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# ZYN Stability Studies

## Discussion and Conclusions

### 1 Purpose

This document summarizes changes in chemical and physical parameters of ZYN during storage during (b) (4) at controlled ambient conditions. The stability studies were performed for a total of 20 different stock keeping units, comprising 10 different flavors and two different nicotine contents.

### 2 Overview of Results

#### 2.1 Batches Used

An overview of the ZYN product batches assigned to the stability studies is shown in [Table 1](#).

**Table 1: ZYN Batches Assigned to Stability Study (b) (4)**

Flavor/Strength	SKU	Batch	Production Date	Storage Start Date	Storage End Date	RH (%)
Cool Mint 3 mg	8105	(b) (4)				
Cool Mint 6 mg	8106					
Peppermint 3 mg	8107					
Peppermint 6 mg	8108					
Spearmint 3 mg	8109					
Spearmint 6 mg	8110					
Wintergreen 3 mg	8111					
Wintergreen 6 mg	8112					
Citrus 3 mg	8122					
Citrus 6 mg	8123					
Coffee 3 mg	8124					
Coffee 6 mg	8125					
Cinnamon 3 mg	8128					
Cinnamon 6 mg	8129					

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Flavor/Strength	SKU	Batch	Production Date	Storage Start Date	Storage End Date	RH (%)
Smooth 3 mg	8134	(b) (4)				
Smooth 6 mg	8135					
Chill 3 mg	8136					
Chill 6 mg	8137					
Fresh 3 mg	8140					
Fresh 6 mg	8141					
RH=relative humidity; SKU=stock keeping unit.						

## 2.2 Storage Conditions

Samples were stored in child-resistant polypropylene cans at (b) (4), and either (b) (4) relative humidity (RH) (b) (4) RH or (b) (4) RH/ (b) (4) RH.

## 2.3 Nicotine

The nicotine content values after different lengths of storage time are shown in Table 2 and Table 3 for 3 mg products and 6 mg products, respectively. The average results are shown graphically in Figure 1 and Figure 2. Nicotine content values do not change substantially during (b) (4) of storage, and all results are within the acceptance criteria ((b) (4) mg/g as is for 3 mg products, and (b) (4) mg/g as is for 6 mg Products). Nicotine content is not a limiting factor for the shelf life of the products.

**Table 2: Nicotine (mg/g as is) versus Storage Time and Flavor for ZYN 3 mg Nicotine Products**

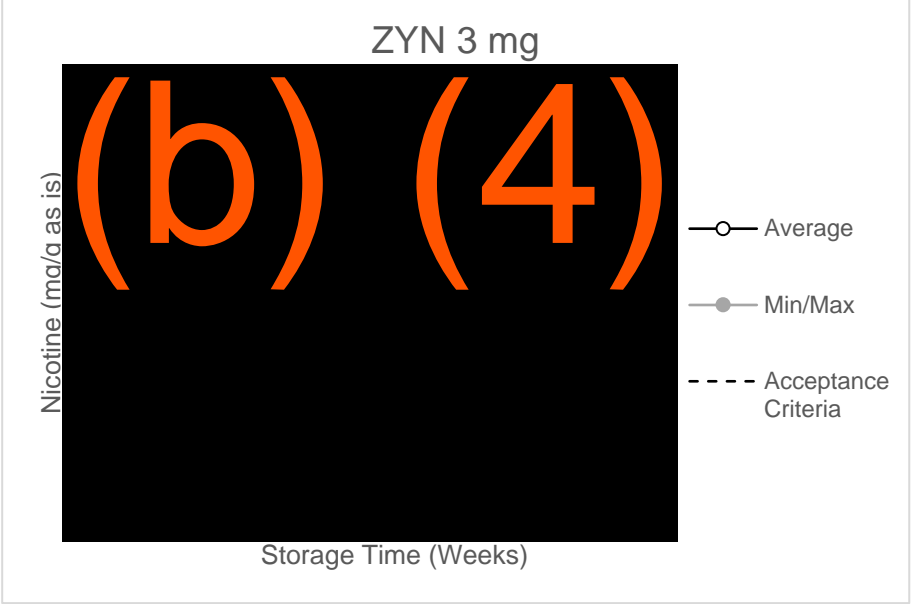
Flavor	Storage Time (Weeks)
Cool Mint	(b) (4)
Peppermint	
Spearmint	
Wintergreen	
Citrus	
Coffee	
Cinnamon	
Smooth	
Chill	
Fresh	
Average	
Standard Deviation	
Minimum	
Maximum	
Acceptance Criteria	(b) (4)

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**Table 3:** Nicotine (mg/g as is) versus Storage Time and Flavor for ZYN 6 mg Nicotine Products

Flavor	Storage Time (Weeks)	
Cool Mint	(b) (4)	(4)
Peppermint		
Spearmint		
Wintergreen		
Citrus		
Coffee		
Cinnamon		
Smooth		
Chill		
Fresh		
Average		
Standard Deviation		
Minimum		
Maximum		
Acceptance Criteria	(b) (4)	

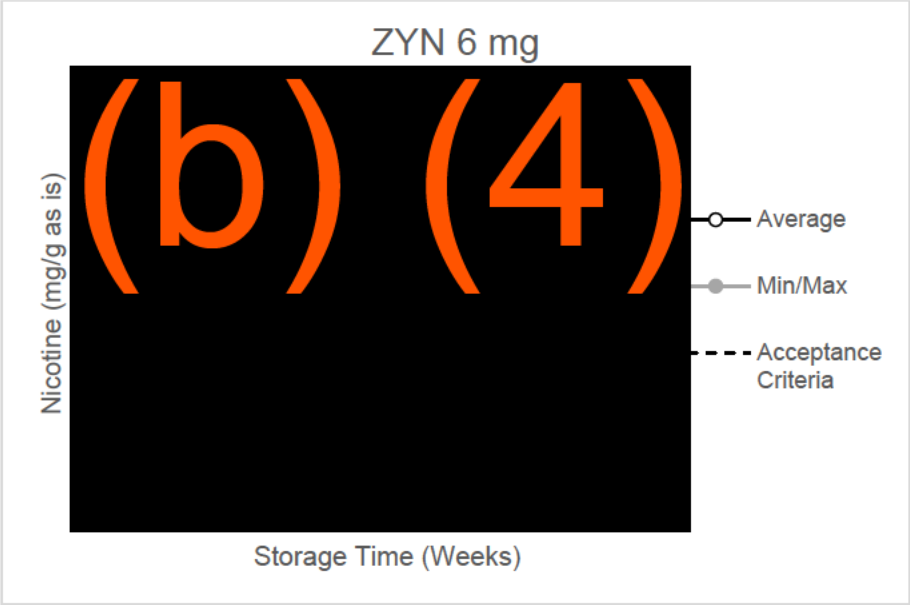
**Figure 1:** Nicotine (mg/g as is) versus Storage Time for ZYN 3 mg Products



Note: Error bars correspond to standard deviation.

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Swedish Match.

Figure 2: Nicotine (mg/g as is) versus Storage Time for ZYN 6 mg Products



Note: Error bars correspond to standard deviation.

2.4 Nicotine Related Compounds

The total concentrations of nicotine related compounds, reported relative to the nicotine content, are shown in Table 4 and Figure 3. For calculating the total related compounds, values for individual analytes below the limit of quantification (LOQ) have been assigned a value of 100% of the LOQ. For calculating the averages, values for total related compounds below the LOQ were assigned a value of 50% of the LOQ. The total amount of related compounds generally increases with increasing storage time, as expected. After (b) (4) of storage, the average concentration of related compounds is (b) (4) of nicotine. The maximum observed concentration is (b) (4) for Citrus 6 mg after (b) (4). All results are below the acceptance criterion (b) (4) and thus demonstrate that all of the products maintain their quality throughout the suggested shelf life under the tested storage conditions.

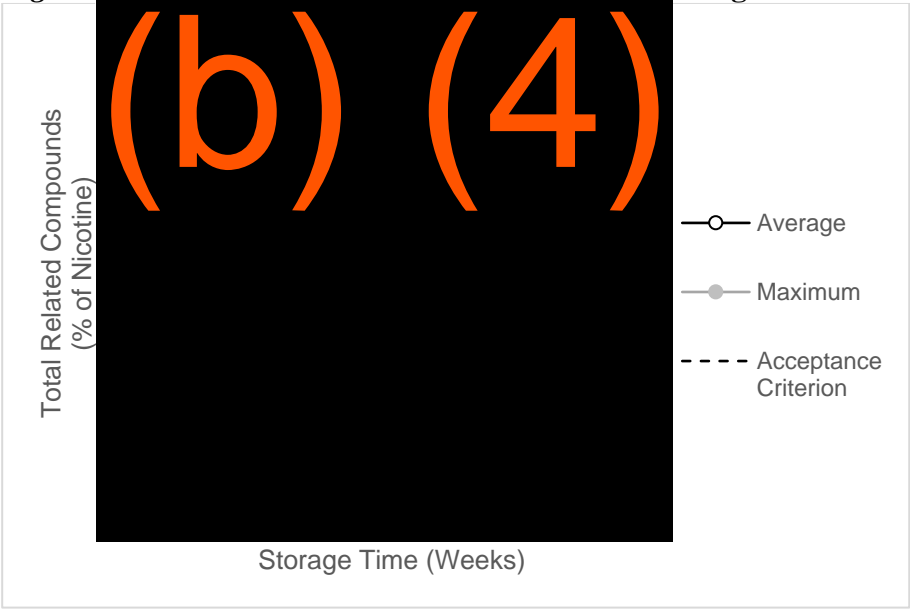
Table 4: Total Related Compounds (% of Nicotine) versus Storage Time - ZYN

Flavor	Storage Time (Weeks)
Cool Mint 3 mg	(b) (4)
Cool Mint 6 mg	
Peppermint 3 mg	
Peppermint 6 mg	
Spearmint 3 mg	
Spearmint 6 mg	
Wintergreen 3 mg	
Wintergreen 6 mg	



Flavor	Storage Time (Weeks)
Citrus 3 mg	(b) (4)
Citrus 6 mg	
Coffee 3 mg	
Coffee 6 mg	
Cinnamon 3 mg	
Cinnamon 6 mg	
Smooth 3 mg	
Smooth 6 mg	
Chill 3 mg	
Chill 6 mg	
Fresh 3 mg	
Fresh 6 mg	
Average	
Standard Deviation	
Minimum	
Maximum	
Acceptance Criterion	(b) (4)
LOQ=limit of quantification. <sup>a</sup> Values are uncertain due to deviations from the validated analytical procedure.	

Figure 3: Total Related Compounds versus Storage Time - ZYN



Note: Error bars correspond to standard deviation.

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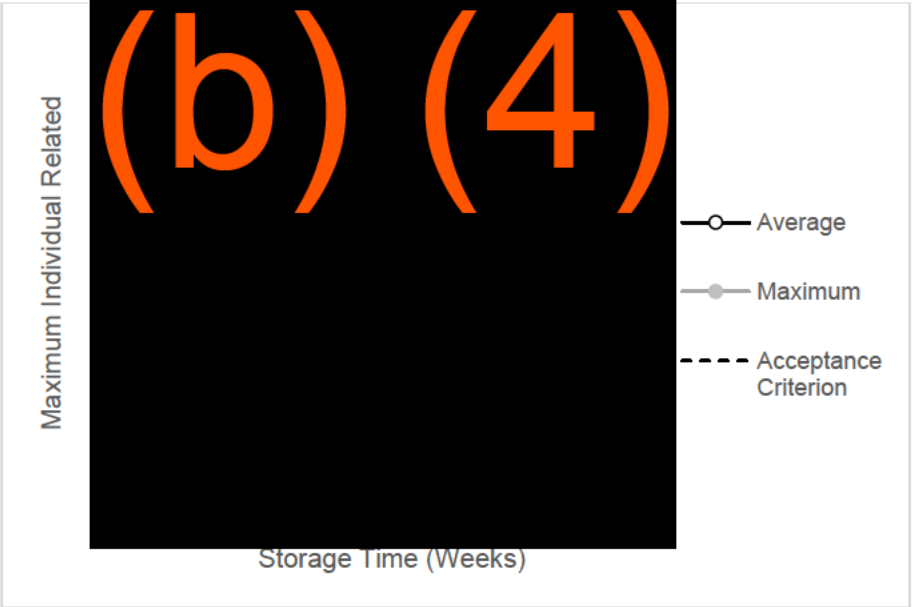
The largest concentrations of any individual related compound are shown in Table 5 and Figure 4. For most of the products, the dominant related compound is (b) (4), and in some samples (b) (4) is the largest related compound. Also cotinine and myosmine are present in concentrations above the LOQ in some of the samples, whereas anabasine, anatabine and (b) (4) are present in concentrations below the LOQ in all of the analyzed samples. After (b) (4) of storage, the average largest concentration of any individual related compound is (b) (4) (b) (4) of nicotine. The maximum observed concentration is (b) (4) for Citrus 6 mg after (b) (4). All results are below the acceptance criterion (b) (4) and thus demonstrate that all of the products maintain their quality throughout the suggested shelf life under the tested storage conditions.

**Table 5: Largest Individual Related Compound (% of Nicotine) versus Storage Time - ZYN**

Flavor	Storage Time (Weeks)
Cool Mint 3 mg	(b) (4)
Cool Mint 6 mg	
Peppermint 3 mg	
Peppermint 6 mg	
Spearmint 3 mg	
Spearmint 6 mg	
Wintergreen 3 mg	
Wintergreen 6 mg	
Citrus 3 mg	
Citrus 6 mg	
Coffee 3 mg	
Coffee 6 mg	
Cinnamon 3 mg	
Cinnamon 6 mg	
Smooth 3 mg	
Smooth 6 mg	
Chill 3 mg	
Chill 6 mg	
Fresh 3 mg	
Fresh 6 mg	
<b>Average</b>	
<b>Standard Deviation</b>	
<b>Minimum</b>	
<b>Maximum</b>	
<b>Acceptance Criterion</b>	(b) (4)
LOQ=limit of quantification.	
*Values are uncertain due to deviations from the validated analytical procedure.	

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Figure 4: Maximum Individual Related Compound (% of Nicotine) versus Storage Time - ZYN



Note: Error bars correspond to standard deviation.

2.5 pH

pH values for the different products are shown in Table 6 and summarized in Figure 5. The values decline during the first (b) (4) of storage (b) (4) but increase upon further storage. The average increase between (b) (4). The changes with storage time are small compared to the variability between different batches, and suggest that pH stability does not limit the shelf life. All of the results are within the acceptance criteria during the (b) (4) storage period.

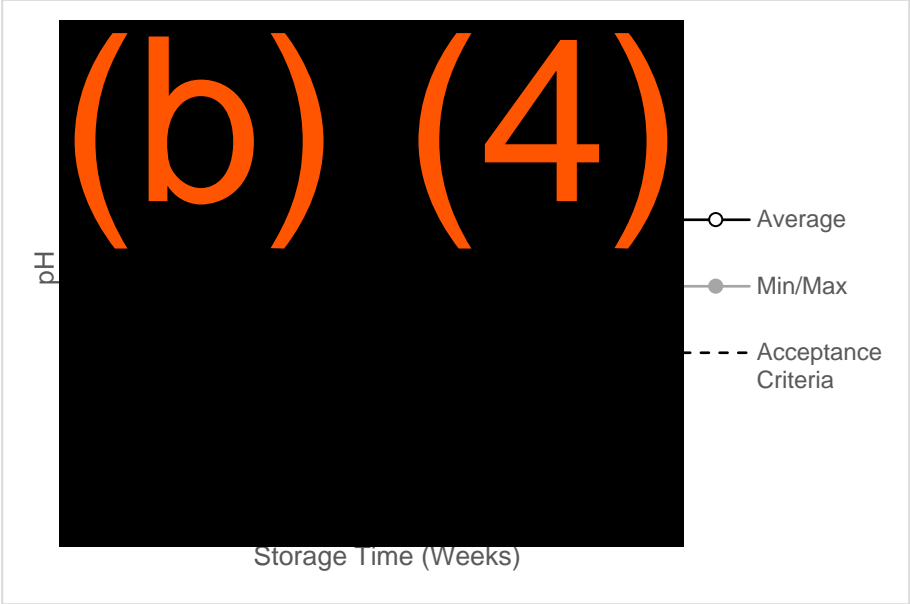
Table 6: pH versus Storage Time (Weeks) - ZYN

Flavor	Storage Time (Weeks)
Cool Mint 3 mg	(b) (4)
Cool Mint 6 mg	
Peppermint 3 mg	
Peppermint 6 mg	
Spearmint 3 mg	
Spearmint 6 mg	
Wintergreen 3 mg	
Wintergreen 6 mg	
Citrus 3 mg	
Citrus 6 mg	



Flavor	Storage Time (Weeks)
Coffee 3 mg	(b) (4)
Coffee 6 mg	
Cinnamon 3 mg	
Cinnamon 6 mg	
Smooth 3 mg	
Smooth 6 mg	
Chill 3 mg	
Chill 6 mg	
Fresh 3 mg	
Fresh 6 mg	
Average	
Standard Deviation	
Minimum	
Maximum	
Acceptance Criteria	(b) (4)

Figure 5: pH versus Storage Time - ZYN



Note: Error bars correspond to standard deviation.

2.6 Moisture Content

Moisture content is shown in Table 7 and summarized in Figure 6. The value increases slightly during the first (b) (4) of storage, but subsequently remains stable throughout the storage time.



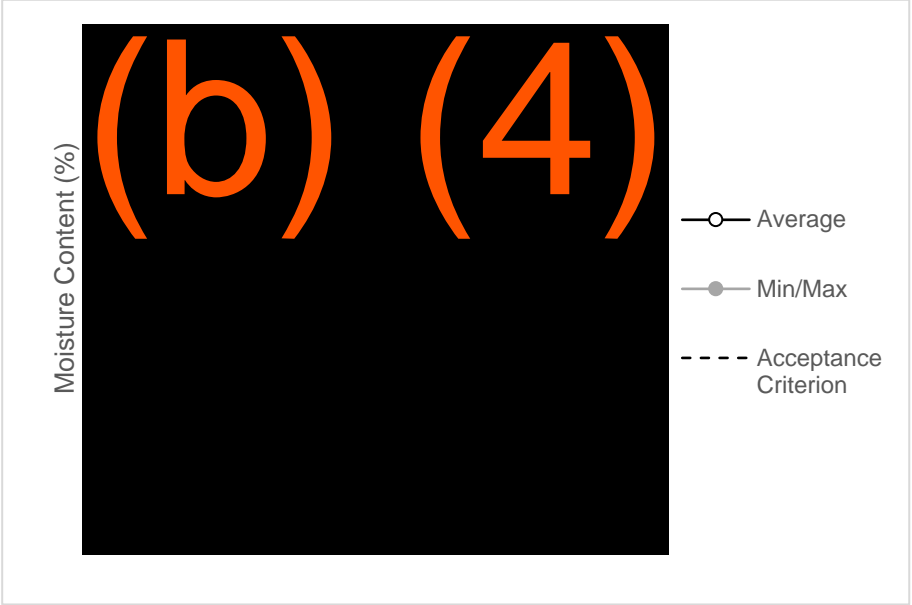
## ☆☆☆ Swedish Match.

The initial increase in moisture content is likely due to absorption of moisture from the environment, whereas the lack of change in moisture content upon further storage suggests that the moisture content has reached equilibrium with the humidity in the controlled storage environment. For storage at (b) (4) relative humidity, moisture content does not limit the shelf life.

**Table 7: Moisture Content (%) versus Storage Time - ZYN**

Flavor	Storage Time (Weeks)			
Cool Mint 3 mg	(b) (4)			
Cool Mint 6 mg				
Peppermint 3 mg				
Peppermint 6 mg				
Spearmint 3 mg				
Spearmint 6 mg				
Wintergreen 3 mg				
Wintergreen 6 mg				
Citrus 3 mg				
Citrus 6 mg				
Coffee 3 mg				
Coffee 6 mg				
Cinnamon 3 mg				
Cinnamon 6 mg				
Smooth 3 mg				
Smooth 6 mg				
Chill 3 mg				
Chill 6 mg				
Fresh 3 mg				
Fresh 6 mg				
Average				
Standard Deviation				
Minimum				
Maximum				
Acceptance Criterion	(b) (4)			

Figure 6: Moisture Content versus Storage Time - ZYN



Note: Error bars correspond to standard deviation.

2.7 Other Specified Tests

For the remaining tests included in the shelf-life specification, an overview is presented in [Table 8](#). Formaldehyde and acetaldehyde are present below the acceptance criteria at the start of the study, but the content declines upon storage. None of the TSNAs were present in amount over LOQ at any of the tested samples. For some SKUs, there is a minor increase in the content of nitrite, albeit at very low levels. The indicators for microbiological activity, TAMC and TYMC, were below the LOQ with the exception of a single sample at (b) (4) which was at the LOQ for TAMC.

Table 8: Overview of Other Specified Tests in the Shelf-Life Specification - ZYN

Parameter	Acceptance Criteria	Value Type	Storage Time (Weeks)
Formaldehyde (µg/g)	(b) (4)	(b) (4)	(b) (4)
Acetaldehyde (µg/g)	(b) (4)	(b) (4)	(b) (4)
TSNA (µg/g)	(b) (4)	(b) (4)	(b) (4)
NNN+NNK (µg/g)	(b) (4)	(b) (4)	(b) (4)
Nitrate (%)	(b) (4)	(b) (4)	(b) (4)
Nitrite (µg/g)	(b) (4)	(b) (4)	(b) (4)

Parameter	Acceptance Criteria	Value Type	Storage Time (Weeks)	
TAMC (lgcfu/g)	(b) (4)	(4)	(b) (4)	(4)
TYMC (lgcfu/g)	(b) (4)	(4)	(b) (4)	(4)
lgcfu/g=log(10) colony-forming units per gram; NA=not tested; NNK=nicotine-derived nitrosamine ketone; NNN=N-nitrosornicotine; TAMC=total aerobic microbial content; TSNA=tobacco-specific nitrosamine; TYMC=total yeast and mold content.				

## 2.8 Summary

An overview of the different stability-indicating parameters is shown in [Table 9](#).

**Table 9: Overview of Stability-Indicating Parameters during Storage at (b) (4) and Either (b) (4) RH (b) (4) RH or (b) (4) RH (b) (4) RH - ZYN**

Parameter	Acceptance Criteria	Value Type	Storage Time (Weeks)	
Nicotine (mg/g as is) 3 mg Products	(b) (4)	(4)	(b) (4)	(4)
Nicotine (mg/g as is) 6 mg Products	(b) (4)	(4)	(b) (4)	(4)
Nicotine Related Compounds (% of Nicotine)	Total	(b) (4)	(b) (4)	(4)
	Maximum Individual	(b) (4)	(b) (4)	(4)
pH	(b) (4)	(4)	(b) (4)	(4)
Moisture Content	(b) (4)	(4)	(b) (4)	(4)
<sup>a</sup> Values are uncertain due to deviations from the validated analytical procedure.				

## 3 Conclusion

The results for nicotine, pH, and moisture content show that these parameters do not undergo appreciable changes during the (b) (4) storage period, and they remain within the acceptance criteria throughout the length of the stability study. The total concentration of nicotine related compounds, as well as the concentration of the largest individual related compound, increases with storage time. The dominant related compound is generally (b) (4).

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For all of the other analyses performed, including other HPHCs, all of the results are within acceptance criteria. Furthermore, with the exception of (b) (4) and (b) (4), all results for other analytes are either below the LOQ, or the trend is either stable or decreasing with increasing storage time. (b) (4)

he analyses for TSNA, NNN+NNK, Nitrate, Nitrite, TAMC and TYMC are required by the proposed rule for pre-market tobacco applications, and they will therefore continue to be analyzed. The results for analytes that are not presented in this document are found in the Stability Data sections (H.1.2.4.2.2 and H.1.2.4.2.3).

All results are within the acceptance criteria at all time points of the stability study, and thus these changes do not correspond to an appreciable change in quality. The stability results for the ZYN batches listed in Table 1 support the proposed shelf life of (b) (4) for all of the tested products.