Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(2): 568-578. **OPEN ACCESS**

Microstructure of drinking yoghurt supplemented with carrot pulp

Asala R. Mohammed., Mohammed. M. Omar, Mohammed M. El-Abbassy and Salah. A. Khalifa

Food Science Department, Faculty of Agriculture, Zagazig University, **Egypt**

***Correspondence: asala@zu.edu.eg** **Received 13-02-2020, Revised: 27-03-2020, Accepted: 07-04-2020 e-Published: 17-04-2020**

This study was aimed to study the microstructure of drinking yoghurt 40% sugar solution, 60% plain yoghurt and fortified with 20% carrot pulp, in addition to control sample. In both samples, dilution with sugar solution and blending resulted in more distribution casein particles to uniform structure. Control one appearance of its image contained casein aggregates, fat and bacteria in serum gaps. Carrot drinking yoghurt contained more different fibers in the shape of finger or sticks, section of it appeared like spun. Dilution and blending destroy the shape and size of fibers in resulting product.

Keywords: microstructure, carrot, fibers, drinking yoghurt.

INTRODUCTION

Yoghurt is a functional food which includes probiotics and prebiotics (synbiotic). Probiotics can be defined as “live microbial feed supplements that beneficially affect the host animal by improving its intestinal microbial balance” (Champagne, et al. 2005). Creating a functional food with plant ingredients will not only meet human needs in terms of basic nutrients and energy but also enrich the active ingredients present in such foods (Ivanov and Rashevskaya, 2011).

Traditional fermented milk drinks, such as drinking yoghurt, Ayran (in Turkey and Lebanon or dough (in Iran) are made from whole milk where the SNF of the milk base in most fortified and is later diluted with water or whey from labneh after the fermentation stage. In the industrialized countries, drinking yoghurt can be clarified as stirred yoghurt of low viscosity. Stabilizer is normally added to the milk base protein matrix in less dense when compared with the traditional yoghurt. The use of pectin in the drinking yoghurt will protect the protein after homogenization stage. Sweetened and fruit flovourd milks are now common place in many countries. The use of different fruits frequently used in yoghurt production to improve its nutritional and sensory properties as well as its consumption (Arslan and Ozel, 2012). Fruit used in yoghurt mixture are plum, cherry, orange, lemon, purple plum, blackberry, spiced apple, apricot, pineapple, strawberries, raspberry and berry *(Cinbas* et al. *2008).*

The root crop carrot (*Daucus carrota* L.) has some of the highest concentrations of β-carotene. β-carotene levels in carrot can range from 3.2 to 6.1 mg/100 g fresh weight (Kopsell and Kopsell, 2010).).

Carrot is a good source of dietary fiber and of the trace mineral molybdenum, rarely found in many vegetables. Molybdenum aids in metabolism of fats and carbohydrates and is important for absorption of iron. It is also a good source of magnesium and manganese. Magnesium is needed for bone, protein, making new cells, activating B vitamins, relaxing nerves & muscles, clotting blood, and in energy production.

Insulin secretion and function also require magnesium. Potassium and magnesium in carrots help in functioning of muscle (Joao et al. 2014). The present work was carried out to study the structure formulation of drinking yoghurt fortified with carrot pulp by scanning electronic microscope (SEM) for determine the distribution of structure elements.

MATERIALS AND METHODS

Fresh buffalo's milk (6.8% fat and 9.86% milk solids not fat MSNF) was obtained from the Dairy Products Food Science Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. Direct vat set yoghurt starter (FD-DVS ABY-3 Probio-Tec®) containing Streptococcus thermophilus, Lactobacillus delbreuckii subsp bulgaricus, Bifidobacterium BB-12., Lactobacillus acidophilus LA-5 were obtained from Chr. Hansen Inc. Laboratories, Milwaukee. Commercial grade sugar and carrot were purchased from the local market. Stabilizer (Lacta) was obtained from Mefad, Egypt.

METHODS:

Preparation of carrot pulp:

Carrot roots were washed thoroughly with tap water, peeled by sharp knife and cut longitudinally into halves. These halves were blanched for (15 minutes), .followed by blending using electric juicer (model: Eicotech (EFP -500, 230v-50Hz, 500w). Carrot pulp was heat treated at 85ºC for 15min, rapidly cooled and frozen until used.

Preparation of sugar solution:

Sweetened solution containing sugar (22.5 g /L) and Lacta (0.1 g/L) was prepared by heating at 85ºC for 15min, cooled and stored in the refrigerator at 5 ºC until used.

Preparation of plain yoghurt:

The milk was standardized to 3% fat, then heated at 85ºCfor 30 min and then cooled to 42ºC, and inoculated with 0.03% starter, poured in glass cups and incubated at 42 ºC until complete coagulation, and then cooled at 4ºC.

Preparation of drinking yoghurt formulation.

Drinking yoghurt was made from plain yoghurt by adding 40% sugar solution (control). While fruit drinking yoghurt was made by adding 40% sugar solution , 20% carrot pulp and 40% plain yoghurt. Control and carrot drinking yoghurt were blended using electric juicer (model: Eicotech (EFP -500, 230v-50Hz, 500w), the resultant products were kept in the refrigerator at 4 ºC up to 12 days.All drinking yoghurt sample were prepared and analyzed when fresh and after 12days of storage at 4 ±1°C, In previous work (mohammed, et al. 2019). The best organoleptic properties were found in addition 20% carrot juice to the plain drinking yoghurt. This product was chosen to study its microstructure.

Scanning electron microscope (SEM):

Drinking yoghurt samples for scan electron microscope (SEM) examination, were prepared when fresh and after 12 days of cold storage as described by Omar, et al. (2014) using SEM (FEI company, Netherlands, Model Quanta 250 FEG), with accelerating voltage 30 K.V., images were captured at 300X, 1000X and 1200X magnifications.

.

RESULTS AND DISCUUSSION

By using scanning electron microscope (SEM) it possible to visualize food microstructure made from similar raw materials may have different structure depending on the other ingredient present and the manufacture procedures used. SEM technique could visualize only the protein network and substances other than protein are appeared as black area. Folkenbery, et al. (2005) and Folkenbery, et al.(2006) demonstrated that applied SEM image help to identify the distribution of protein network and other addition in the complex matrix and providing complementary information to interpret textural and complementary information to interpret textural and sensorial properties. Dilution and homogenization of the yoghurt curd grains could be resulted in the disintegration of the curd particles into smaller unites in all samples.

SEM image of control drinking yoghurt (Fig .1) (magnitude 300x) shows the surface mass contains coarsely dispersed particles of casein micelles and fat globules composed of populates of different size particles. Fat globules show a central cavity within the fat phase. Such cavities are more or less absent. The fat structure is related to the blending step. Also casein aggregates to be their normal spherical shape formed an open mesh like structural in which the casein aggregates have elliptical around the fat globules. SEM micrograph shows bacteria embedded in the protein matrix. Aqueous phase appeared as serum channels and more small pores of uniform size and distribution.

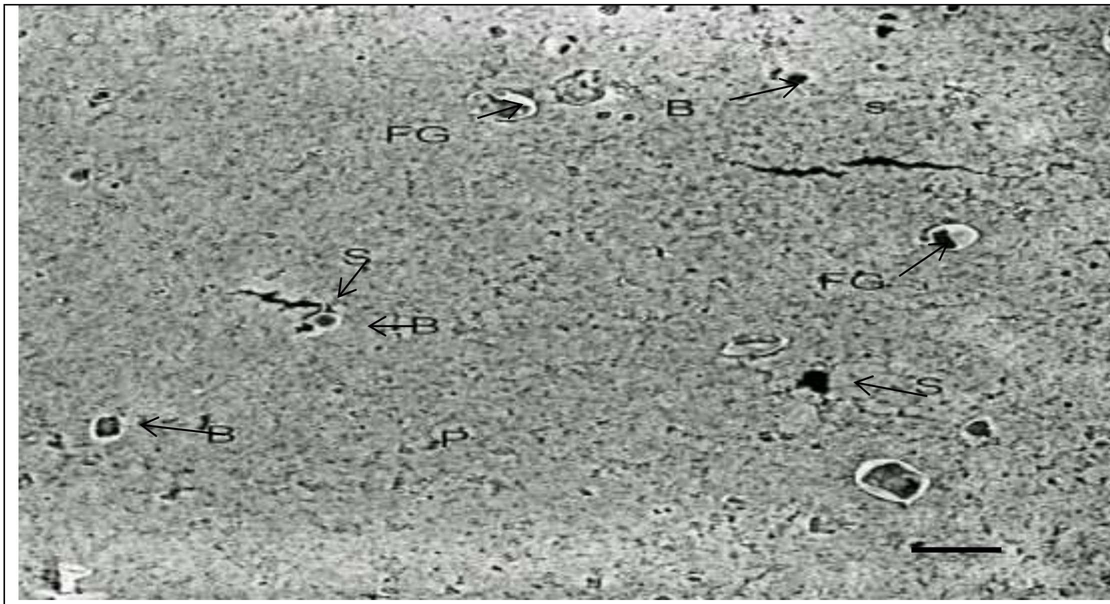

Figure1: SEM micrograph of fresh drinking yoghurt (control) made from 60% plain yoghurt + 40% sugar solution. Protein matrix (P) to be composed of relatively uniform small particles and arrow indicate the presence of serum pores within the network (S). Casein micelles are pocked on the surface on bacteria (B) and fat globules (FG). Magnitude 300x. Bar: 50 µm

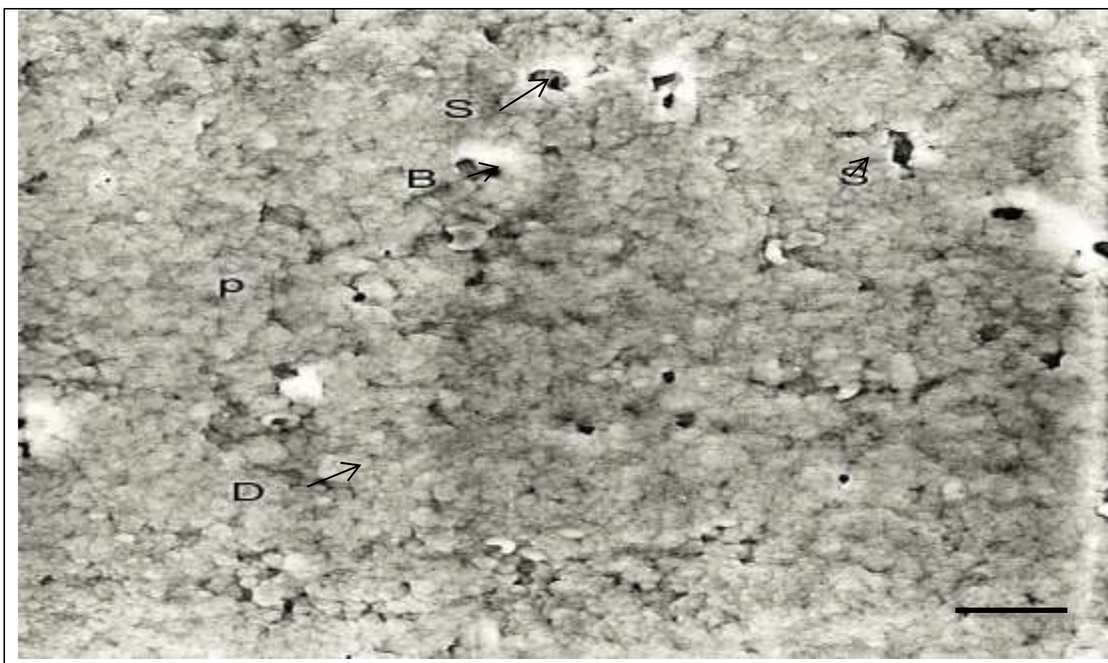

Figure 2 : Detail of smooth particle clusters confirmed that casein particles aggregation was

market disintegrated as the result of homogenization, The grains having a uniform structure. Compact protein particles (P) formed the walls a small void space (S) in the matrix, sugar crystals (D), Bacteria (B). Magnitude 1000x. Bar: 25µm

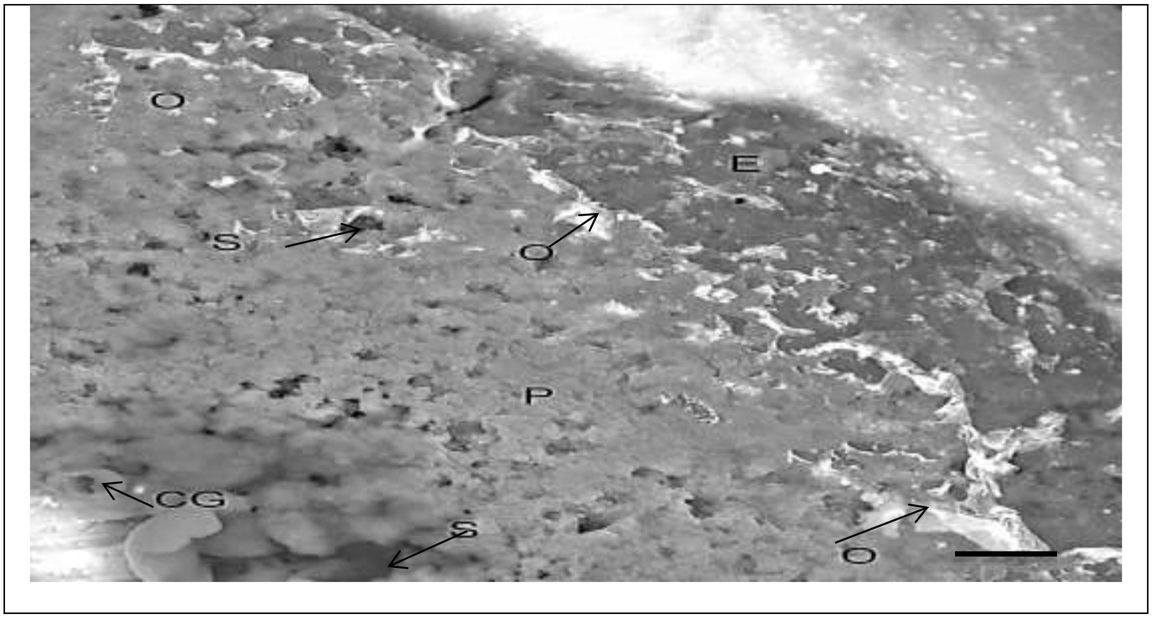

Figure3: SEM of drinking yoghurt at higher magnification 1200 x magnitude shows a coarse structure of the protein matrix (P), outer surface (O) and inner structure of compact particles (P) and shows etched area of casein aggregates (E). Pocket occupied by serum(S). E: etched area of casein aggregates: (S)Serum pores. (P): Protein matrix. (O): Outer face of casein particles, cavity of fat globule (CG). Magnitude 1200X. Bar 25µm.

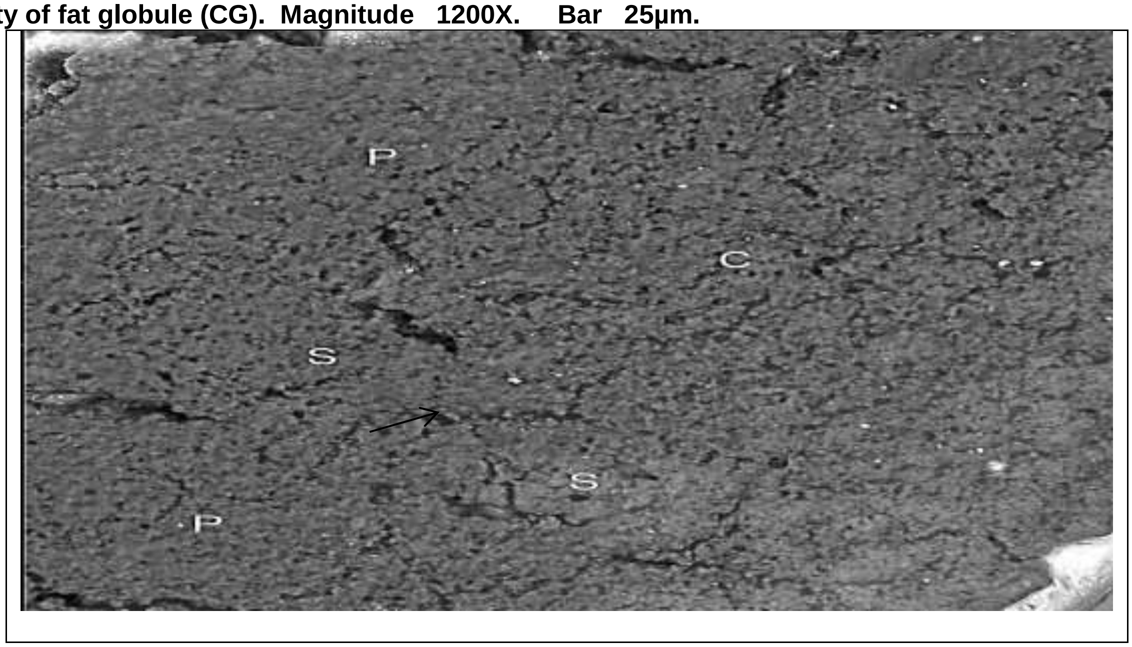

Figure 4 : SEM image of drinking made from 60% yoghurt + 40% sugar solution at 12 days storage. The pore size appears to be larger than in fresh drinking yoghurt (serum channels) and the protein network shows links between casein micelles composed of P: protein matrix (S): Serum channels (C): Homogenous casein granules. Magnitude 300X. Bar: 50 µm

At higher magnification (1000X) (Fig. 2), casein particles are held together by short thin links and appeared to be homogenization enclosed the void space which preset. SEM image in (Fig. 3) (Magnitude 1200X), shows a coarse of the protein matrix outer and inner surface. Etched area of protein aggregates had gritty particles of consist compact protein where on the surrounding protein matrix was porous.

Fig (4), SEM image after 12 days of storage period show that there are a significant difference between and stored samples. The pore sizes appear to be larger than in fresh one due to the whey syneresis during storage period as demonstrate by Mohammed, et al.(2019). Casein particles appears as granulated mass less fused and dispersed in loose particles surrounding the void and serum channels.

Fig. (5), at higher magnification (1000X) image shows the protein aggregates density arranged with entangled pore spaces inside the protein matrix. These results show that microstructure changed during drinking yoghurt preparation. These changes can be quantified with good results. The changes of aggregates into partiality homogenized structure mass is clearly seen in micrograph..

Fig. (6) shows SEM image, low magnification (300X), of fresh drinking yoghurt fortified with carrot pulp, reveled extensive fusion of casein micelles, linked in chains were clearly visible in SEM micrograph. The carrot fibers embedded in the protein network which seen more dense, rigid continuous and compact in many area formed the walls of void spaces. Sugar crystals arranged in the form like fingers on the particles surface. Some bacteria found in the serum pores. Details of fibers shown in **Fig. (7)**. SEM image shows spun isolate fiber and cross section and striations of surface of individual fiber. Relates SEM of spun fibers was described by wolf and Baker (1980). Addition of carrot cell wall particle (CWP) effect on yoghurt properties**,** its accelerated the rate of pH reduction and induced earlier gelation. The gel viscoelastic properties were enhanced with increased CWP concentration. Microstructure of yoghurt showed that carrot CWP occupied the void space within casein particle network. The enhanced gel strength and reduced whey loss achieved by this addition (McCann, et al. 2011).

Fig. (8) SEM image of drinking yoghurt fortified with carrot juice view an enlargement carrot fibers at high magnification (1200X) view carrot fibers, casein clusters, bacteria and serum gaps. The fibers details of the cell wall. Long thick fiber in this image permeating the protein matrix was clearly visible in this image.

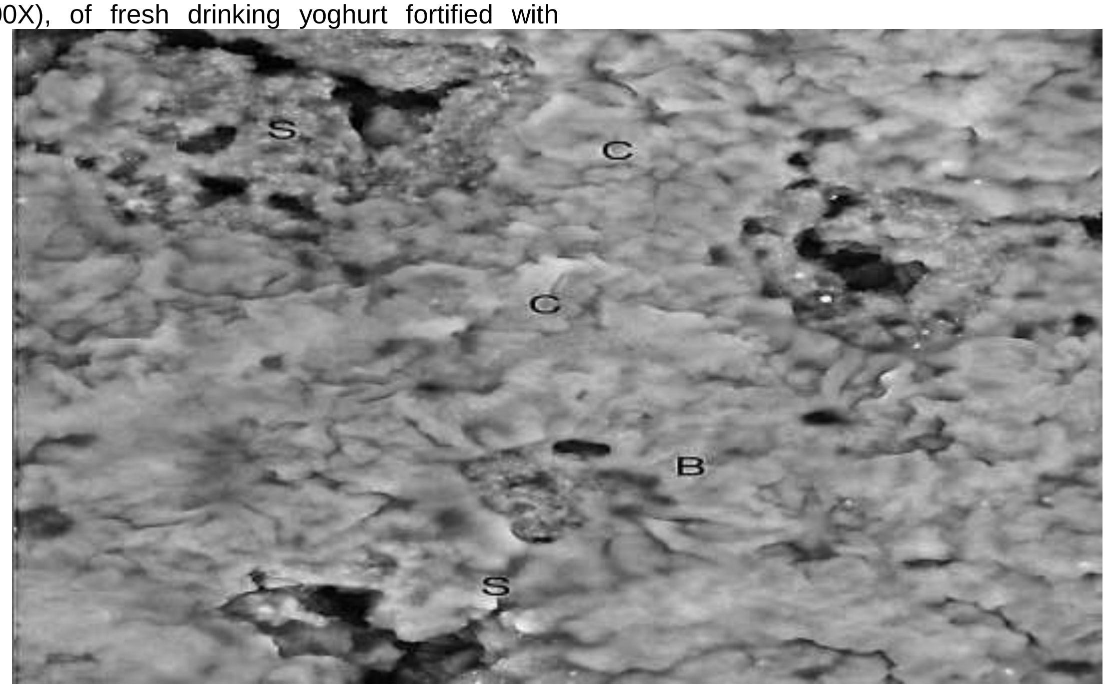

Figure 5 : SEM image of drinking yoghurt made from 60% yoghurt + 40% sugar solution at 12days of storage, shows bacteria (B) inner serum pores. (S): Serum pores. (B): bacteria (C): Casein Clumps. Magnitude 1000X. Bar 25µm

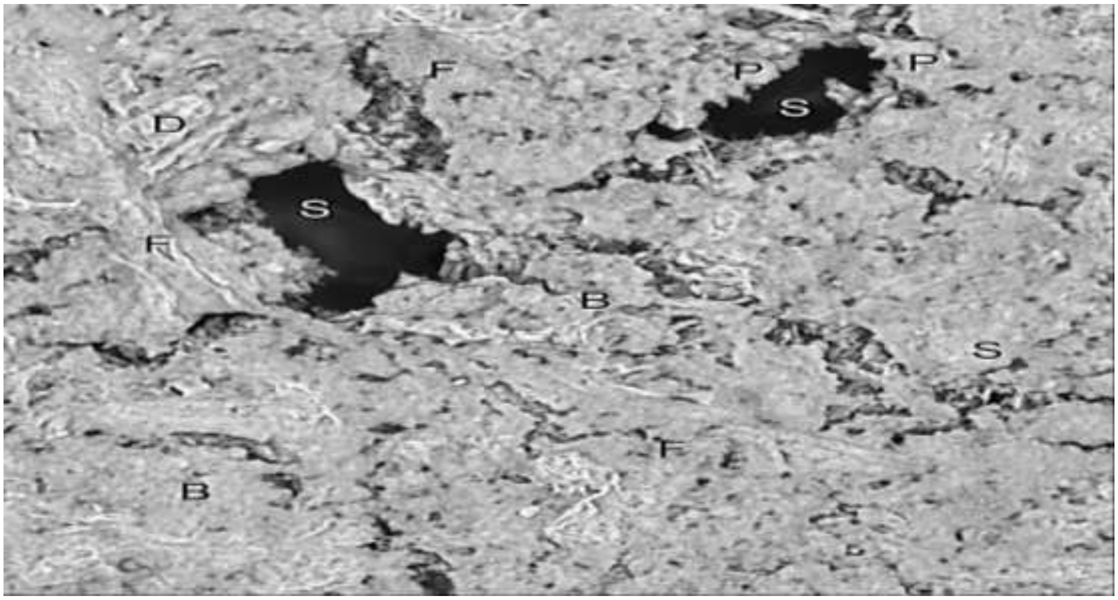

Figure 6a: SEM image of drinking yoghurt made from 40% yoghurt + 40% sugar solution + 20% carrot juice, shows compact protein particles (P) formed the walls of a small void space (S), and many fibers of carrot juice are embedded in protein matrix(F). Sugar crystals (D) are arranged on the form of like fingers on the particles surface. Some bacteria found in the serum pores (B).. Magnitude 300X. Bar: 50µm

Figure 6b: Details of Fig. 6a.shows fibers are embedded in protein matrix. F (Fibers).

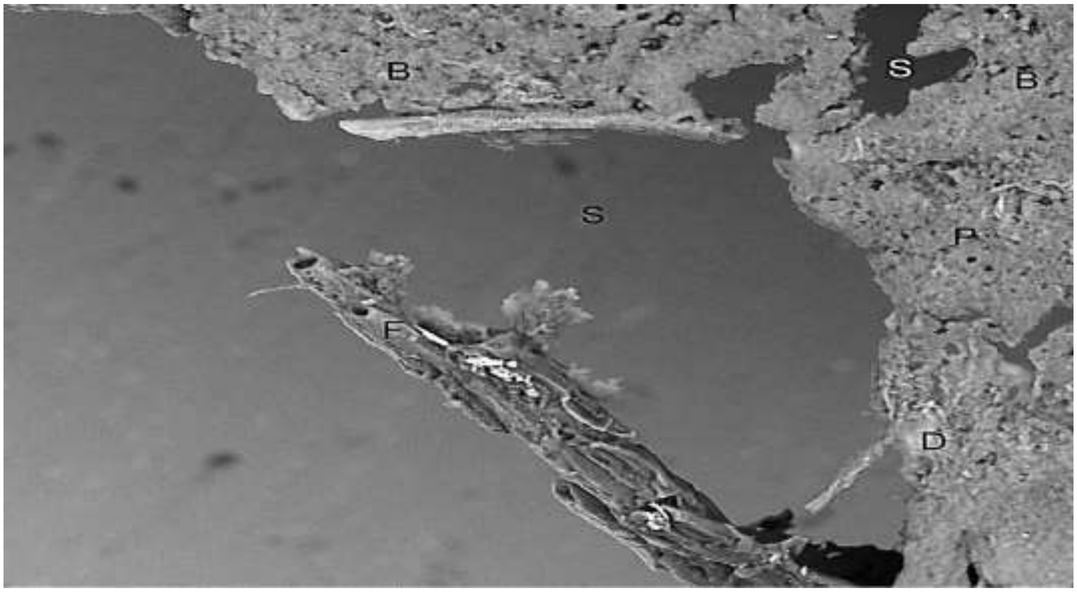

Figure 7: SEM micrograph of fresh drinking carrot yoghurt made from 40% yoghurt + 40% Sugar solution + 20% carrot juice, showing spun in isolated fiber (F), sugar crystal (D) connected with protein aggregates (P) . Bacteria also found in serum poles. (F): Fiber. (B): Bacteria (D): Sugar crystal (P): protein aggregates S: Serum gaps Magnitude 300 X Bar 50µm

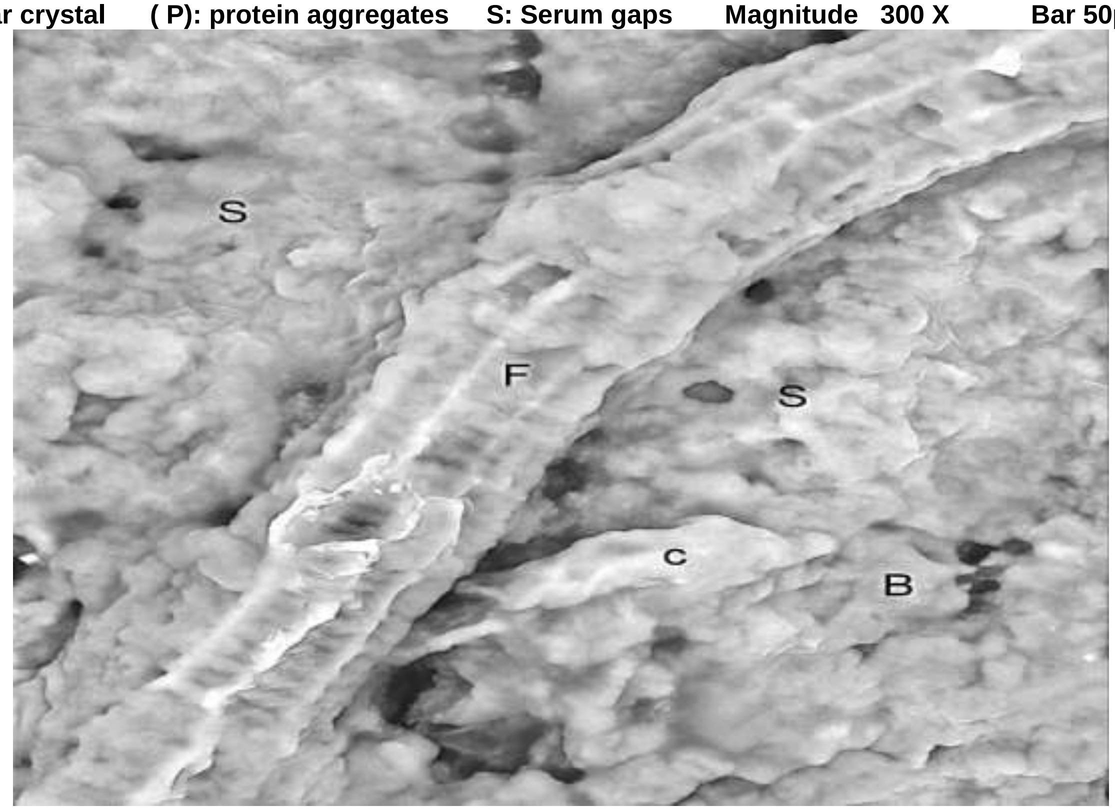

Figure 8: SEM micrograph of the carrot fibers in drinking fresh yoghurt fortified with carrot juice. (F): Carrot fiber (C): Casein Cluster (B): Bacteria (S): Serum pores. Magnitude 1200X. Bar: 25µm.

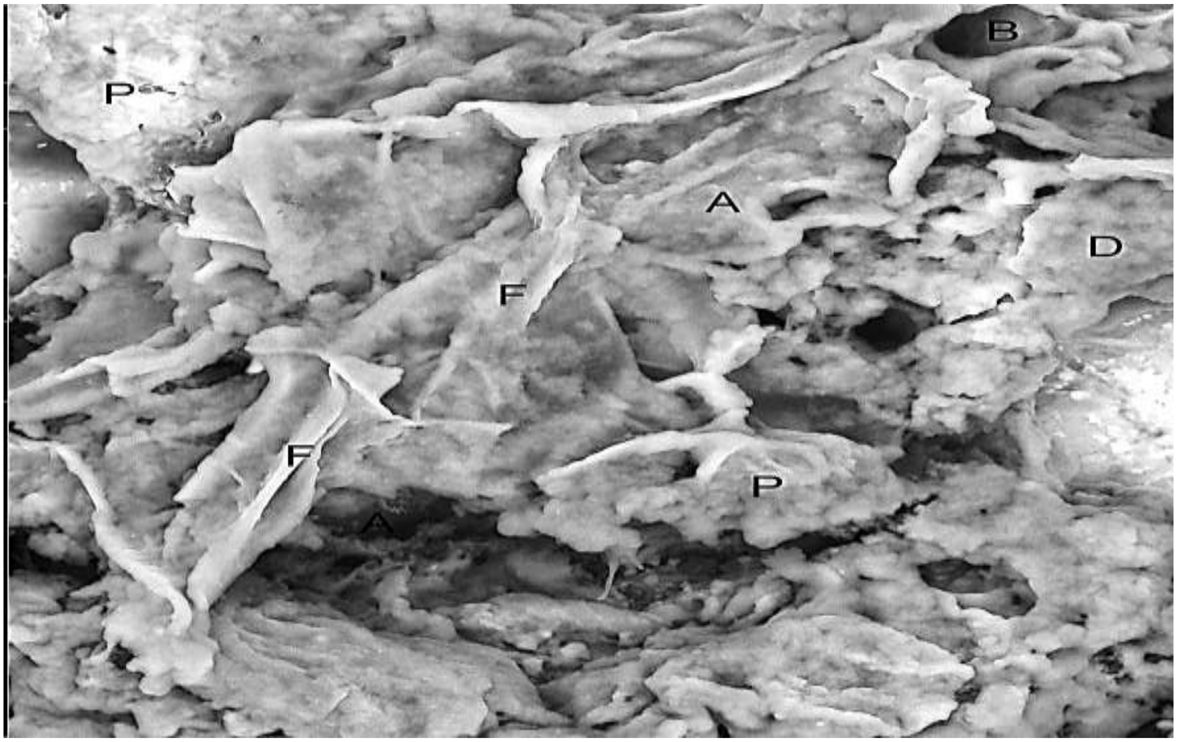

Figure 9: SEM micrograph of high magnification (1000X) of drinking yoghurt fortified with carrot juice at 12 days of storage. (F): Carrot filament (cell wall). (P): protein aggregate. (D): sugar crystal. (A): Aqueous phase Bar 25µm.

After 12days of storage period, Fig .9 SEM image revealed an open microstructure and a smooth continuous zone than control at low magnification the continuous zone are a combination of casein with fibers. The aqueous phase contributes to the structure in many channels and contrast to aqueous phase formed free space between the protein matrix formed open structures. Fortified drinking yoghurt with carrot juice in this study caused the casein micelles to various degree of which appeared in the form of fibers either linking protein clusters or having free termination formed thread like structure. At higher magnification 1000X Fig 10. SEM view, the appearance of carrot filaments distributed through the protein matrix as folded sheets with large spaces of aqueous phase included bacteria and the sugar crystals distributed of the surface of casein clumps.

After 12days of storage period, **(Fig. 9)**, SEM view the appearance of carrot filaments distributed through the protein matrix as folded sheets with large spaces of aqueous phase included bacteria and the sugar crystals distributed of the surface of casein clumps. **Fig. 10**. SEM image revealed an open microstructure and had a smooth continuous zone than control at low magnification the continuous zone are a combination of casein with fibers. The aqueous phase contributes to the structure in many channels and contrast to aqueous phase formed free space between the protein matrix formed open structures. Therefore, fortified drinking yoghurt with carrot pulp in current study caused the casein micelles to various degree of which appeared in the form of fibers either linking protein clusters or having free termination formed thread like structure. (Higher magnifications 1000X).

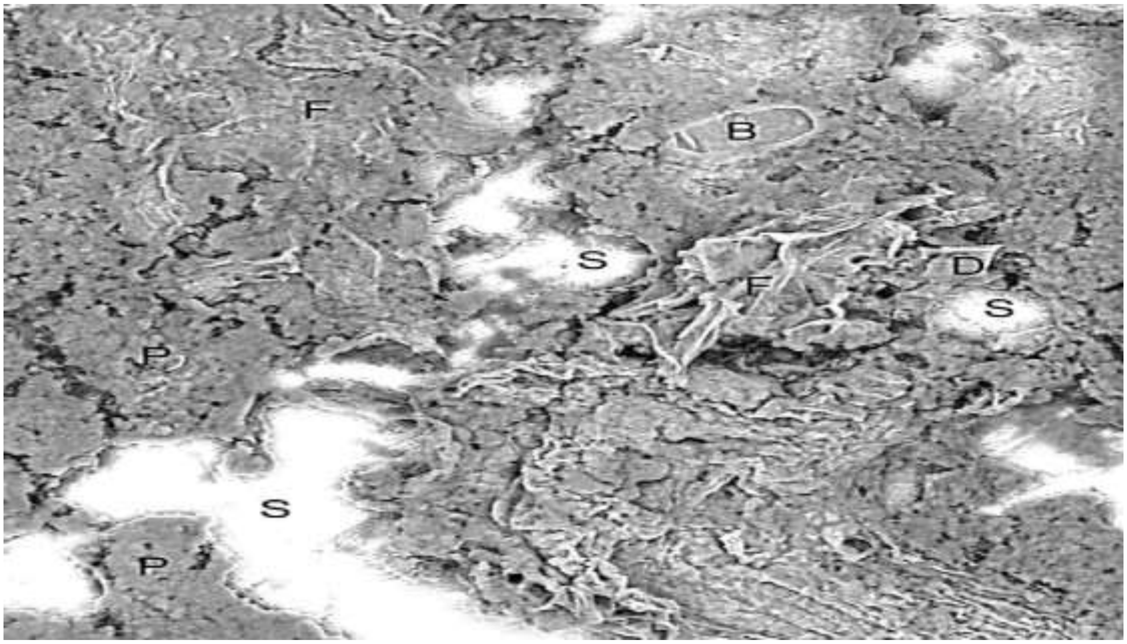

Figure 10a: SEM image of (12days of storage) drinking yoghurt fortified with carrot juice, revealed protein with more fibers of carrot juice, sugar crystal appears at the surface of aggregates casein. (D): Sugar crystal (B): Bacteria (F): Carrot filaments. (P): aggregates casein Magnitude 300X Bar: 50µm.

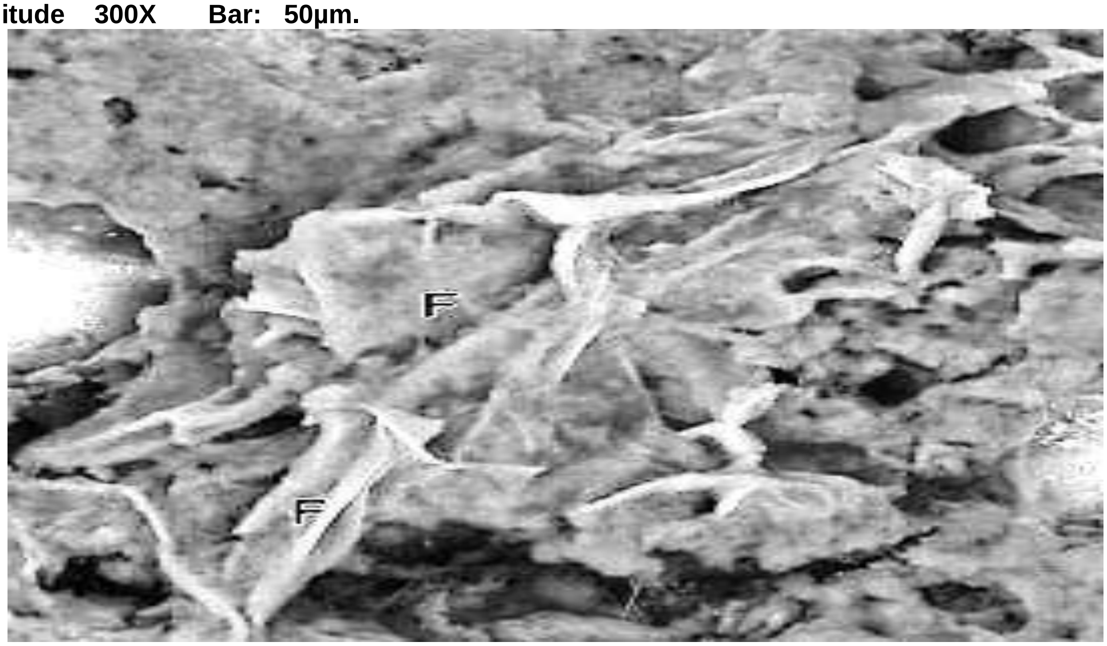

Figure 10b: Details of Fig. 10a. Shows fibers appear at the surface of aggregates casein. Fibers F).

CONCLUSION

Scanning electron microscope (SEM) techniques were employed to study the microstructure of drinking yoghurt. SEM image help to identify the distribution of protein network and the other addition in the complex matrix while providing complementary informed to interpret texture and sensorial properties. Sugar dilution and blending of drinking yoghurt resulted in the disintegration of curd grains into smaller particles and produced uniform structure. The micrograph of control drinking yoghurt presented protein network with speeded serum round pores which were homogenous distribution and contained a few bacteria, fat globule and cavity in fat globules and sugar crystals on the surface. Image showed the carrot drinking yoghurt microstructure in composed of fibers embedded in protein network and the cell wall were explosively damages after blending instead explosive distribution of the physical structure in cell walls of tissue. That present pores structure and cell walls are greatly shrunk which leave wide space between cells.

.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The present study was carried out in the Food Science Department, Faculty of Agriculture, Zagazig University, Egypt. The authors would like to thank the dairy processing unit staff and Mr. Wael Twofik, General Manager for providing the equipment's of processing and storage for to help complete this study, Faculty of Agriculture, Zagazig University, Egypt

AUTHOR CONTRIBUTIONS

The supervision of Prof. Dr. Omar, El-Abbassy, and Khalifa are designed experiments and reviewed the manuscript. Asala R. Mohammed performed the experiments, data analysis and also wrote the manuscript. All authors read and approved the final version.

REFERENCES

Arslan, S. and Ozel, S. (2012). Some properties of stirred yoghurt made with processed grape seed powder, carrot juice or a mixture of grape seed powder and carrot juice. Milchwissenschaft*,* 67, 281-285.

Champagne, C.P. and Gardener, N.J. (2005). Challenges in the Addition of Probiotic Cultures to Foods. Critical Reviews in Food Sci. and Nut., 45: 61-84.

Cinbas, A. and Yazici, F. (2008). Effect of the addition of blueberries on selected physicochemical and sensory properties of yogurts. Food Technol. Biotechnol., 46: 434-441.

Folkenbery, D.M, Dijmek, P., Skriever, A, and Ispen, R. (2005). relation between texture properties and exepolysaccharide distribution in set and stirred yoghurt produced with different starter cultures. J. Texture Studies.36: 174-189.

Folkenbery, D.M, Dijmek, P., Skriever, A, skov-Guildager,H and jpsen, R. (2006) Sensory and rheological screening of exopolyscarides producing strains of bacteria yoghurt culture .Int. Dairy J. 16:111-118.

Ivanov, S V and Rashevskaya, T. A. (2011). The nanostructure's management is the basis for a functional fatty foods' production. Procedia Food Sci., 1: 24-31.

Joao Carlos da Silva D. (2014). Nutritional and health benefits of carrots and their seed extracts. Food and Nutrition Sciences, 5:2147-2156.

Kopsell, D. A., and Kopsell, D. E. (2010). Carotenoids in Vegetables: Biosynthesis, Occurrence, Impacts on Human Health, and Potential for Manipulation. In Bioactive Foods in Promoting Health. Academic Press. pp. 645-662.

McCann, T.H., Fabre, F. and Day, L. (2011). Microstructure, rheology and storage stability of low-fat yoghurt structured by carrot cell wall particles. Food Res. Int., 44: 884-892.

Mohammed, A. R., Omar, M. M., El-Abbassy, M. M., & Khalifa, S. A. (2019). manufacture of yoghurt drink supplemented with carrot and guava pulps. Zagazig Journal of Agricultural Research, *46*(6), 1975-1984.

Omar, M.M., Guirguis, A.H., El-Abbassy, M.Z.

and Ismail, H.A. (2014). Manufacture of limburger cheese by semi-continuous method. Egypt. J. Dairy sci., 42:189.

Wolf, W.F and Baker, F.L. (1980). Scanning electron microscopy of soybeans and soybean protein products. Scanning electron microscopy, 111 : 621-634.