Temperatures:***
- 20°C
- 30°C
- 40°C
- 50°C
- 70°C
- 90°C

**Legend:**
- Blue diamond: 20°C
- Red circle: 30°C
- Green cross: 40°C
- Orange triangle: 50°C
- Yellow asterisk: 70°C
- Pink square: 90°C

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Leaves - drying at constant temperatures

replications: 3
probability: 0.11%
signification: HS**
coeff. variation: 10.4%

* Newman-Keuls test 5%

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replications: 3
probability batch effect: 0.01% HS**
probability temperature effect: 0.86% HS**
probability interaction: 68.36% NS
coef. variation: 6.5%
* Newman-Keuls test 5%

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Leaves - 1h30 at high temperatures then 30°C

Decreased temperatures
replications: 3
probability: 7.48% NS
coeff. variation: 9.4%

Constant temperatures
replications: 3
probability: 0.53% HS**
coeff. variation: 11.6%
* Newman-Keuls test 5%
Leaves - different moisture content * different temperatures

replications: 3
probability temperature effect: 0,00% HS**
probability moisture content effect: 48,49% NS
probability interaction: 48,54% NS
coef. variation: 10,0%
* Newman-Keuls test 5%

X: 78,2% moisture content (leaves)
Y: 71,7% moisture content (leaves)
Z: 63,7% moisture content (leaves)
W: 45,4% moisture content (leaves)

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Entire plant - cut or «crushed» * different temperatures

replications: 3
probability cut or crushed effect: 0,00% HS**
probability temperature effect: 0,00% HS**
probability interaction: 5,89% NS
coef. variation: 10,9%
* Newman-Keuls test 5%

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Entire cut plant - storage or not * different temperatures

- Immediately dried
- Stored 4 hours at 30°C before drying

Probability storage effect: 11.07% NS
Probability temperature effect: 0.19% HS**
Probability interaction: 56.55% NS
Coeff. variation: 11.7%
* Newman-Keuls test 5%

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Entire «crushed» plant - storage or not * different temperatures

replications: 3
probability storage effect: 36,17% NS
probability temperature effect: 0,00% HS**
probability interaction: 2,63% S*
coef. variation: 10,7%
* Newman-Keuls test 5%
2-Effect of temperatures during the storage on the artemisinin content

21- Leaves, storage at constant temperatures 20, 30, 40, 50 or 70°C
22- Powder (<0.5 mm), storage at constant temperatures 20, 30, 40, 50 or 70°C

- *Artemisia annua* produced by Médiplant
- Storage in incubators (RH=30% maxi)
- Sampling every 10, 20, 40 days (1 year)
- Moisture content analysis (oven 105°C)
- Artemisinin content analysis (TLC + densitometer)
- 4 replications

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Dry leaves - storage at constant temperature

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Dry powder - storage at constant temperature

- 20°C
- 30°C
- 40°C
- 50°C
- 70°C

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Estimation of the activation energy

The activation energy changes with the temperature and there off involves a diffusion depending transformation

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Conclusions:

1- Don’t use temperatures higher than 30-40°C (leaves or entire plants);

2- No interaction between leaves moisture content and drying temperatures;

3- Avoid to damage leaf structure before the drying;

4- A low drying process (open field, 20°C, ...) is not a problem; in some case it could increase the artemisinin content;
5- Too high temperatures during the transport and storage could affect quickly the artemisinin content;

6- Stored dry leaves at temperatures below 40°C (maxi 30°C for a long period)

7- Leaves powder are very sensitive even to low temperatures

**Coming …**

1- Leaves and powder storage at RH=85%

2- Light effect during the drying

3- On farm trials