A COMPARISON OF MICROSCOPIC STRUCTURES OF HOMOGENIZED DISPERSIONS OF ISOLATED SOY-PROTEIN, WHEY AND FAT AS A FOOD COLLOID

SOYA PROTEİNİ İZOLATI, PEYNİR ALTI SUYU TOZU VE YAĞIN HOMOJENİZASYONUNDAN ELDE EDİLEN DİSPERSİYONLARA AİT MİKROSKOPİK YAPILARIN BİR GIDA KOLLOİDİ OLARAK KARŞILAŞTIRILMASI[1]

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SUMMARY: The microscopic structures of soy-protein isolates with fat and whey applying different pressures of homogenization were observed. A discussion of the complete structural observations of dispersions with the photomicrographs is in the scope of this paper.

ÖZET: Soya proteini izolatlarının yağ ve peynir altı suyu ile farklı basınçlarda homojenize edilmeleri yoluyla elde edilen dispersiyonların mikroskopik yapıları incelenmiştir. Dispersiyon yapılarının gözlemleriyle ilgili yorum, fotoğraflarla birlikte yayın içinde yer almaktadır.

INTRODUCTION

The new developments in the science of food colloids have focused on the functional properties and structures of isolated soy-proteins as a biopolimer in food macromolecules which are relevant to the manufacture of food products having acceptable texture, shelf-life and organoleptic characteristics. The functional properties of isolated soy-proteins are dependent upon primary, secondary, tertiary and quaternary structure of the molecule. The presence of lipophilic and hydrophilic groups in the same polymer chain facilitates association of the soy-protein with fat and water, and this results in the formation of stable oil and water emulsions when a protein dispersion is mixed with oil. Isolated soy-proteins have a complicated quaternary structure in bulk solution, of which the two major fractions are the 7S globulin ($2x10^5$ daltons, largest fraction of soy protein, known as glycinin) - its sub-units are partially held together by -S-S- linkages-. The compact tertiary structures of the molecular sub-units are destroyed when the globulins dissociate. Whey proteins, in contrast to isolated soy-proteins, do not form complexes of high aggregation number. The functional properties of isolated soy-proteins such as gelling, emulsifying, emulsion stabilizing, foaming, texture and fiber forming, texture control, moisture and fat binding play a role in the design of foods from a functional standpoint (ALTSCHUL, 1974; DICKINSON and STAINSBY, 1982; KROG, 1977; NASH and BRINKMAN, 1972; PARKER, 1987; PETROWSKI, 1975, 1976).

The microscopy has always played an important role in the practice of food science. The literature on food microscopy showed how microscopy may be used to investigate problems of food processing. The purpose of this study is to observe the microscopic structures in the various dispersion matrix of isolated soy-proteins, whey powder and fat obtained by different homogenization pressures and degrees.

EXPERIMENTAL

Materials

- Isolated soy-proteins PP-710 and PP-760 (Protein Technologies International, St. Louis).
- Butter oil (NCZ Amsterdam, Holland), 99.8% milkfat.

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Batch 1
- 1000.0g water
- 61.0g whey powder
- 35.5g PP-710
- 60.0g butter oil

Batch 2
- 1000.0g water
- 61.0g whey powder
- 35.5g PP-760
- 15/20/60/100g butter oil

Batch 3
- 1000.0g water
- 35.5g PP-760
- 45.0g butter oil

Batch 4
- 1000.0g water
- 61.0g whey powder
- 45.0g butter oil

Batch 5
- 1000.0g water
- 92.6g whey powder
- 31.7g PP-760

Table 1. Physical and microbiological properties of ISP's

ISP	PP-710	PP-760
pH	6.9	7.0
color	cream	cream
flavor	bland	bland
particle size	90 % (t.100 mesh)	90 %
standard plate count	<30,000/g	<30,000/g
Salmonella (by test)	negative	negative
yeast-mold	<100/g	<100/ g
TTAS[1]		125/10 g max.
TA[2]		50/10 g max.
TANP[3]		5/10 g max.
TANN[4]		3 positive/6 tubes max.

[1]Total termophilic aerobic spores, [2]Thermophilic aerobic: flat sour spores, [3]Thermophilic anaerobic, H_2S positive spores [4]Thermophilic anaerobic, H_2S negative spores

Preparation of Dispersions

Whey powder was dissolved by magnetic stirrer at room temperature and isolated soy-protein PP-710 or PP-760 was dispersed in the reconstituted whey while heating the mixture up to 60°C during 12 minutes in the Polytron. Then the foam was removed and after 15 minutes the dispersion was homogenized by Rannie High Pressure Laboratory Homogenizer (MINI-LAB, type 8.30H) at 100 bar to improve the dispersibility of the isolated soy-protein. Afterword pre-emulsion was made by adding of butter oil.

Microscopic Observations

For the dispersion-photomicrographs which showed the structures of the protein granules and fat globules after homogenization and gave data about the homogenization efficiency, a POLYVAR microscope (Reihard-Jung) was used.

RESULTS AND DISCUSSION

The production of foods based upon isolated soy-proteins has now become an important aspect of food technology. During processes, structural changes take place, which can be monitored by microscopy, in the row material, giving rise to a structurally different end-products. Isolated soy-proteins which are designed to provide fat emulsifying and emulsion stabilizing properties, are essentially pure powdered protein products (ANONYMOUS, 1987a, 1987b; DICKINSON and STAINSBY, 1982; VAUGHAN, 1979). Data on the physical and microbiological properties are given in Table 1.

Due to the results of a previous study the observed structure of the protein isolate and protein concentrate showed that the new structural elements are formed during the processing, with none of the cotyledonary cell structural features being retained. The protein isolate was found to contain spheres 2-40µm in diameter, some partially colcapsed, and with both rough and smooth surfaces. Whey products offen contain relatively large, characteristic lactose crystals, easily found in polarized light (VAUGHAN, 1979).

Figures 1 to 4 show the results of dispersions in Batch 1 with PP-710 for one and two stage homogenization. In this experiment, the homogenization degrees were dropped and there was separation in the protein, fat and water layers. Therefore the further analysis were stopped.

Homogenization results of dispersions in Batch 2-5 with PP-760 and various amounts of butter oil - 15g to 100g- at different homogenization degrees and pressures can be seen in Figures 5-16.

The homogenization of same dispersion under the same conditions for a second time further decreases globule size. On repeating homogenization, the size distribution becomes much narrower. These results are in agreement with the stochastic aspect of the disruption process. Two stage homogenization was used primarly to break up homogenization clusters. It may also affect average size but only slightly

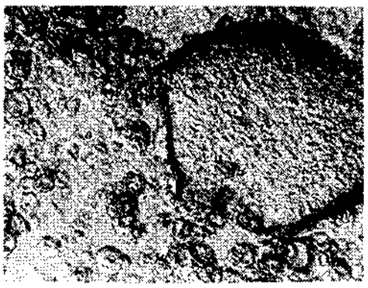

Figure 1. Photomicrograph of dispersion in Batch 1 at 0 bar, x 125

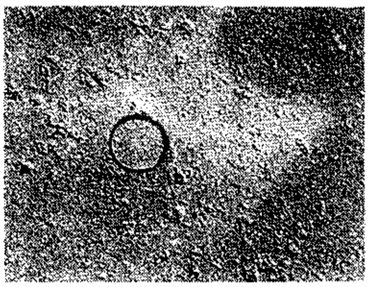

Figure 2. Photomicrograph of dispersion in Batch 1 at 50 bar, x 125

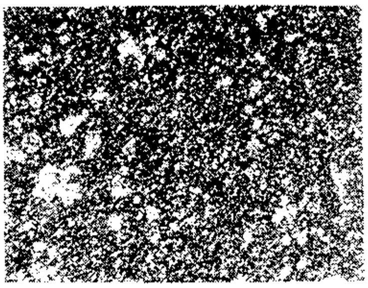

Figure 3. Photomicrograph of dispersion in Batch 1 at 400 bar, x 125

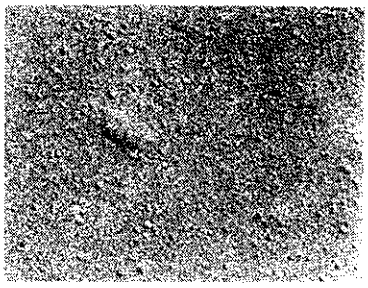

Figure 4. Photomicrograph of dispersion in Batch 4 at 200/50 bar, x 800

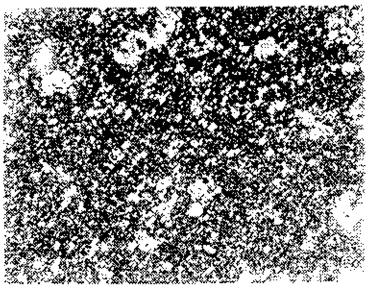

Figure 5. Photomicrograph of dispersion in Batch 2 at 0 bar, x 125 (15g butter oil)

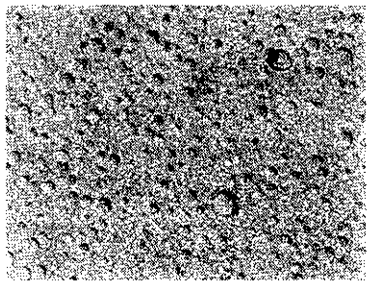

Figure 6. Photomicrograph of dispersion in Batch 2 at 50 bar, x 1250 (15g butter oil)

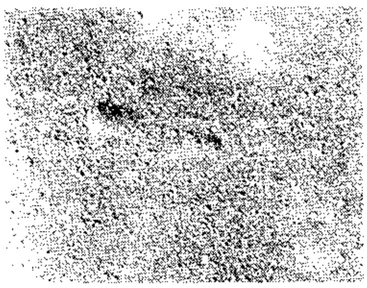

Figure 7. Photomicrograph of dispersion in Batch 2 at 200/50 bar, x 800 (20g butter oil)

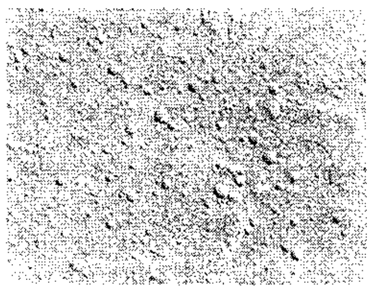

Figure 8. Photomicrograph of dispersion in Batch 2 at 50 bar, x 800 (60g butter oil)

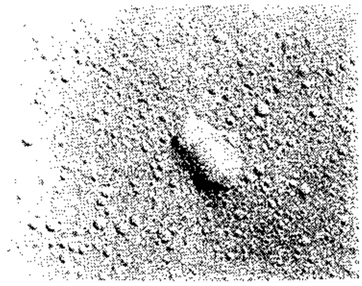

Figure 9. Photomicrograph of dispersion in Batch 2 at 100 bar, x 800 (60g butter oil)

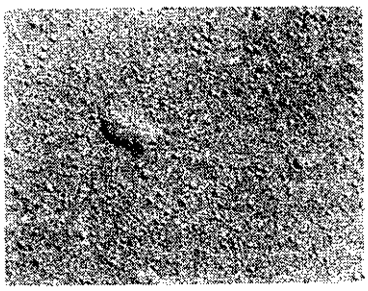

Figure 10. Photomicrograph of dispersion in Batch 2 at 200/50 bar, x 800 (60g butter oil)

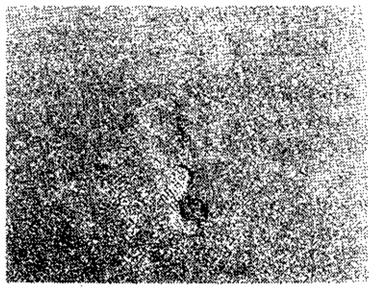

Figure 11. Photomicrograph of dispersion in Batch 2 at 200/100 bar, x 800 (60g butter oil)

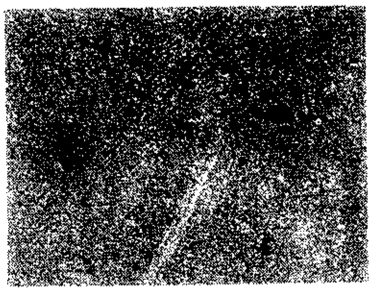

Figure 12. Photomicrograph of dispersion in Batch 2 at 200/200 bar, x 320 (60g butter oil)

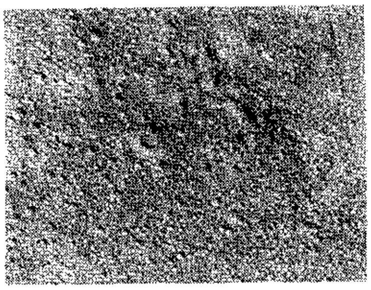

Figure 13. Photomicrograph of dispersion in Batch 2 at 100 bar, x 800 (100g butter oil)

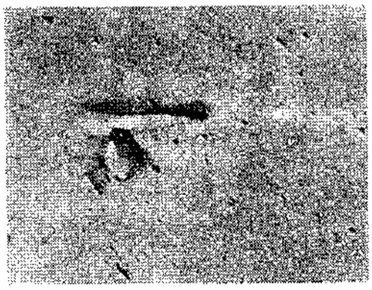

Figure 14. Photomicrograph of dispersion in Batch 2 at 200/0 bar, x 800 (100g butter oil)

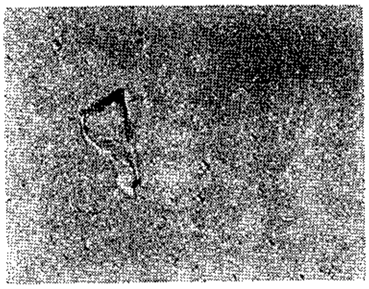

Figure 15. Photomicrograph of dispersion in Batch 2 at 200/50 bar, x 800 (100g butter oil)

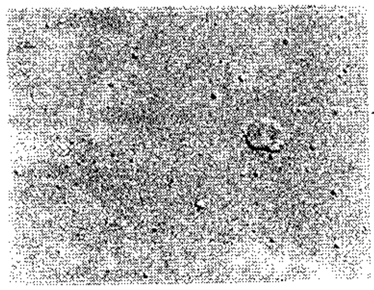

Figure 16. Photomicrograph of dispersion in Batch 2 at 200/100 bar, x 800 (100g butter oil)

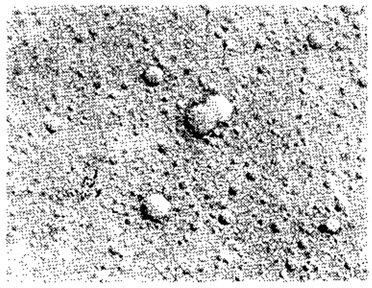

Figure 17. Photomicrograph of dispersion in Batch 3 at 100 bar, x 800

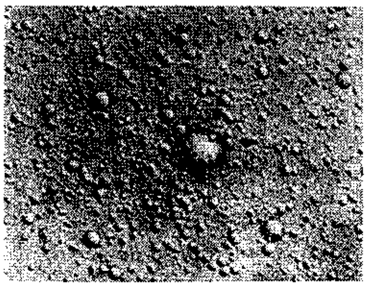

Figure 18. Photomicrograph of dispersion in Batch 4 at 100 bar, x 800

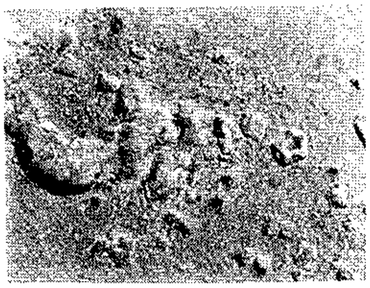

Figure 19. Photomicrograph of dispersion in Batch 5 at 100 bar, x 800

(Figures 7, 10, 12, 14, 15 and 16).

Figures 13 to 16 on the dispersions of high fat products showed that the newly formed fat globules clustered into smaller or larger aggregates, which are neither fat clumps, as they do not coalesce into big droplets, nor loose floccules, as they can not be disrupted by gentle agitation. When dispersions was homogenized higher pressures than zero, the properties of the dispersion formed were effected (Figures 1 to 19).

A summary of the influence of various factors on homogenization efficiency of dispersions is given in Table 2.

Table 2. Factors Effecting The Homogenization Efficiency

Factor	Magnitude of the effect	Globules, smaller when
pressure	very large	high pressure
two stage	small	two stages
fat content	moderate	lower fat content

Structure of emulsifying agents such as soy proteins in prepared food dispersions during food processing observed by using of the microscope should add knowledge to the understanding of mixing affinity reactions between ingredients and desirable physical and chemical composions required for production of high quality foods. We hope that this research will stimulate microscopists to further investigate this field of study.

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