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# Image Analysis: A Novel Method in the Assessment of Pharmaceutical Foams

**DÓRA FARKAS; NIKOLETT KÁLLAI-SZABÓ; ISTVÁN ANTAL**

*Department of Pharmaceutics, Semmelweis University, Hőgyes Endre St. 7., H-1092, Budapest, Hungary*

*Correspondence: antal.istvan@pharma.semmelweis-univ.hu*

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## 1. Introduction

For almost half a century foams have been present in the pharmaceutical markets worldwide. Generally, they can be defined as thin liquid or solid film separated gas bubble agglomerations, but the pharmacopoeial monograph of medicated foams recognizes only the aforementioned [1,2].

Pharmaceutical foams offer an outstanding alternative to conventional dosage forms in topical treatment. Apart from the satisfactory drug delivery ability, the ease and convenience of application contributes to the high acceptance and excellent patient compliance of this dosage form. Despite the growing interest for foams, the current pharmacopoeial examinations are not sufficient for the description of their unique nature and virtue. Although image analysis can not provide an exhaustive overview on foams, it offers a great complementary method for their assessment [3,4].

This research aims to demonstrate the extensive applicability of image analysis in the evaluation process of pharmaceutical foams. It also aims to make assumptions on important foam characteristics based on the composition and the micro- and macroscopic properties of foams.

## 2. Materials and methods

The examined propellant-free foams were produced with a pump device (140 ml, PET from Nordtek Imexco Kft., Hungary) from various initial liquids. Along with foams formed from simple and complex solutions of surface active foam forming agents, active ingredient-bearing systems, as well as synthetic and natural oil containing nano- and microemulsions were also examined. Dynamic light scattering and laser diffraction (Mastersizer 2000TM with Hydro SM instrument and Zetasizer Nano ZS; Malvern Instruments Ltd., UK) measurements were carried out for the evaluation of the emulsion stability of the initial emulsions.

Microscopic and macroscopic images (Olympus Stylus TG-4, Olympus Corp., Japan; Nikon D90 with Nikon AF-S 50 mm f/1.8G objective, Nikon Corp., Japan, Keyence VHX-970F, Keyence Corp., Japan) were taken to describe the foam structure, the bubble size distribution of the foams, the foam stability, likewise the collapse tendencies. Additional test was performed to gain information about the bubble forming ability of the initial liquids. Image J software (Wayne Rasband, National Institute of Health, USA) was used to analyse the processed videos and photos.

## 3. Results

To the macroscopic description visual appearance and parameters like the height of the actuated foam and its stability were investigated. Foam collapse was followed in time and analyzed from horizontally taken photos (***Figure 1.***). It is clear, that the composition influences the time required for the structural breakdown, thus the choice of surface active foam forming excipient is crucial.

As the physical properties of the foams result from the characteristics of the individual foam cells, their research is particularly important. The analysis of microscopic images enables the inspection of the number, the size distribution and the shape of bubbles in foams. The shape of the bubbles is influenced by the liquid fraction, as they are more deformed in case of decreased moisture content that is, amongst others, affected by the type and amount of surface active agent.

Bubbles can be investigated individually, as foaming and single bubble forming ability of the initial liquid are connected. The speed and rate of bubble forming affect the quality attributes of foam cells and consequently the foam properties.

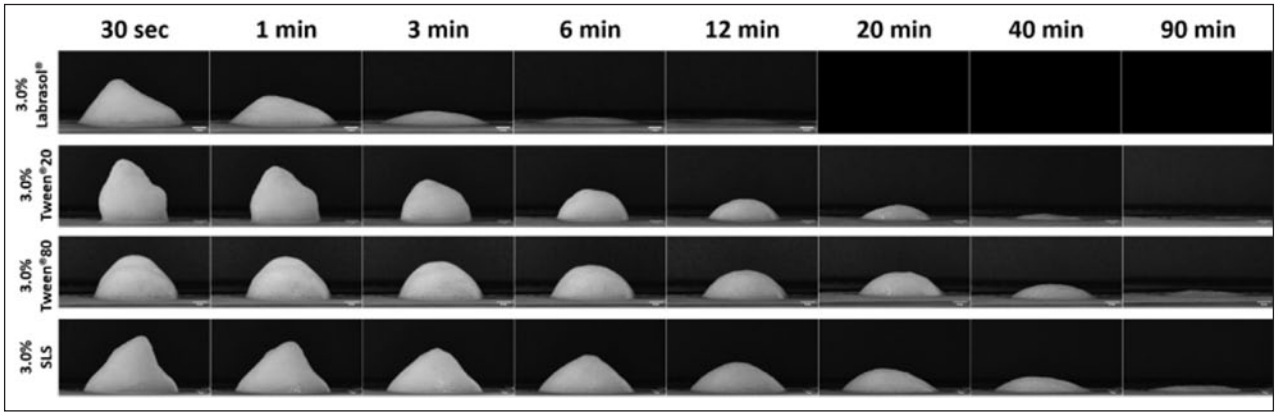


***Figure 1*** *Foam collapse tendencies*

## 4. Conclusions

Having acknowledged the complexity of foams, it is clear that the description and evaluation of this dosage form is complicated. Beyond the pharmacopoeial instructions more tests are required. Image analysis is a universal tool for this purpose as its applicability ranges from microscopic to macroscopic foam characterization therefore it extends the evaluation methods of pharmaceutical foams.

## 5. Acknowledgements

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### References

1. *Bikerman, J. J. General. Foam Films. in Foams: Theory and Industrial Applications 1–22 (Springer-Verlag, 1973).*
2. *Council of Europe. Medicated foams. in European Pharmacopoea 9.0 859 (2016).*
3. *Farkas, D., Kállai-Szabó, N. & Antal, I. Foams as carrier systems for pharmaceuticals and cosmetics. Acta Pharm. Hung. 89: 5–15 (2019).*
4. *Tamarkin, D. Foam : A Unique Delivery Vehicle for Topically Applied Formulations. in Handbook of Formulating Dermal Applications: A Definitive Practical Guide vol. 9 233–237 (2013).*