BRITISH AMERICAN TOBACCO

A comparison of the level of selected volatile aldehydes in contemporary US and Swedish smokeless tobacco products

Faizi A, Mola M, Rodu B, McAdam K.

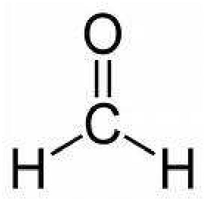
CORESTA Joint Study Group Meeting, Aix en Provence, 2009

Background

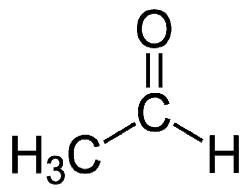
- To date, researchers have reported identifying 28 toxicants in smokeless tobacco products (STP)
  - Summarised in the recent Monograph 89 by the International Agency for Research on Cancer (IARC).
- Included in the list are three volatile aldehydes
  - Formaldehyde
  - Acetaldehyde
  - Crotonaldehyde
- According to IARC:
  - Formaldehyde Group 1 Carcinogen
  - Acetaldehyde Group 2B Carcinogen
  - Crotonaldehyde Group 3 Carcinogen
- Acrolein – Group 3 Carcinogen

Formation of Volatile Aldehydes in tobacco

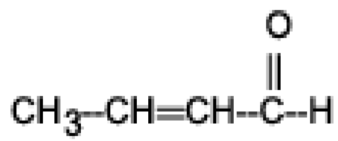
- Formed during heating processes from amino acids and sugars.



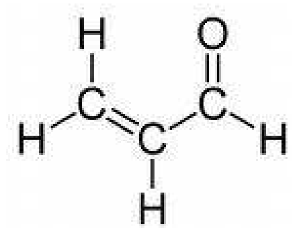
Formaldehyde



Acetaldehyde



Crotonaldehyde



Acrolein

- Two pathways
  - Maillard reaction
  - Strecker degradation

Historical

- Previous studies states volatile aldehydes ranged from 0.2ug/g to 7.4ug/g on a dry weight basis (DWB) for moist snuff and dry snuff

- These values were measured over 20 years ago.
  - Different manufacturing procedures have been introduced
  - Grades of tobacco have changed
  - Addition/removal of ingredients/materials
  - Introduction of limits on other constituents

Aim and Approach to study

- Aim: To establish whether the levels of volatile aldehydes in current STPs are similar or different to the levels previously reported

- Approach:
  - Sample current STPs indicative of the major classes of products used in the US and Sweden
  - Measure volatile aldehyde levels
  - Establish any differences between STP product groups
  - Compare to historical data

Review historic information

BRITISH AMERICAN TOBACCO

- External literature sourced from
  - **IARC Monograph** on the Evaluation of Carcinogenic Risk to Humans, IARC Press, Lyon, France, Volume 89 ,2007, 55-60
    - **Brunnemann K.D. and Hoffmann D**., Chemical Composition of Smokeless Tobacco Products, smoking and tobacco control Monograph No 2 1992, 96-108
    - **Hoffmann, Dietrich et al**., Toxic and Carcinogenic agents in dry and moist snuff, Journal of the National Cancer Institute 1987; 79 (6) 1281-6
  - **Stepanov, Irina et al.,** New and traditional smokeless tobacco: Comparison of toxicant and carcinogen levels, Nicotine and Tobacco Research, 2008, 10, (12) 1773-1782

Sourcing STPs within Sweden and US

BRITISH AMERICAN TOBACCO

- Sourced in total 70 different STPs of which 32 Swedish and 38 US.
- Represent ~88% market share for US and 89% Sweden.
- 7 different manufacturers within Sweden
- 9 different manufacturers within US
- Swedish samples were sourced from Swedish Websites, exported and kept frozen
- US samples were sourced from US shops, exported and kept frozen

Product groups

BRITISH AMERICAN TOBACCO

Categories	Types
Loose SNUS	10
Pouched SNUS	22
Chewing Tobacco	13
Dry Snuff	5
Moist Snuff	16
Pellet	3
Plug	1

Sweden

US

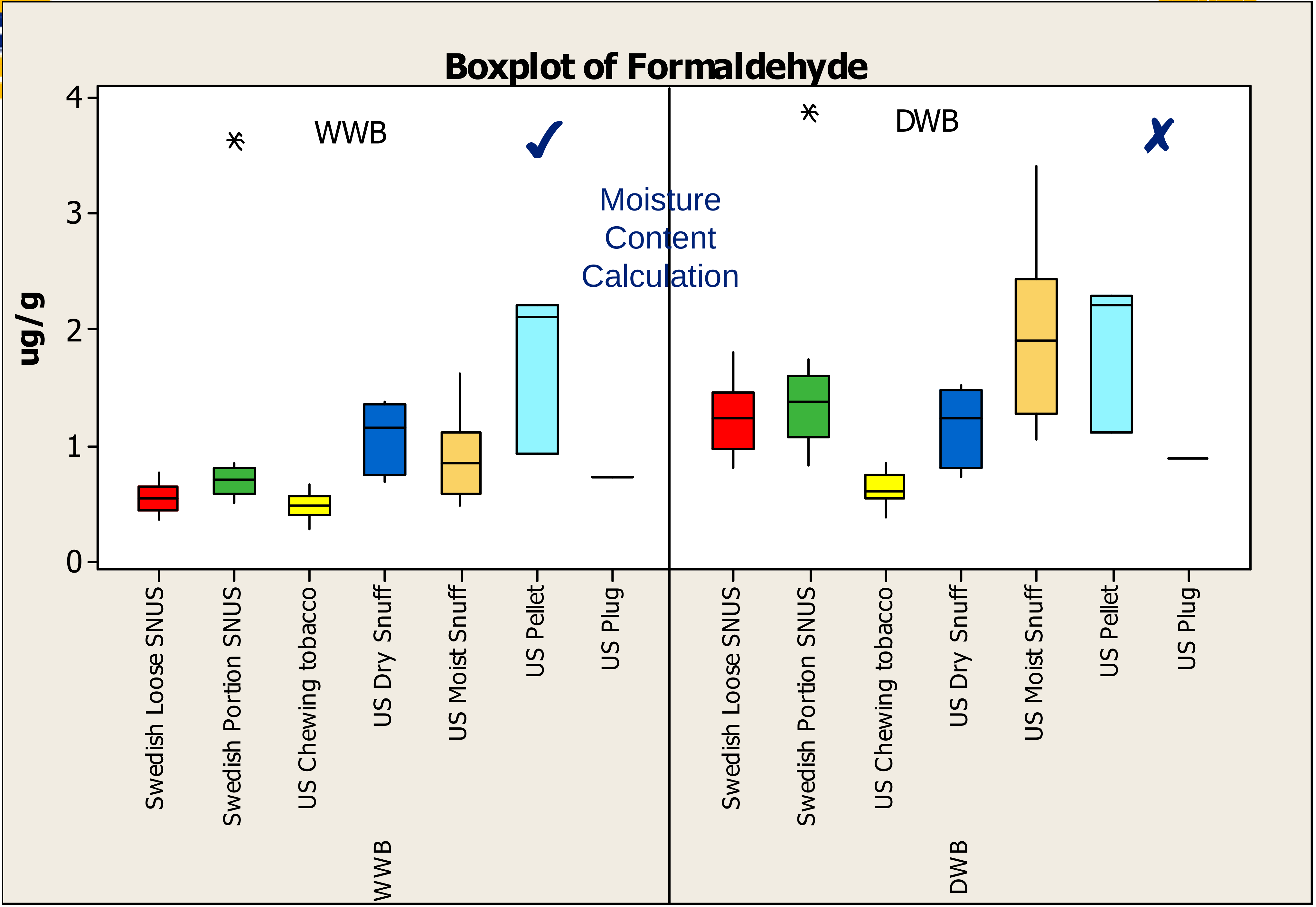
Measurement capability

- Identified an external lab that could measure two volatile aldehydes within tobacco
  - Formaldehyde
  - Acrolein
- Commissioned extension to existing method
  - Acetaldehyde
  - Crotonaldehyde

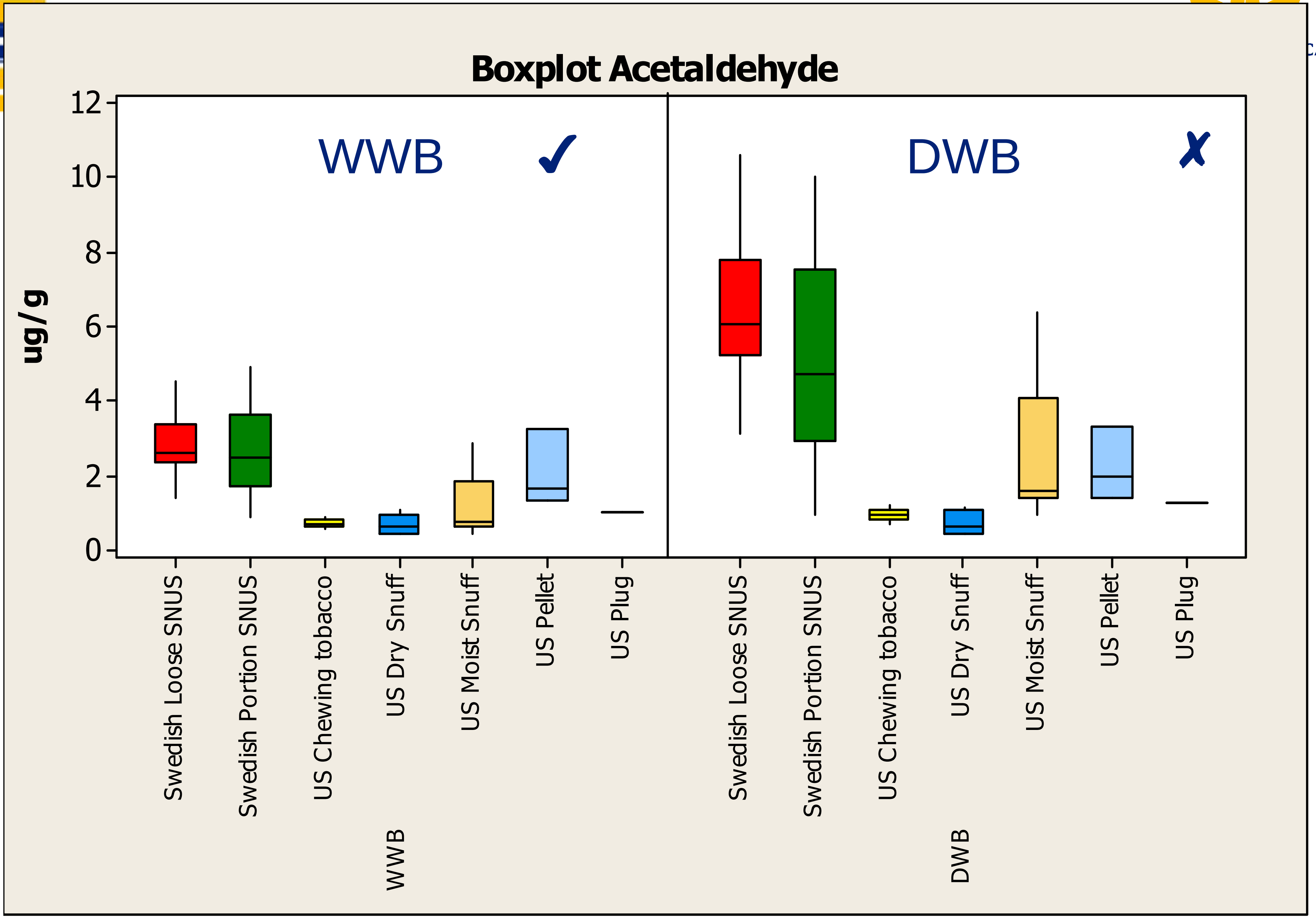
Sensitivity: LOD and LOQ for method

BRITISH AMERICAN TOBACCO

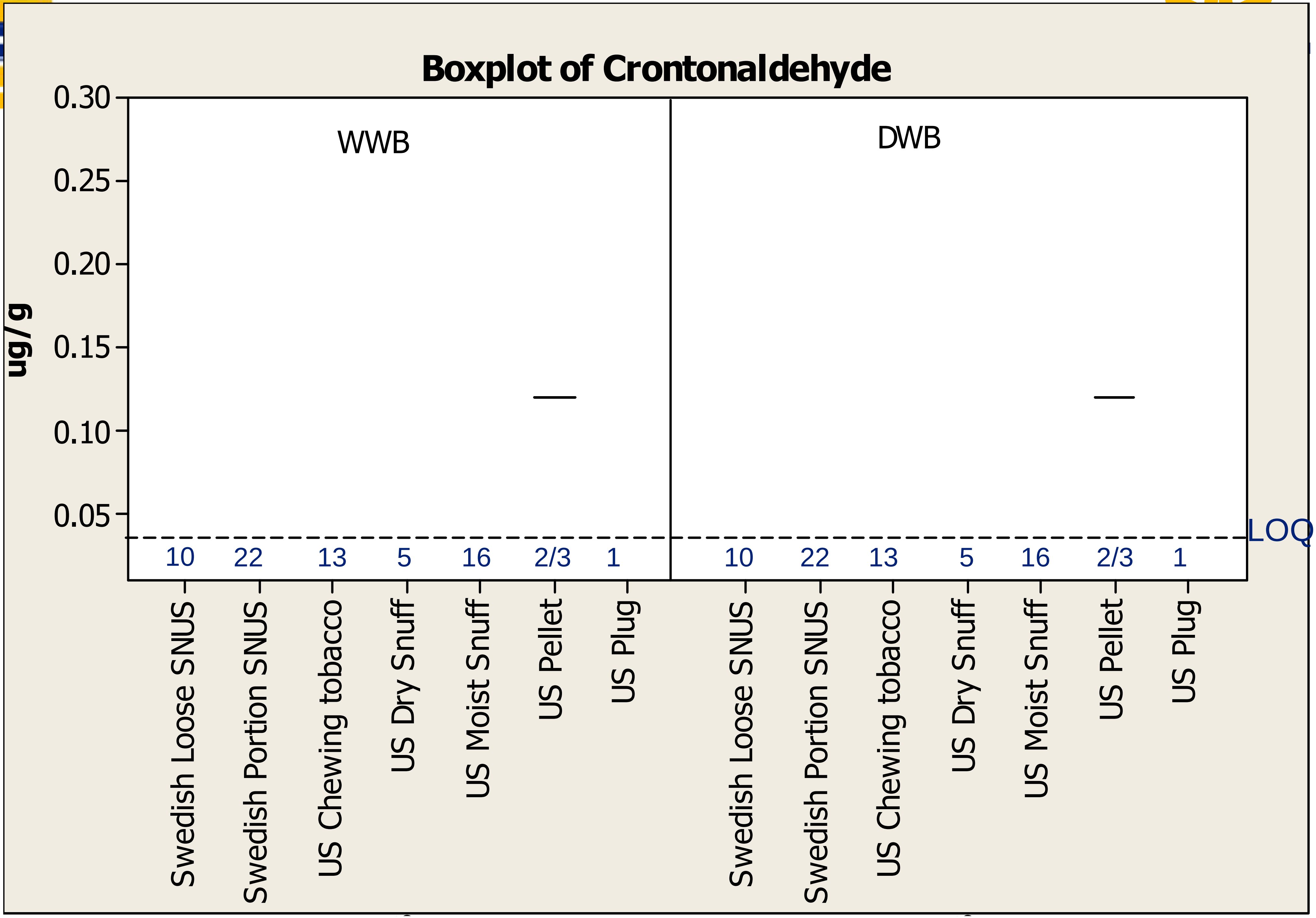
Analytes	LOQ (ug/g)	LOD (ug/g)
Formaldehyde	0.012	0.004
Acetaldehyde	0.032	0.010
Acrolein	0.033	0.010
Crotonaldehyde	0.024	0.007

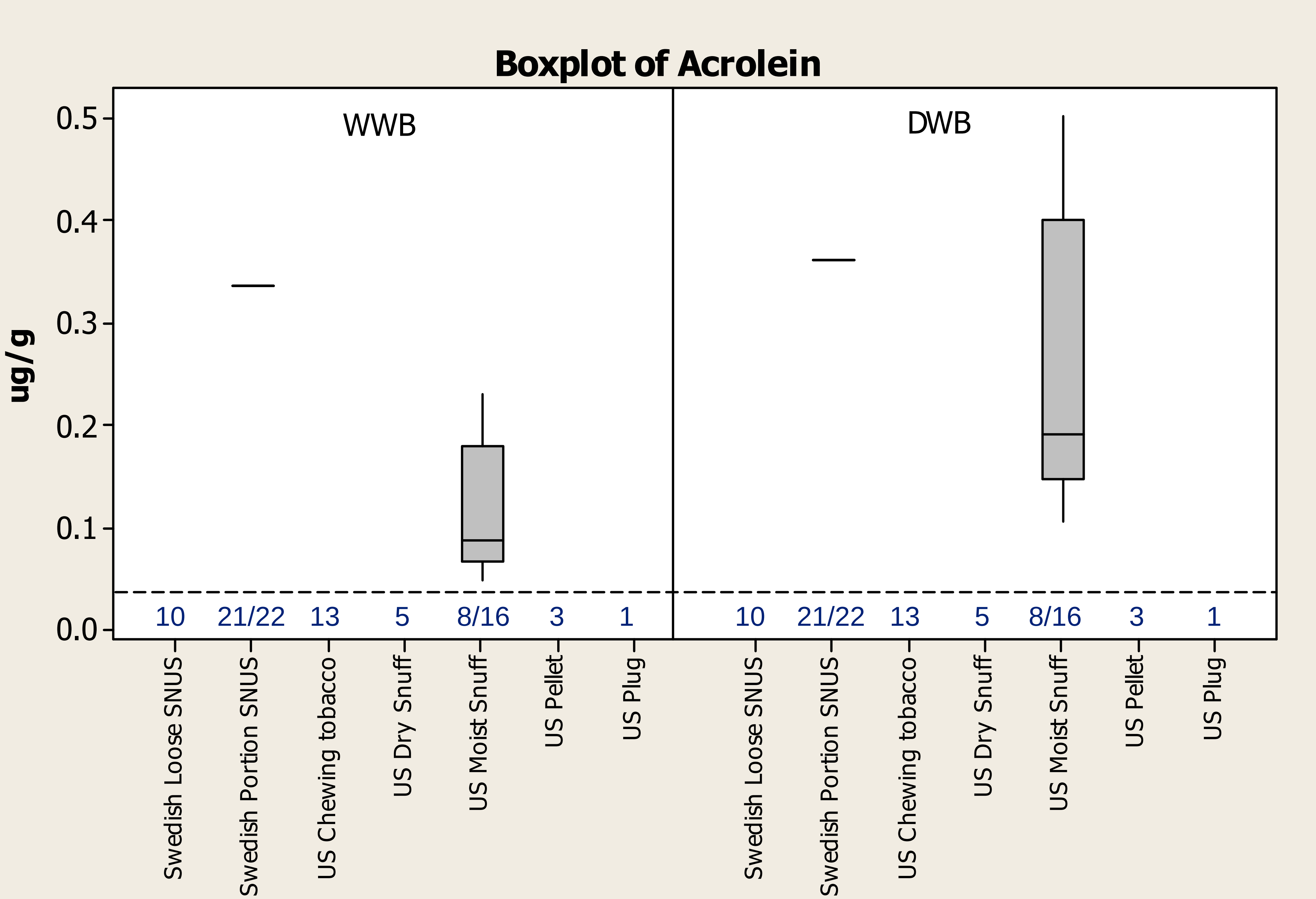


Boxplot of Formaldehyde
ug/g
4
3
2
1
0
WWB
DWB
Moisture Content Calculation
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug
WWB
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug
DWB



Boxplot Acetaldehyde
ug/g
WWB ✓
DWB ✗
0
2
4
6
8
10
12
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug
WWB
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug
DWB


Boxplot of Crontonaldehyde
ug/g
0.30
0.25
0.20
0.15
0.10
0.05
WWB
DWB
LOQ
10
22
13
5
16
2/3
1
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug


Boxplot of Acrolein
WWB
DWB
ug/g
0.0
0.1
0.2
0.3
0.4
0.5
10
21/22
13
5
8/16
3
1
Swedish Loose SNUS
Swedish Portion SNUS
US Chewing tobacco
US Dry Snuff
US Moist Snuff
US Pellet
US Plug

Comparison with historic results Crotonaldehyde

- IARC states a range of 0.2ug/g – 2.4ug/g DWB for Crotonaldehyde in Moist snuff and dry snuff

- Study has shown for all 70 STPs that the levels for Crotonaldehyde are either below detection limit (0.007ug/g) or non quantifiable (0.024ug/g), apart from a pellet sample 0.124ug/g on a DWB

Comparison with previous values Formaldehyde

BRITISH AMERICAN TOBACCO

Product Type	Current (ug/g dwb)	Historic 1987 (ug/g dwb)	Stepanov 2008 (ug/g dwb)
Moist Snuff	1.04 – 3.42	3.9 – 6.8	6.58 -10.6
Dry Snuff	0.73 – 1.51	1.6 -7.4	-
Chewing tobacco	0.38 – 0.84	-	-
Pellet	1.12 – 2.3	-	-
Plug	0.87	-	-
Pouched SNUS	0.83 – 3.89	-	0.21 – 7.04
Loose SNUS	0.80 – 1.80	-	-

Comparison with previous values Acetaldehyde

BRITISH AMERICAN TOBACCO

Product Type	Current (ug/g dwb)	Historic 1987 (ug/g dwb)	Stepanov 2008 (ug/g dwb)
Moist Snuff	1.04 – 3.42	2.4 – 7.4	17.1 – 72.3
Dry Snuff	0.73 – 1.51	1.4 – 3.9	-
Chewing tobacco	0.70 – 1.21	-	-
Pellet	1.4 – 3.33	-	-
Plug	1.28	-	-
Pouched SNUS	0.9 – 10.0	-	1.83 – 16.4
Loose SNUS	3.15 – 10.61	-	-

Conclusion

BRITISH AMERICAN TOBACCO

- Evidence for all three aldehydes reported previously were found in contemporary STPs
  - Crotonaldehyde not quantifiable apart from a pellet sample
- Formaldehyde levels found in Moist and Dry Snuff in the current work are lower than reported in previous studies.
- Acetaldehyde levels found in this study also lower than with historic data.
  - A wide range found with Swedish products
- Study has shown Acrolein and Crotonaldehyde are below limit of quantification (LOQ) for all categories of STPs apart from:
  - Acrolein in US moist snuff and
  - Crotonaldehyde in a pellet sample

www.bat-science.com

we welcome your comments

British American Tobacco