Formation of Tobacco Specific Nitrosamines in Flue-Cured Tobacco

Tobacco Science Research Conference

September 15, 1999

David M. Peele, Marvin G. Riddick, and Mike Edwards, R.J. Reynolds Tobacco Company, Avoca Division, Merry Hill, NC, 27957; and Jeff S. Gentry and Timothy B. Nestor, R.J. Reynolds Tobacco Company, Winston-Salem, NC, 27102

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CORESTA Smoke and Technology Meeting
September 6-10, 1999

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CORESTA Agronomy and Phytopathology Meeting
October 11-14, 1999

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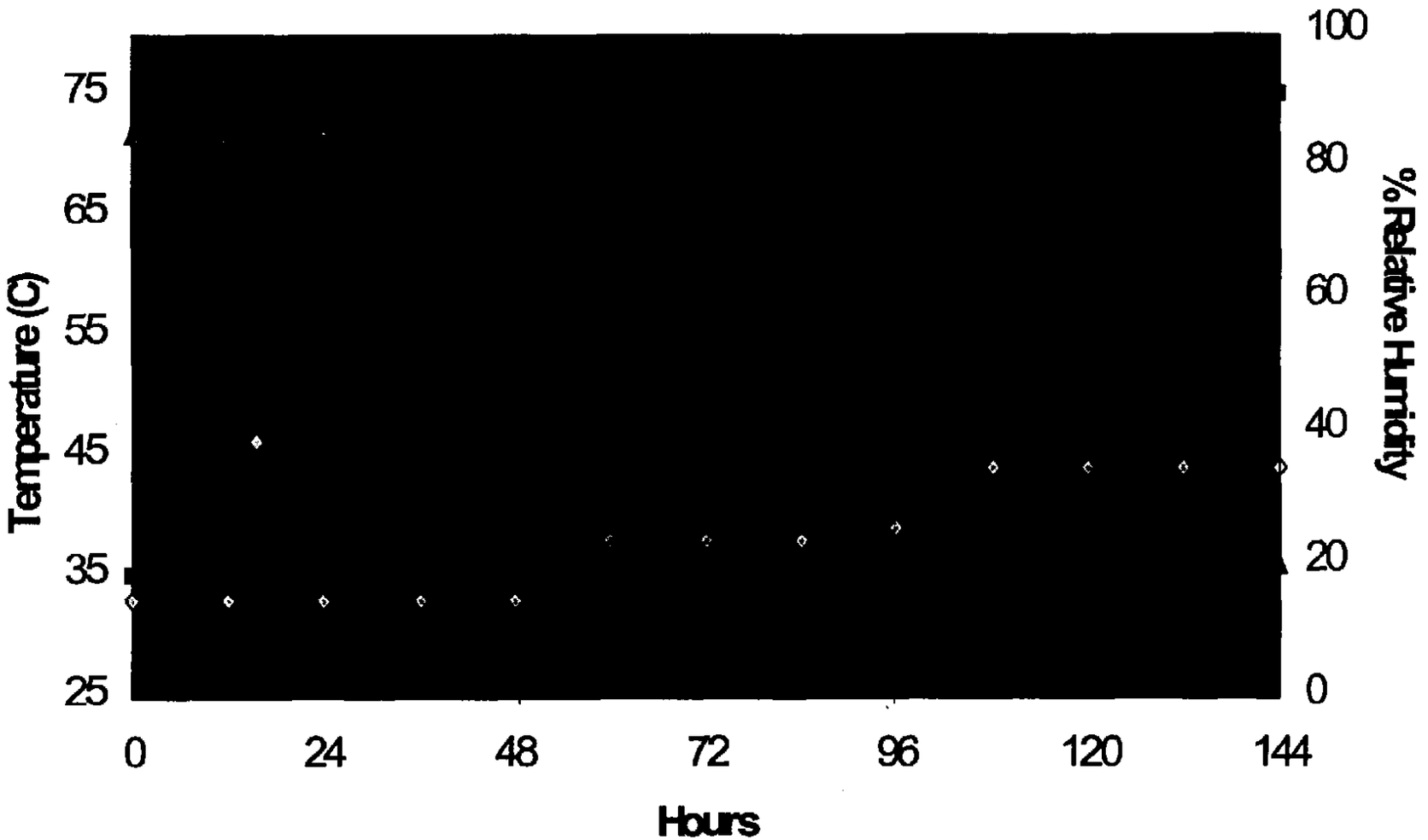
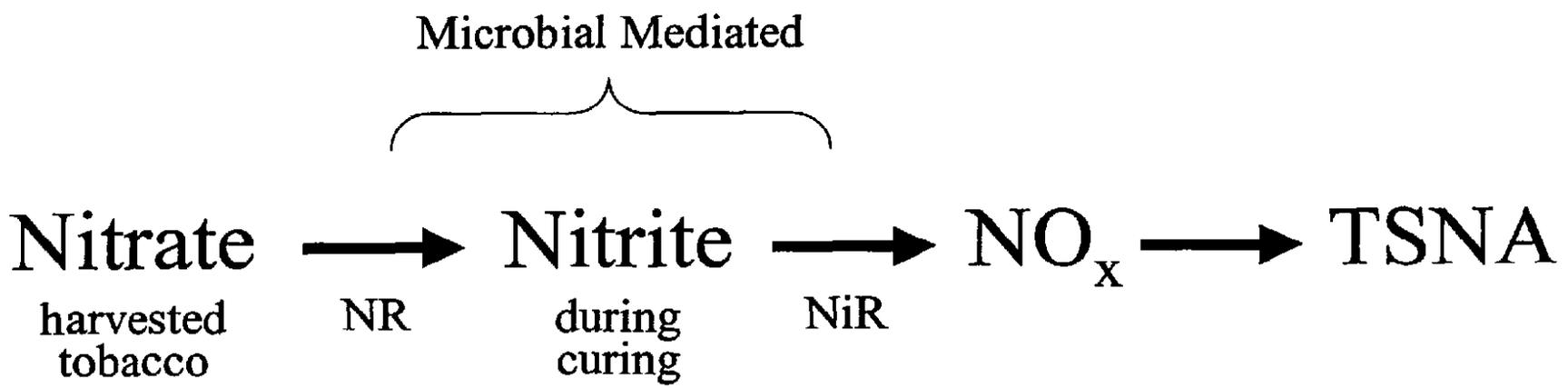
Tobacco Specific Nitrosamines

- Eight tobacco specific nitrosamines (TSNA) identified
  - Seven reported in cigarette smoke
- Formed by nitrosation of tobacco alkaloids
  - Nicotine — NNN & NNK
  - Nornicotine — NNN
  - Anatabine — NAT
  - Anabasine — NAB
- Most prevalent TSNA dependent on tobacco type
  - Flue-cured — NNK
  - Burley — NNN
  - Oriental — low or non-detectable

Typical Curing Schedule for Flue-curing Tobacco



Generally Accepted Hypothesis for TSNA Formation



Nitric Oxide Production

- Commercial barns consume 150 - 300 gallons of LPG per cure (570 - 1140 liters)
- US EPA Agency reports 14 lbs of NO_x per 1,000 gallons combusted LPG (1.7 kg/1000 liters)
- Direct-fired flue-cured tobacco exposed to 2 - 4 lbs of NO_x per cure (1.0 - 1.9 kg)

Effect of Fuel Source on TSNA

Barn Type	Burner Configuration	TSNA (ppm)	NO_x (lbs)	NO_x (kg)
R&D Electric	Heat Exchange	0	n/a	n/a
R&D LPG	Direct-fired	2	0.4	0.18
Commercial LPG	Direct-fired	13	2.5	1.14

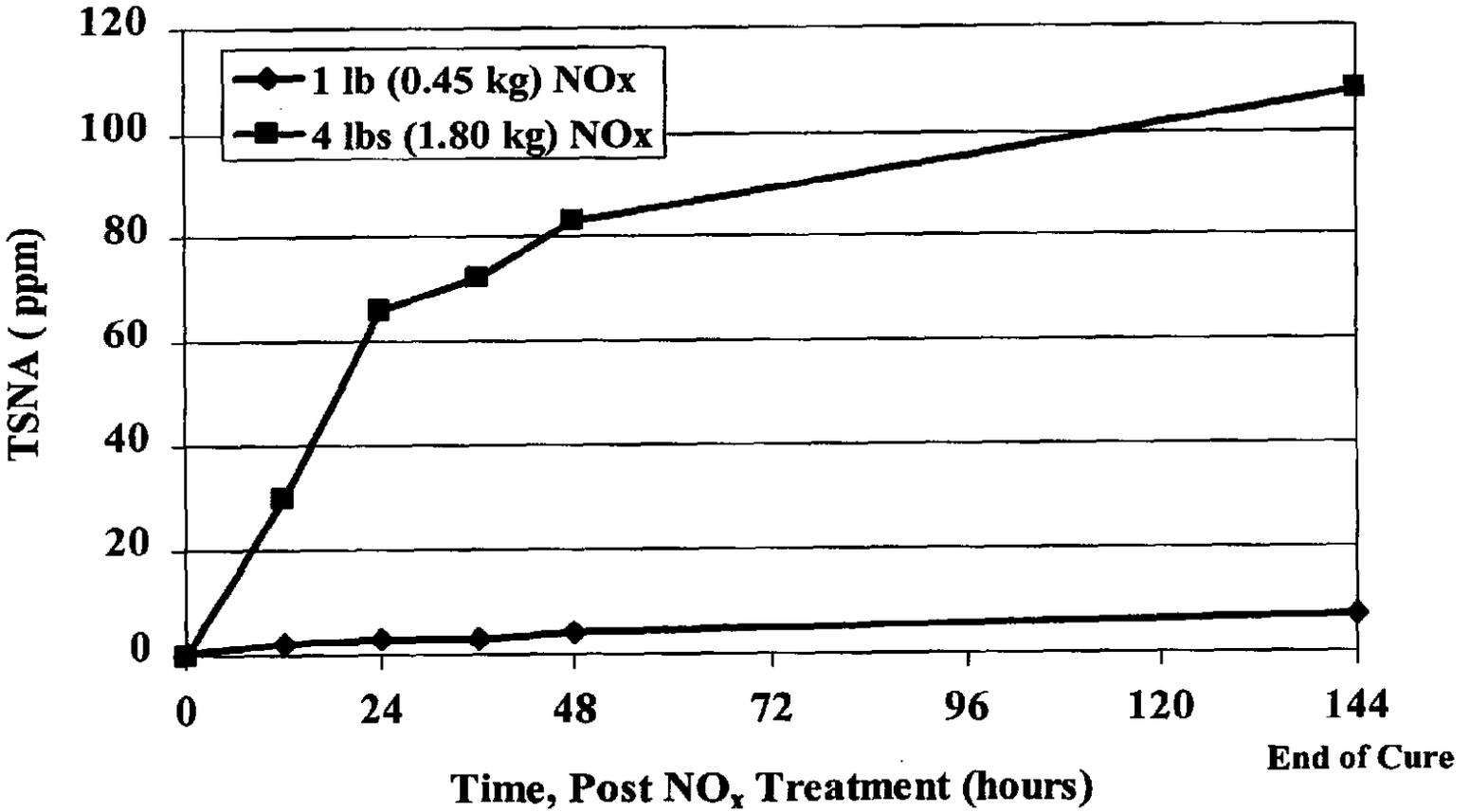
Flue-Cured Tobacco, 1998

Effect of NO_x on TSNA
Using Electric & LPG

R&D Barn Type	Treatment	TSNA (ppm)
Electric	w/o NO_x	1
LPG	w/o NO_x	5
Electric	w/ NO_x	174
LPG	w/ NO_x	107

Flue-Cured Tobacco, 1998

Dose Effect of NO_x on TSNA



Flue-Cured Tobacco, 1998

1998 Barn Sampling

Fuel	Burner	Samples	TSNA (ppm)
Stick (Wood)	Flues	6	0.3
Diesel	Heat Exch	27	1.0
LPG	Heat Exch (Turkey)	23	0.0
Stick (LPG)	Direct	1	5.9
LPG	Direct	43	11.0

1999 Commercial Barn Conversions

- 27 barns converted to heat exchange curing
- Eastern Belt tobacco
- Field data through 8/30/99

Curing Type	TSNA (ppm)
Heat Exchange	1.3
Direct-Fired	7.1

Summary

- Direct-fired curing is the primary source of TSNA formation during flue-curing of tobacco.
- Microbial mediated TSNA formation appears to be of secondary significance in flue-cured tobacco.
- Heat exchange curing significantly reduces TSNA levels in flue-cured tobacco
  - Integrity, quality, and smoking characteristics of flue-cured tobacco are maintained.

Significance

- No basis for concluding relevance of TSNA to chronic disease in smokers.
- Potential benefits of reducing TSNA cannot be definitively asserted
- Responsible product stewardship advocates implementing effective and commercially practical technology to reduce TSNA.