The sweetness of D-tagatose - a novel food ingredient

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Introduction

D-Tagatose is a monosaccharide, which is receiving attention as a sweetener for applications in low calorie and diabetic foods. The taste quality is similar to sucrose with a slightly lower taste intensity at equal w/v concentration. The tolerance level of tagatose is, however, relatively low. Therefore, applications as sweetener in foods may require combinations with other bulk or intense sweeteners.

D-tagatose is structurally similar to D-fructose, which is known to cause variable sweetness due to mutarotation (**Figure 1**). The sensory significance of mutarotation of tagatose has not been reported.

Two aspects of the sweetness of tagatose were investigated, namely mutarotation and taste synergy in binary mixtures.

Conclusions

- Mutaroation did not play a significant role in sweetness of D-tagatose at the ambient temperatures investigated.
- Sweet taste synergy of D-tagatose in combination with aspartame or acesulfame K and to less degree sucralose was observed in aqueous media.
- The promising taste and other properties of D-tagatose require further investigations in real food systems; multiple component sweetener mixtures are currently studied.

Experimental

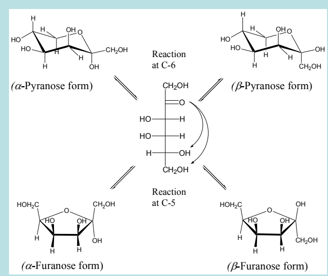
Mutarotation

The mutarotation experiment (13 trained subjects, 2 replicates) involved sweetness evaluation at 7.5% SEV of 8 water solutions: D-fructose (10ºC, 0h and 24h equilibration), sucrose (10 and 30ºC, 24h) and D-tagatose (10ºC, 0h and 24h; 30C, 0h and 24h). Sweetness was rated on a 15 cm sucrose-referenced line scale and bitter taste on a 7 points intensity scale. Data were analysed by ANOVA.

Sweet taste synergy

The synergy experiment (12 trained subjects, 2 replicates) included aqueous solutions (22ºC) of self-mixtures and binary combinations of acesulfame K, aspartame, sucralose and sucrose with D-tagatose aiming at 2% SEV and 6% SEV. Sweetness responses were measured on a sucrose-referenced line scale (Dubois et al, 1991) and by time-intensity. Assessor-replicate weighted average TI sweetness curves (non-centered PCA modeling) were compared.

Theory



Tautomers of D-tagatose in aqueous solution and their ratio at 27ºC:

79%	α-tagatopyranose
16%	β-tagatopyranose
1%	α-tagatofuranose
4%	β-tagatofuranose

In D-fructose, changes in concentration of β-fructopyranose causes sweetness to vary over time and temperature. E.g. increasing temperature from 20ºC to 31ºC significantly reduces sweetness, which is explained by the decrease of β-fructopyranose from 73% to 65% (Shallenberger, 1993).

Figure 1. **Mutarotation of D-tagatose in aqueous solution, leading to 4 ring isomers in varying ratios depending on equilibration time and temperature.**

Results

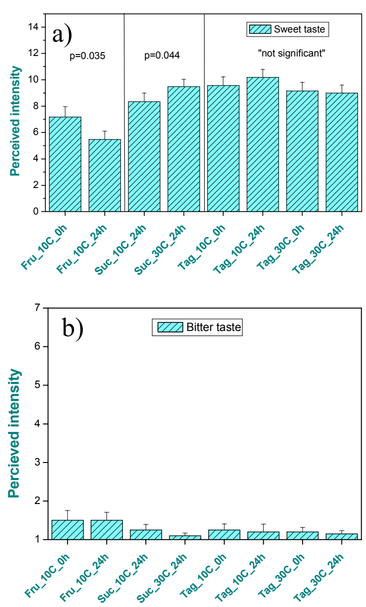


Figure 2. **Mutarotation experiment: Sweetness score on a 15 cm scale (a) and bitter score on a 7 points scale (b), average values (SE) are shown.**
Sample codes: Fru = D-fructose, Suc = sucrose, Tag = D-tagatose, C = ºC and h = incubation time (h) at given C.

Mutarotation

A significant ($p \leq 0.05$) reduction in sweetness was observed between 0h and 24h equilibration of the D-fructose samples, evidently due to mutarotation **(Figure 2a).** No significant time effect was observed for D-tagatose. Increasing temperature of the sucrose samples increased sweetness ($p \leq 0.05$) but did not significantly affect D-tagatose. Sensitivity to sweetness increases around body temperature. This may explain the higher sweetness of sucrose at 30ºC compared to 10ºC. Absence of this effect for D-tagatose could suggest some effect of mutarotation. However, these effects appeared to be relatively small in comparison to D-fructose. This may be explained by the relative low ratio of β-D-tagatopyranose. Bitter taste did not significantly vary between the treatments of sweeteners (**Figure 2b**).

Sweet taste synergy

Sweetness responses were measured on a sucrose-referenced line scale and by the TI method. No clear synergy could be observed in mixtures at 2% SEV. In mixtures at 6% SEV, weak synergy was observed with aspartame and acesulfame K using the line scaling method (**Figure 3a**). The TI method indicated a synergistic contribution of aspartame and acesulfame K and also some synergy in the tagatose-sucralose mixture (**Figure 3b**).

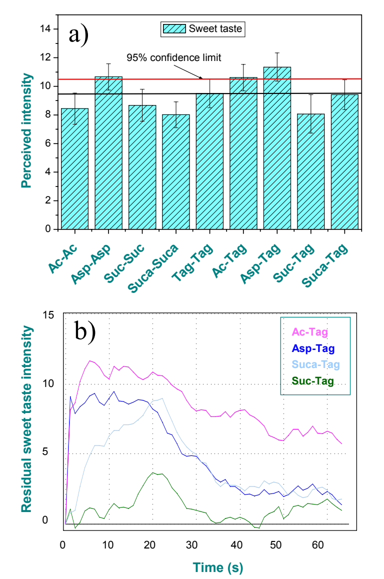


Figure 3. **Synergy experiment: Sweetness score of D-tagatose mixtures at targeted 6% SEV (a). Similar mixtures by TI method showing residual sweetness score after subtracting TI curve of the D-tagatose self-mixture (b).** Sample codes: Ac = Acesulfame K, Asp = Aspartame, Suc = sucrose, Suca = Sucralose, Tag = D-tagatose.

References

DuBois, G. E., D. E. Walters, et al. (1991). Concentration-response relationships of sweeteners. Sweeteners-discovery, molecular design, and chemoreception. D. E. Walters, F. T. Orthoefer and G. E. DuBois. Washington DC, American Chemical Society: 261-276.

Shallenberger, R.S. (1993). Taste Chemistry. Blackie Academic & Professional, London.

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