Characterization of oil migration in confectionery products

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1. Challenges

Oil migration between different phases in composite confectionery products, such as filled chocolate bars, is a common yet poorly understood phenomenon. It is of great concern to food manufacturers as fat migration leads to visual and sensory defects making the product unacceptable for the consumer. In fact, migration from a highly oil-rich phase to a crystalline fat-rich phase, i.e. “oiling out”, is becoming more and more relevant since the liquid lipid fraction is constantly increased in order to achieve a better product nutritional profile. However, current interpretation of actual mechanisms are mostly speculative even though the triacylglycerol (TAG) chemical potential ($\mu_{TAG}^{oil}$) gradient implies that there will be some net diffusive flux.

The aim of this study is to pose the methodology bases for further elucidation of the driving forces behind oil migration but also to assess some kinetic factors. Thus, robust characterization protocols combined with analytical methods were developed in order to quantify this process. Finally, an accelerated shelf life test, over 3 months, on filled, enrobed wafer products was conducted.

3. Approaches – Part 1

Four different variants with four types of fat were produced. The reference variant does not oil out in real life whereas the negative reference, with HOSFO shows oil migration.

To quantify oil migration, oil uptake experiment consisted in putting in direct contact a thin milk chocolate tablet with the negative reference filling. At regular time intervals, the chocolate mass was recorded.

5. Oil Uptake

Typical mass uptake results obtained within the oil uptake experiment at 20°C using milk commercial chocolate in contact with HOSFO filling.

- An initial time lag period $t_{lag}$ was observed, i.e. no important weight gain.
- After seven days, 22% of HOSFO migrated into milk chocolate.
- A linear weight gain increase against square root of time was obtained.

6. Differential scanning calorimetry (DSC)

Migration of 22% of HOSFO in milk chocolate did not lead to significant melting peak shift.

However, the melting enthalpy decreased, i.e. area above the curve.

7. Conclusion

- In this work, a systematic tool was developed to elucidate both thermodynamic, i.e. amount of HOSFO that migrated at saturation, and kinetic, i.e. how fast HOSFO migrated, information on oil migration in confectionery systems. This study made an improvement by using more authentic filling recipes, i.e. similar to those used in factory.
- The oil uptake experiment showed that fat migration followed a linear dependence with square root of time.
- Calorimetric curves combined with H-NMR highlighted that HOSFO migration in milk chocolate at 20°C did not lead to recrystallization of cocoa butter crystals, i.e. no significant melting peak shift. However, the melting enthalpy decreased significantly due to a dilution effect. This effect was more pronounced for samples that underwent temperature cycling.

References