improved anhydrous toothpaste thickening system

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The structure and processing of an anhydrous, stannous fluoride toothpaste thickened with carbomer homopolymer type b was significantly improved by incorporating a small amount of a swellable, lightly to moderately crosslinked polyvinyl pyrrolidone (PVP). The addition of this special grade of PVP resulted in a formula with substantially improved ribbon stand-up, reduced stringiness, syneresis and increased toothpaste viscoelasticity and thixotropy. Further, the toothpaste made with the combination of carbomer and the special grade of PVP improved process robustness by preventing shear-induced viscosity loss and maintaining higher viscosities at each stage of manufacture.

introduction

Anhydrous toothpaste formulations are used to protect water-sensitive active ingredients. Currently, there are only a few polymeric rheology modifiers capable of adequately structuring anhydrous toothpastes. Carbomer (crosslinked polyacrylic acid (CPA)) is widely used to structure anhydrous toothpastes but its viscoelastic properties in the absence of water are poor and anhydrous toothpastes made with CPA typically exhibit poor ribbon stand-up, stringiness and syneresis. In addition, these carbomer-based anhydrous formulations are known to have poor process robustness; with difficulty building and maintaining stable viscosity.

It was found that by adding a small amount of swellable, lightly to moderately crosslinked PVP, it was possible to improve the structure/rheology of an anhydrous stannous fluoride toothpaste formulation and overcome the deficiencies that are often seen in anhydrous toothpaste thickened with carbomer alone.

methods

Toothpaste formulations were made at room temperature at the lab scale using conventional toothpaste manufacturing methods and packaged into tubes.
Viscosities were measured at 23° C with a Brookfield Model DV2T viscometer using a T-D spindle at 2 RPM in the Helipath mode.
Toothpaste bead integrity ('stand-up') was measured using the Cuban test which has been described elsewhere[1].
Rheology measurements were taken using a AR-G2 rheometer (TA Instruments) with 40 mm sand blasted stainless steel parallel plates with solvent trap at 25°C. Measurements were conducted using a continuous shear ramp up and down test between 0 to 4 1/s . The LAOS tests were conducted within the range of 1-600%, strain amplitude at 50 rps.

toothpaste formulas

ingredient	carbomer, only % (w/w)	carbomer + PVP % (w/w)
Stannous Fluoride	0.45	0.45
Glycerin	50.80	50.60
PEG 400	20.00	20.00
Carbomer Homopolymer, Type B	0.75	0.75
PVP (lightly to moderately cross-linked)	----	0.20
Zeodent* 113 silica	15.00	15.00
Zeodent*165 silica	5.00	5.00
SLS, USP/NF	1.00	1.00
Cocamidopropyl Betaine	0.50	0.50
Peppermint Flavor Oil	0.70	0.70
Titanium Dioxide	0.50	0.50
Sodium Saccharin	0.30	0.30
Sodium Tripolyphosphate (STP)	5.00	5.00
total	**100.00**	**100.00**

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results

effect of special grade of PVP on toothpaste structure

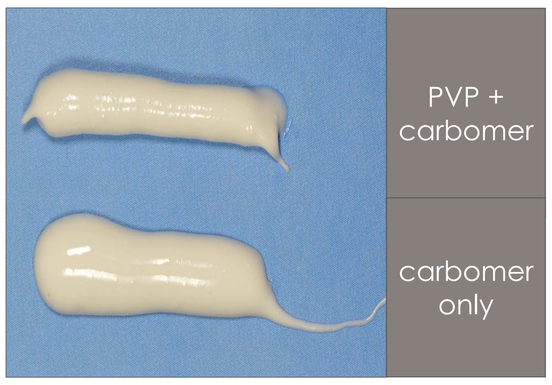

Figure 1. toothpaste appearance

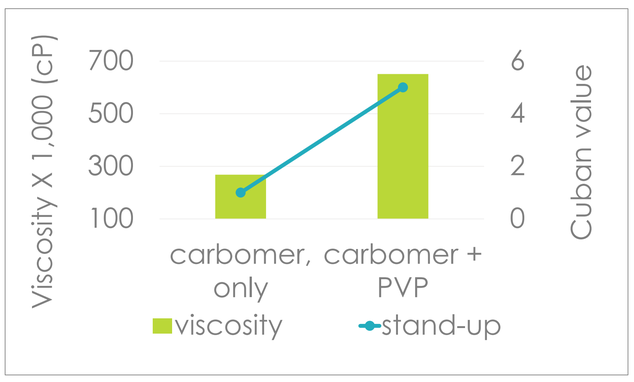

Figure 2. toothpaste viscosity and stand-up

toothpaste rheology

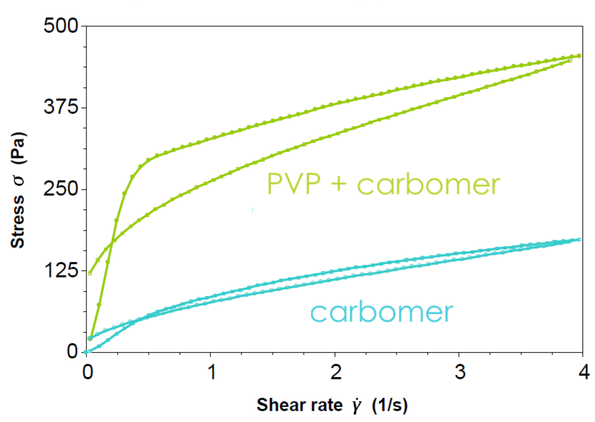

Figure 3. Toothpaste thixotropy

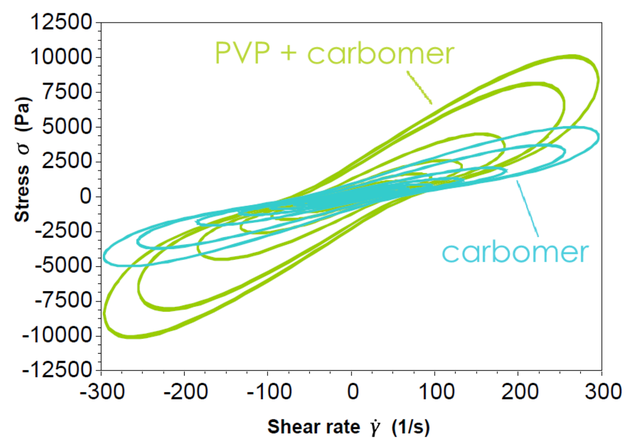

Figure 4. Toothpaste viscoelastic properties using LAOS

effect of special grade of PVP on process robustness

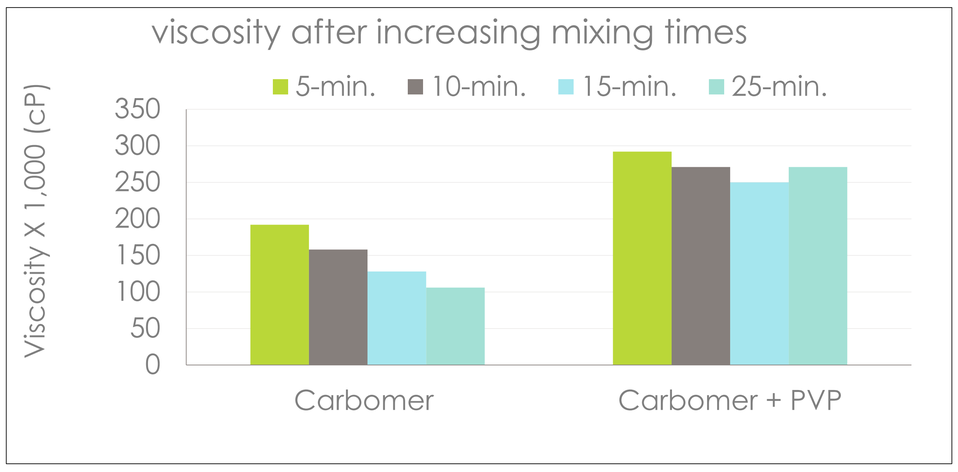

Figure 5. viscosity of toothpastes after stannous fluoride addition (last step) at increasing mixing times

discussion & conclusions

- The addition of a small amount of a swellable, lightly to moderately crosslinked PVP to an anhydrous toothpaste thickened with carbomer doubled the viscosity, indicating an interaction between the two polymers.
- The toothpaste with PVP showed increased viscoelastic and thixotropic properties, resulting in a ribbon with improved characteristics.
- During manufacture, the addition of PVP improved process robustness by stabilizing toothpaste viscosities.
- This special grade of PVP could be useful in providing improved toothpaste properties and processing of anhydrous toothpastes.

references

(1) Kamalakanta, G. (2015). *Toothpaste Compositions With Reduced Abrasivity*. U.S. Patent No. 9,072,658.
Ashland is the manufacturer of the PVP polymer tested herein.

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