WOW Emulsion for Sugar Reduction

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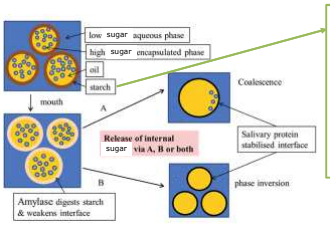
INTRODUCTION

This research concerns a sugar reduction technology for emulsion based foods applying the principle of taste enhancement. This technology has been demonstrated for salt reduction [1]. It is based on encapsulating the tastant in the internal phase of a water-in-oil-in-water (wow) emulsion stabilised with starch. Upon ingestion and oral processing, salivary amylase destabilises the starch and thus the emulsion microstructure, releasing the tastant close to the taste buds. Applying this strategy to sugar reduction, the hypothesis that a proportion of the interface stabilising starch can be replaced with non-starch emulsifiers to minimise the amount of ingested starch in a reduced sugar product is tested this research. Reducing starch as an essential component of this sugar reduction technology was motivated by the fact that the digestion product of starch is sugar itself.

Protein as a frequently applied in foods was selected as the co-emulsifier. This poster introduces results on whey protein/OSA starch and casein/OSA starch as mixed emulsifier systems for wow emulsion stabilisation, and encapsulation efficiency for sugar solutions. OSA starch is commercially available hydrophobic starch for the stabilisation of food emulsions.



Modified from [1]

This research: Substitute with starch/protein mixed interfacial layer.
Note: Glucose was used as tastant due to the method developed to assess encapsulation efficiency.

MATERIALS

- OSA starch: N-Creamer 46, Univar, UK · Whey protein: Organic Whey Protein Company, D · Sodium caseinate (Na-CAS): 1-800-Acros-01, USA
- Sodium azide (added to water as antimicrobial), phosphate buffer (0.1 M, pH 7): Sigma-Aldrich, UK · Polyglycerol Polyricinoelate: PGPR 90, Danisco, DK · sunflower oil (supermarket own brand) · Glucose: Thornton & Ross Ltd, UK

METHODS

o/w emulsions for selection of starch/protein as mixed emulsifier for wow emulsions

- High shear overhead mixing (8000 rpm, 5 min) · 20 (w/w) % oil · phosphate buffer or water used as continuous emulsion phase · starch or protein concentration varied
- Interfacial composition inferred from compositional analysis of continuous phase pre and post emulsification · enzymatic digestion assays

wow emulsions

- Two step processing · step 1: w/o emulsion consisting of 30% w = 50% aqueous glucose solution & 70% o = oil containing 2.85% PGPR processed for 5 min @ 8000 rpm · step 2: emulsifying of w/o into external water phase containing 5% glucose, 0.4% OSA starch and 0.5% protein for 5 min @ 8000 rpm · stored @ 24°C · final theoretical emulsion composition: 7.6% sugar of which 4.29% encapsulated, 20% oil, 0.4% OSA starch, 0.5% protein

Emulsion analyses

- Droplet size distributions acquired with laser diffraction equipment
- Stability assessed via zeta potential
- Microstructure visualised through confocal laser scanning microscopy, staining with Nile red for oil, Fast green for protein and Fluorescein isothiocyanate (FITC) for starch
- Encapsulation efficiency analysed via UV based method · final part of Megazyme total starch assay

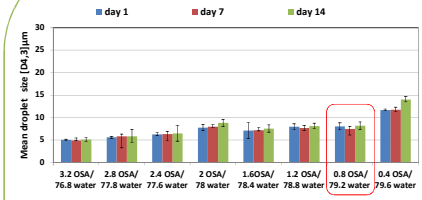
CONCLUSIONS AND NEXT STEPS

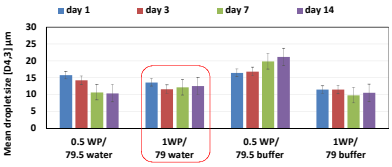
Mixed OSA starch/protein wow emulsions with encapsulated sugar were successfully designed. The emulsions were stable for at least 14 days.

Future work includes

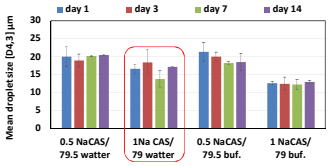
- Assessment of sugar release using *in vitro* assay
- Developing detailed understanding of the properties of the starch/protein layer to minimise starch and maximize sugar encapsulation and release
- Evaluation of process stability of the emulsion systems (pH, temperature, salt)
- Sensory/consumer studies: *in vivo* assessment of sugar release · validation of sugar reduction approach through formulating and evaluation of commercially relevant foods

RESULTS & DISCUSSION: single emulsifier o/w emulsions



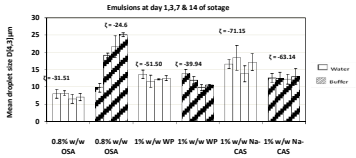


- Lowest OSA starch concentration leading to a stable emulsion (20% oil) was 0.8% (based on emulsion)



- Lowest whey protein concentration leading to a stable emulsion (20% oil) was 1% (based on emulsion) independent of use of buffer

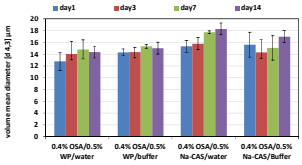
- Na-CAS emulsions more stable with buffer



- Zeta potential analysis validates emulsion stability for selected concentrations
- No statistically significant differences in droplet size or zeta potential for selected concentrations except for starch as emulsifier in buffer
- 0.4% OSA starch and 0.5% protein chosen for mixed emulsifier system

RESULTS & DISCUSSION: mixed emulsifier system o/w emulsions

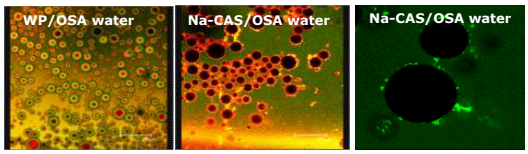
- No significant changes in droplet size during storage at 24 °C
- Water selected as solvent



- Both, starch and protein adsorbed at interface indicating that a mixed emulsifier system stabilised emulsion was successfully formulated

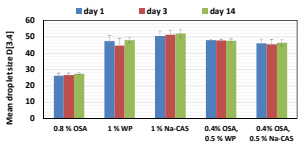
Emulsion	% of starch or protein at interface	
	protein	starch
WP/OSA water	0.12	0.26
WP/OSA buffer	0.18	0.27
Na-CAS/OSA water	0.14	0.25
Na-CAS/OSA buffer	0.14	0.26

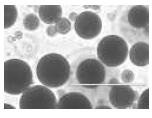
- Non quantitative evidence gathered via in confocal laser scanning microscopy



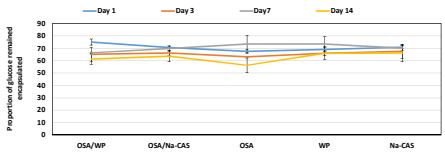
RESULTS & DISCUSSION: wow emulsions

- The microstructure of both types of wow emulsions was stable for at least 14 days





- Sugar encapsulation efficiency was high and stable for at least 14 days



Acknowledgments:

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Reference

1. Chiu, N., et al. (2015). "Programmed emulsions for sodium reduction in emulsion based foods." Food Funct **6**(5): 1428-1434.