# USE OF IMAGE ANALYSIS AT THE STUDY OF GEL STRUCTURE FORMATION IN DAIRY ACID PRODUCTS

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## Abstract

*In this paper, image analysis is used for the study of structure formation in the natural yogurt without and with stabilisers added. The initial images are processed using GIMP2, a free manipulation program. The procedure allows the better identification of fat globules in the initial product, the presence of starch granules provided by stabilisers and the distribution of compact gel structures and gel-free areas during curdling and in the finished yogurt.*
***Keywords:*** image analysis, yogurt, stabiliser

## Introduction

Food biopolymers are used as functional ingredients in the food emulsions or gels in order to create microstructures which provide products with desirable texture and rheological properties (Aguillera, 2005).

The control and/or manipulation of the macromolecular interactions between biopolymers is a key factor in developing and proper structuring of multiphase foods to provide increased stability or protection as well (Cesaro et al., 1992) (Pelletier et al., 2001).

In the case of yogurt, a classical dairy acid product, proteins and/or polysaccharides are added for the improvement of flow properties, texture or water retention (Mironescu et al, 2006).

In a previous paper (Mironescu et al., 2007) the structure formation by some industrial biopolymeric mixtures in yogurt was investigated. Two types of stabiliser mixtures, provided by Liliput Constanta, Romania were used: Bekaplus Y2 (gelatine and whey protein) and Bekaplus Y3 (modified starch, gelatine and pectin). The results indicated that the stabiliser type (meaning composition) and quantity influence strongly the structure and the functional properties. The use of small quantities of stabiliser Y2 (0.3 mg/l) allows the formation of very uniform structure, which retains well the water. The increase of quantity of Y2 in the initial milk determines non-significant

changes of the curdle flow resistance, but high differences at the structural level, where aggregates form, looking as self-assembly structures. In the case of using stabiliser Y3, compact and resistant final coagulum was obtained at the addition of 2 mg/l, whereas smaller quantities of stabiliser (0.5 to 1 mg/l) gave weaker curdles, having structures near the natural yogurt. During curdling, an increase of the flow resistance well correlated with the microstructural changes was observed after 210h of lactic fermentation.
Images obtained at the optical microscope are not always very clear and don't present the relevant aspects at the structure formation. In this paper, image analysis is used to reveal the structure formation in yogurt (Mironescu et al., 2007).

## Experimental

Milk with 2.5% protein content was used.

Two types of stabiliser mixtures, provided by Liliput Constanta, Romania were tested:

- Stabiliser Bekaplus Y2 containing gelatine and whey protein;
- Stabiliser Bekaplus Y3 containing modified starch, gelatine and pectin.

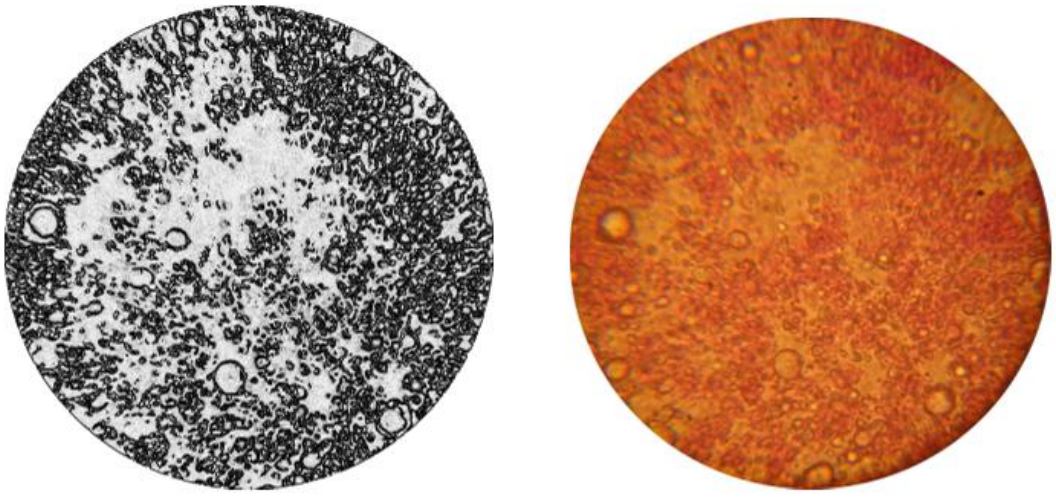
For each stabiliser type, three concentrations were tested (Mironescu et al., 2007).

The structure formation during curdling was analysed through optical microscopy using basic fuxine for staining. The microscope Kruss Optronic with digital camera was used.

The digital images obtained were processed with the image manipulation program GIMP 2.

## Results and Discussion

One example of the results obtained at the use of GIMP for image analysis is presented in figure 1. Starch granule is very clear revealed in both images (the round grey structures surrounded by black), whereas the gel formed during curdling is more visible in the processed image (the dark regions). The white or light grey regions are gel-free zones.



a b

**Fig 1**: Initial and processed image of gel obtained using stabiliser Y3 at the obtaining of yogurt. a) initial image; b) processed image.

In milk, the raw material at the obtaining of yogurt, the structures visible at the optical microscope are the fat globules (mean diameter 0.01 μm), whereas the casein micelles (20 – 400 nm) (Borda, 2007) are too small to be observed with this technique. Even, the aspect of fat globules in milk obtained through optical microscopy is not very clear.

The use of image analysis allows the visualisation of fat globules in milk, as figure 2a shows. In the initial milk, the round structures correspond to the fat globules. The white or grey surrounding areas represent the plasma. The addition of stabilisers in milk modifies its aspect. In figures 2c and 2e two processed images of milk immediately after the addition of mixtures Y3 and Y2 are presented. The presence of starch granules from the stabiliser Y3 is clearly observed, as the more compact structure of the initial milk where stabiliser Y2 (containing whey protein) is added.

After the maintaining the milk at 45°C for 210 min., a gel is formed. The differences between the three gel types are observed at the analysis of figures 2b, 2d and 2f. The gel obtained at the classical processing is not compact, having large gel-free areas (the white regions; this gel isn't very dense, as the figure 2b shows.

The final gel obtained at the addition of 2 mg/l Y3 is more compact as the gel without stabilisers (figure 2d). In the same time, the gel has large regions where the gel is very dense.

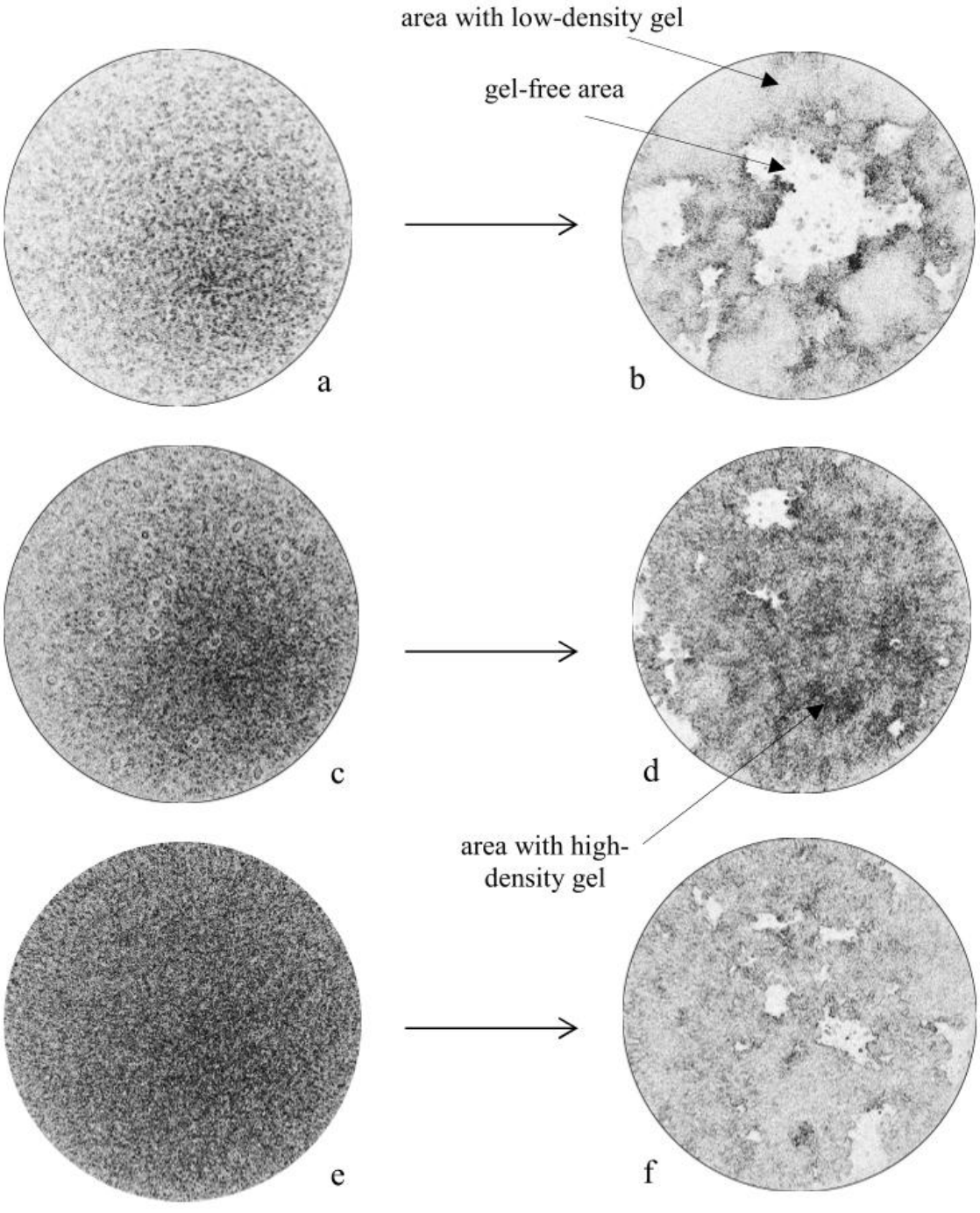
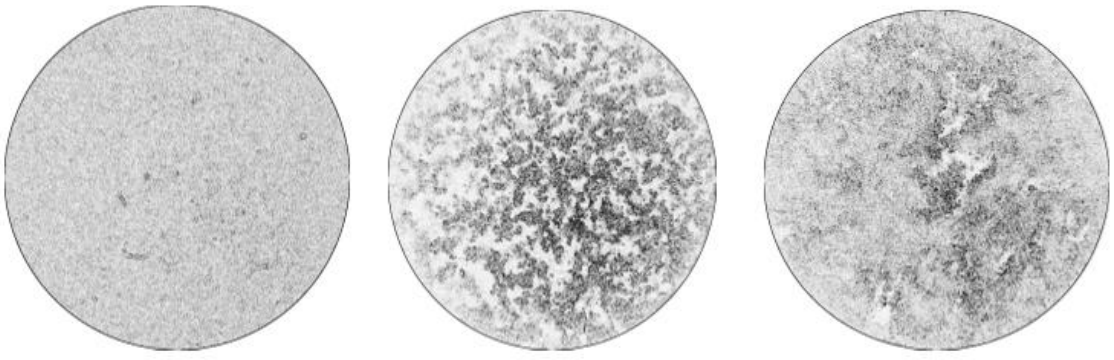



**Fig. 2**: Processed image of initial milk and final gel obtained without stabiliser (a and b), using stabiliser Y3 (c and d) and Y2 (e and f).

A gel with similar compactness can be obtained by using another stabiliser. The aspect of gel obtained with 0.5 g/l Y2 is presented in figure 2f. The structure is compact and not very dense. This result can be attributed to the presence of whey protein in the composition of stabiliser Y2. The

literature (Sodini et al., 2004) shows the positive influence of whey protein addition on water-binding capacity in yogurt.



a b c

**Fig 3**: Processed image of yogurt obtaining using stabiliser Y2. a) initial milk with 0.3 g/l Y2, b) product after 150 h of curdling, c) final product, after 210 h

The technique of image processing is very efficient in describing the evolution of gel structure formation, as figure 3 shows.

## Conclusions

Image analysis is a powerful tool at the study of structure formation in food products. In the concrete case of yogurt obtaining using various types of stabilisers, the processing of initial images offers clear and visible informations on gel formation, gel structure (showing gel areas and gel-free regions) and on gel density.

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