International Journal of Agriculture Innovations and Research
Volume 5, Issue 4, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received: 20/01/2017 | Accepted on: 26/01/2017 | Published: 09/02/2017

Properties and Microstructure of Dangke Fresh Cheese Made with Passion Fruits Juice as Coagulant

Ratmawati Malaka *, Wahniyathi Hatta and Sudirman Baco
Department of Animal Food Technology, Faculty of Animal Science, University of Hasanuddin.
*Corresponding author email id: malaka_ag39@yahoo.co.id

Abstract – **Dangke, a natural cheese South Sulawesi is made through clotting boiled milk of buffalo, cow, goat or sheep by using sap of papaya *(carica papaya)*. Passion fruits (*Passiflora edulis*) juices can used to coagulated of milk in cheese making but have not been found information about the properties of product by using passion fruits juice as clotting agent of milk. The objective of this study was to investigate the properties of fresh Dangke by using passion fruits juice as coagulate of milk. Dangke was made by 10 lt of raw whole milk and heating in 73^{o}C coagulated by addition of passion fruits juice (7.5% and 10%), and added 1% of salt. Curd was entered to dangke cheese template and pressed until compact. The cheese was packaging and was monitored during 28 d of ripening at approximately 5^{o}C. Dangke was studied toward hardness, pH, level of fat and microstructure. Ripening times was increases the soft cheese hardness, but decreases the pH. Fat level of Soft cheese Dangke was average 21.4% and 30.5% by addition of passion fruit juice 7.5% and 10%, respectively. Hardness of Dangke was increase by increase the time of ripening (1.38 to 3.73 kg/cm), but pH of Dangke was decrease by increase of time of ripening storage (5.34 to 4.1). Microstructure of cheese from 10% of passion fruits was extremely more firm with full fat globular than 7.5%. The properties the Dangke modification making were similar with generally dangke properties. Manufacturing processes by addition passion fruits juice coagulant applied to Dangke had affect on hardness, pH, fat content and microstructure during cooling storage at 5^{o}C for 1 – 28 d.**

Keywords — **Dangke, Passion Fruits, Microstructure, Cheese.**

I. INTRODUCTION

Dangke, a natural semi solid and salty cheese that available in the traditionally market and traditionally manufactured by local people of Enrekang, South Sulawesi, Indonesia [1]. The composition of Dangke are 47.75% of water, 3.32% of ash, 3.89% of fat and 17.01% protein [2]; According to [3], cow milk dangke has a high nutrient content (water content of 55%, protein of 23.8%, fat of 14.8% and ash 2.1%) and its nearly normal pH value of 6.4. Its self life is generally two days at room temperature, while at the refrigerator temperature; it can reach five to seven days.

Recently, South of Sulawesi are being intensively to develop dairy cattle breed, therefore product of milk become increases. Passion fruits (*Passiflora edulis*) as a natural fruits have juices can used to coagulated of milk in Dangke making . Natural cheeses are widely produced by homemade industry in the word. For many years, rennet was the most frequently used clotting enzyme for cheese making. A large number of known protease only a few were accepted to replace rennet.

One of natural fruits of South Sulawesi have potential for clotting protein of milk is Marquise (*Passiflora edulis* Sims) (markisa in Indonesian) juice. The juice of this fruits has high acidity that contains citric acid, malate acid, lactic acid, ascorbic acid and other organic acid [4]. Most of these acid show more evident coagulated activity than rennet to production acid-coagulated milk product such as fresh acid-coagulated cheese varieties. An excessive protein hydrolysis may negatively affect on curd formation and cheese-making yields. The susceptibility of the peptidic bond to the proteolytic activity depends on both, accessibility and specificity of the attack sites. External factors, such as pH, temperature, presence of non-protein substances like polysaccharide, as well as ionic strength of the medium may cause conformational modifications. Consumer acceptance of a cheese product depends directly on its appearance, flavor and texture that affect microstructure directly or indirectly [5]. Therefore, it is important to study conformational modifications as diversification of Dangke of the formation of milk curd during protein catalytic by passion fruits juice.

A number of factors, both compositional and process parameters, are known to influence texture of cheese [6]. In recent years, much attention has been given to the microstructure of cheese. Several techniques have been used for this purpose. In particularly, the use of scanning electron microscopy has become the method of choice in many investigations [7]-[8]-[9]-[10]-[11].

Acid coagulated milk products such as fresh-coagulated cheese varieties are important dairy products [12]. However, little is known regarding the mechanism involved in the gel formation, physical properties of acid gels, and the effect of processing varieties, gelation temperature on the important physical properties of acid-coagulated milk products [13]-[14]-[15]. The objective of this study was to evaluate microstructure of properties of soft cheese by using passion fruits juice as new coagulant.

II. MATERIALS AND METHOD

Cheese Making

Acid coagulated fresh cheese was accomplished using whole milk. This Dangke diversification product were

Malaka, R*. Department of Animal Food Technology, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia, telp. 062-0411-583111, fax. 062-0411-587217, (e-mail: malaka_ag39@yahoo.co.id; ratihtamalag39@gmail.com). *corresponding author

International Journal of Agriculture Innovations and Research
Volume 5, Issue 4, ISSN (Online) 2319-1473

manufactured by modification of normal procedures according to [16] as shown in Table 1. The acid coagulated fresh cheese kept at about 5°C until used for experiments. This research was conducted in the laboratory of biotechnology of milk processing, Faculty of Animal Science Hasanuddin University, from June to November 2013.

Table 1. Steps in manufacturing of acid coagulated fresh cheese as modification of Dangke

Manufacturing steps	Note
Pasteurization	Whole milk was heating at 73°C, 15 s
Passion fruits juice added	7.5 and 10.0 %
Salt added	1% waiting until milk coagulated
Separation curd and whey	The whey was pouring on cheese template
Pressing	Curd was pressed by press tool
Filling and packaging	Hot-pack method

Sensory Evaluation

The sensory evaluation was performed according to a procedure of [17]-[18]. Sensory characteristics were determined by 20 untrained panelist for judging the quality of the cheese in term color, aroma, flavor and acceptability. Each panelist received a whole sample 2 cm edge and was requested to taste, carefully, each one. Sensory attributes were measured by using a 6-point hedonic scales : 1 is extremely like to 6 is extremely dislike. A two way analysis of variance (ANOVA) was used to test the sensory score data. Differences among the means were compared using Duncan's Multiple Range Test.

Estimation of Physical Properties

Estimation of Hardness was evaluated by used CD-shear force modificated by [19]. Cheese sample was cut one cm^2. The operating condition was use formulation as follow:

$$A = \frac{A'}{\pi r^2}$$

Where : A = The penetration plunger (kg/cm^2)
A' = The power of plunger (kg)
Π = 3,14
r = ½ diameter of plunger CD-shear Force (0,635 cm)

Level of fat was evaluated by Gerber Methods, and pH evaluator by Hanna-pH-meter [20].

Estimation of Microstructure

Microscopic analysis of acid coagulated fresh cheese was carried out by some modification of the techniques [21]-[10]. The one method was using histological method. Cheese samples approximately three mm cubes were fixed in 5% glutaraldehyde solution for 24 h and dehydrated in a series of ethanol-distilled water solutions (60, 70, 80, 90 and 100% (v/v) ethanol). Sample was cut by microtome knife and fixated in object glass then dyed by Hematoxylin Eosin, and then view by light microscope with 1000 x magnification [21].

The second methods by using the technigue scanning Elrctrone microscopic sample. The cheese sample was cut with 6 mm cubes. The cubes were fixed in 2.5% glutaraldehyde solution buffered at pH 7.0 with 0.1 M phosphate buffer, and post fixed in 1% osmium tetraoxide solution. Samples were dehydrated in a graded alcohol, and then dried in a Hitachi HCP-2, ion type sputter coater (Hitachi Ltd. Tokyo), and viewed in a Hitachi S-4100 type SEM.

III. Results and Discussion

Sensory Evaluation

Results obtained from sensory evaluation by panelists are summarized in Table 2. The passion fruits juice are known as fruits with yellow color, so that showed significance differences ($p>0.05$) in color, aroma, flavor and acceptability. Passion fruits juice have specific flavor because of ester and non-ester component contains. Marquise have minor component that are caroteneoid figment, specially β-carotene, carotene and fitofluen [22]. This is to be expected, since it has been shown in model system that passion fruits juice with concentration 7.5% impart excellent in sensory parameter than concentration 10%. The average acceptability was near neither like or dislike indicating the cheese still need an introduction and dissemination of product on the consumer society.

Table 2. Summary of sensory evaluation results of acid coagulated fresh cheese

Sensory parameters	Clotted by 7,5% of passion fruits juice	Clotted by 10% of passion fruits juice
Color	3.53 ± 0.03 a	4.42 ± 0.06 b
Aroma	3.60 ± 0.04 a	4.43 ± 0.07 b
Flavor	3.74 ± 0.05 a	4.41 ± 0.05 b
Acceptability	3.01 ± 0.25 a	3.49 ± 0.04 b

Note: Each value is a means of 20 of 6-point hedonic scale: 1-like extremely 3-4-neither like nor dislike, 6-dislike extremely. Means in the same row bearing a different letter are significantly different ($p>0.05$).

Cheese properties may be defined as a composite of sensory attributes resulting from a combination of physical properties perceived by the sense of sight and touch [23]-[11]. The flavor, color and mouth feel of cheese affected by a few component of cheese especially fat and proteins [24]. The variation in characteristics of cheese could be attributed to the different basic material and to the age of cheese [25] also by the presence of lactic acid bacteria in cheese [26].

Physicochemical Properties (pH, Fat and Hardness)

The range pH value of fresh Dangke cheese from coagulated passion fruits were at range 6.12 – 6.45 indicating nearly of pH of normal milk. The less variation of pH of this Dangke cheese indicated less of microbial

activity during processing. Results of testing the pH of the Dangke cheese modification is equal to the result obtained by (1) that ranged between 6.10 - 6.87. This is different from other cheeses that use rennet as the coagulant and ripening having a pH of about 4.81 - 4.95 [27].

The hardness of cheese of all processed cheese samples greatly improved during ripening when compared with the fresh products. The hardness was increased by increasing storage from 1.382 to 3.73 kg/cm^2 with 14 days to 28 days storage. Within the same ripening period, the hardness of the cheese was similar by using the level 7.5 or 10%. It is evident that the physical properties of all processed cheese were influenced by duration of ripening. Although cheese may withstand out of refrigeration conditions similar used in the present study, in order to minimize any public health risks, it is recommended that processed cheese should be stored, distributed and handled under refrigerated conditions.

Hardness and texture is related to the various chemical component within microstructure level that manifestation in the protein network by aggregation and interaction between caseins, fat, and another components of milk [28]. The fat level of dangke clotting by passion fruit juice with concentrations of 7.5 and 10% were 21.4 to 30.5%. Physico-chemical characteristics of this type cheese were similar for cheeses made with rennet as milk clotting enzyme. Ripening greatly affect the properties of the cheese. According to [29] indicated that relative that relative amounts of water, protein, and fat were the dominant factors electing cheese hardness. Fat and moisture act as the filler in the casein matrix of cheese texture [7], giving it lubricity and softness. Results of experiment of [30] found that the hardness increased with decreasing the pH in the processing cheese.

Microstructure

Microstructure of Dangke soft cheese manufactured by passion fruit juices coagulant and different time ripening were examined by light microscopic and electron microscopy (Fig. 1 and Fig. 2). The textural properties of acidified milk gels are noticeably affected by the microstructure of these gels. The microstructural changes in casein micelles during the acidification by passion fruits juice with different concentration can be influenced by various factors, including enzyme-mediated cross-linking casein micelles via microbial transglutaminase (TGase) – a transferase that form bonds both within and between several proteins via glutamine and lysine residues [31]. Dangke cheese is a spreadable soft cheese, which structurally differ from other cheeses because of its lack of a compact protein matrix, coupled with a relatively high moisture content. Its microstructure has been defined as composed of compact – fat-calcium-casein aggregates with large spaces filled with whey.

Chesee structures were appeared like sponge. The protein matrix was continues microstructures with close network densities. Every cheese variety has its characteristics structural features that reflect the chemical and biological changes in the cheese [32]. The number of milk fat globules decreased and the protein matrix became more compact [33].

Acid coagulation of heated milk gave the resulting curd a microstructuresifnificantly different from renneted milk. Renneted curd consists of casein particlesfused together in chains and clusters. In spite of the fusion, individual casein particles can still be distinguised [28]. However, Dangke fresh cheese using passion fruits coagulant consist of relatively of relatively more particles casein and more fat in the protein matrix with more core indicated microstructural changes characterized by solid casein micelles core. Individual casein micelles were easy to distinguished. The result can be explained according to [12] that there are five main pH ranges of microstructure changes in casein micelles during milk acidification, which were: 1) The first stage of aggregation (pH 6.7 to 5.8), micelles started to lose their individually, came closer and formed clusters, but the initial shape was still seen; 2) pH 5.5 to 5.3, most casein particles were significantly deformed, stretched, and extensively coalesced; thus forming a pseudo network with a very open structure; 3) pH 5.3 to 4.8, the network became more dense and fragmented into small units with new casein particles acting like individual characteristics; 4) pH 4.8 to 4.7, casein particles with the previous stage of fusion were followed by a stage of contraction and rearrangement, resulting in new casein particles with spherical shapes; 5) pH 4.6, the formation of acidified milk gels was completed with the casein particles aggregated into a true tree-dimensional network of chains and clusters.

Level of clotting materials was very significant influence to hardness, pH, and fat level. Ripening times was increases the soft cheese hardness, but decreases the pH. Fat level of Soft cheese Dangke was average 21.4% and 30.5% by addition of passion fruit juice 7.5% and 10%, respectively. Hardness of Dangke was increase by increase the time of ripening (1.38 to 3.73 kg/cm), but pH of Dangke was decrease by increase of time of ripening storage (5.34 to 4.1). Microstructure of cheese from 10% of passion fruits was extremely more firm with full fat globular than 7.5%. The properties of soft cheese of modification of Dangke making were similar with generally dangke properties. Manufacturing processes by addition passion fruits juice coagulant applied to Dangke had affect on hardness, pH, fat content and microstructure during cooling storage at 5ºC for 1 d – 28 d.

ACKNOWLEDGMENT

Authors gratefully acknowledge the financial assistance receiver from Ministry of Education and Research and Technology and Hasanuddin University, Indonesia.

REFERENCES

[1] Rasbawati, B. Dwiloka, A.N. Al-Baari, A.M. Legowo and V.P. Bintoro. 2014. Total Bacteria and pH of Dangke Preserved using natural antimicrobial lactoferin and lactoperoxidase from bovine whey. International Journal of Dairy Science, 9:116-123.

[2] Marzoeki, A.A., M.A. Hafid, J.M. Lewis, J.M. Amir and Madjid. 1978. Quality improvement research Dangke. Research Institute of Chemical Industry Ministry. Makassar.

[3] Hatta, W., M. Sudarwanto, I. Sudirman, and R. Malaka. 2013. Prevalence and Sources of contamination of *Escherichia coli* and

Salmonella spp. in cow milk Dangke, Indonesian fresh soft cheese. s.l. : Global Veterinaria, 11: 352-356.

[4] Casimir, D.J., J.F. Kefford and F.B. Whitfield. 1981. Technology and flavor chemistry of passion fruits juices and concentrates. s.l. : Adv. Food. Res, 27: 234 – 290.

[5] Adhikari, K., Heymann, H., and Huff, H.E. 2003. Textural characteristics of low fat, full fat and smoked cheeses: sensory and instrumental approaches. s.l. : Food Quality and Preference, 2003, 14: 211-218.

[6] Wium, H., Pedersen, P.S; Qvist. K.H. 2003. Effect of coagulation condition on the microstructure and the large deformation properties of fat-free Feta cheese made from ultrafiltered milk. Food Hydrocoll, 17, 287-296.

[7] Madallon, A., Khosrosahahi, A., Mousavi, S.M., Djome A.E., 2005. Rheology, microstructure and functionality of low fat Iranian white cheese made with different concentration of rennet. J. Dairy Science, 88: 3032-3062.

[8] Madallon, A., Khosrosahahi, A., Mousavi, S.M., Djome A.E., 2006. Microstructure and rheological properties Iranian white cheese coagulated at various temperature. J. Dairy Science, 89: 2359-2364.

[9] Madallon, A., Mousavi, S.M., Khosrosahahi, A, Djome A.E., 2007. Effect of cream homogenization on textural characteristics of low fat Iranian white cheese. International Dairy Journal, 17: 547-554.

[10] Khosrosahahi, A., Madallon, A. Mousavi, S.M., Djome A.E., 2006. Monitoring the chemical and textural changes during ripening white cheese made with different concentration of starter. J. Dairy Science, 89: 3318-3325.

[11] Hussein, G.A.M. and A.M. Shalaby. 2014. Microstructure and textural properties of Kareish cheese manufactured by various ways. Annals of Agricultural science, 59(1): 25-31

[12] Phadungath, C. 2005. The mechanism and properties of acid-coagulated milk gels. Songklanakarin J. Sci. Technol, 27: 433 – 448.

[13] Horne, D.S. 1999. Formation and structure of acidified milk gels. s.l. : Int. Dairy J, 9: 261 – 268.

[14] Kudryashov, E.D., N.T. Hunt, E.O. Arikainen, and V.A. Buckin. 2001. Monitoring of acidified milk gels cheeses: sensory and instrumental approaches. Food Quality and Preference, formation by ultrasonic shear wave measurements: High-frequency viscoelastic moduli of milk and acidified milk gel. s.l. : J. Dairy Sci, 84: 375 – 388.

[15] Lucey, J.A. and H. Singh. 2003. Acid coagulation of milk. s.l. Aspen Publishers, Gaitthersburg.

[16] Ohashi, T., S. Nagai, K. Masaoka, S. Haga, K. Yamauchi, and N.F. Olson. 1983. Physical properties and microstructure of cream cheese. Nippon Shokuhin Kogyo Gakkaishi, 30:303 – 307.

[17] Kanombirira, S. and K. Kailasapathy. 1995. Effects of interactions of carrageenan and gellan gum on yields, textural and sensory attributes of Cheddar cheese. s.l. : Milchwissenschaft, 50: 452 – 457.

[18] Bodyfelt, F., Potter, D. 2009. Creamed cottage cheese. Springer Science Business Media. LLC. New York. USA. Pp. 167-190.

[19] Abustam, E. 1992. Peranan Maturasi (Aging) terhadap Mutu Daging Sapi Bali yang dipelihara Intensif dan dengan Penggemukan. Laporan Hasil Penelitian. . Makassar : Fakultas Peternakan Universitas Hasanuddin, 1992.

[20] Malaka, R. Effect of Curdlan, a Bacterial Exopolysaccahride on Rheological Properties and Microcstucture of Acid Milk Curd by Lactis Acid Fermentation. Thesis. Japan : Miyazaki University, 1997.

[21] Malaka, R., Baco, S; Prahesti, K.I. 2015. Karakteristik dan mekanisme gelatinasi curd dangke melalui analisis fisiko kimia dan mikrostructure. Jurnal Ilmu dan Teknologi Peternakan, 4(2): 56-62.

[22] Desai and Salunke. 1986. Post Harvest Biotechnology of fruits. Florida : CRC Press.

[23] Fox, P.F., Guinee, T.P., Cogan, T.M., Mc.Sweeny, P.L.H. 2000. Starter culture, In. Fundamentals of Cheese Science. Aspen Publishers Inc. Gaithersburg, MD, USA, pp:54-97.

[24] Mistry, V.V. Lowfat cheese technology. 2001. International Dairy Journal, 11: 413-422.

[25] Hamid, O.I. and O.A.O. El Owni. 2007. Microbial Properties and Sensory Characteristics of white cheese (Gibna bayda) collected in Zalingei in Zalingei Area, West Darfur State. s.l. : Research Journal of Animal and Veterinary Science, 2: 61 – 65.

[26] Delamare, A.P.L., C.C.P. de Andrade, F. Mandelli, R.C. de Almeida, S. Echeverrigaray. 2012. Microbiological, Physico-chemical and sensorial characteristics of Serrano, an artinasal Brazilian Cheese. s.l. : Food and Nutrition Sciences, 3: 1068-1075.

[27] Ozcan, T, and U. E-Vapur. 2013. Effect of Different Rennet type on physico- chemical properties and bitterness in white cheese. International Journal of Environmental Science and Development, 4: 71-75.

[28] Kalab, M and H.W. Modler. 1985. Development of Microstructure in a cream cheese based on Queso Blanco Cheese. Food Microstructure, 4: 89-98.

[29] Olson, N.F., Johnson, M.E. 1990. Low fat cheese products characteristics and economics. Food Technol. 44: 93-96.

[30] Awad, R.A., Abdel-Hamid, L.B., El-Shabrawy, S.A., Singh, R.K., 2002. Texture and microstructure of block type processed cheese with formulated emulsifying salt mixture. Lebensm. Wiss. Technol. 35: 54-61

[31] Kashiwagi, T., Yokoyama, K., Ishikawa, K., Ono, K., Ejima, D., Matsui, H. 2002. Crystal structure of microbial transgluaminase from Streptoverticillium mobaraense. s.l. : J. of Biological Chemistry, 277: 44252-44260.

[32] Abd. El-Salam., M.H., El-Shibiny.S. 1973. An electron-microscope study of the structure of Domiati cheese. J. Dairy Res. 40: 113-115.

[33] Rahimi,J., Khosrowshahi, A., Madadlou, A., A. Azizma, S. 2007. Texture of low-fat Iranian white cheese as influenced by gum tragacanth as a fat replacer. J. Dairy Sci. 90: 4058 – 4070.

AUTHORS' PROFILES

Ratmawati Malaka
Professor of Animal Product Technology, Hasanuddin University
Biotechnology of milk processing
Verified email at unhas.ac.id - Homepage
My profile is public
email id: ratihtamalag39@gmail.com; malaka@unhas.ac.id

Sudirman Baco
Professor of Animal Production, Faculty of Animal Science, Hasanuddin University
Animal Production, Animal Breeding, Management
Verified email at unhas.ac.id - Homepage

International Journal of Agriculture Innovations and Research
Volume 5, Issue 4, ISSN (Online) 2319-1473

Table 3. The changes in properties of Dangke clotting by Passion fruits juices during ripening

Variable	0 d		14 d		21 d		28 d	
	7.5	10	7.5	10	7.5	10	7.5	10
pH	6.45 ± 0.19	6.12 ± 0.54	5.34 ± 0.43	5.0 ± 0.19	5.1 ± 0.34	4.8 ± 0.42	4.5 ± 0.06	4.1 ± 0.12
Hardness	1.98 ± 0.90	1.63 ± 0.21	2.88 ± 0.20	2.57 ± 0.12	2.96 ± 0.67	2.61 ± 0.02	3.73 ± 0.10	3.7 ± 0.08
Fat	24.9 ± 1.29	21.4 ± 1.63	27.6 ± 1.89	25.2 ± 1.79	29.8 ± 1.78	27.1 ± 0.83	30.5 ± 0.34	28.8 ± 0.23

Notes: Hardness unit is kg/cm^2 ; Fat level unit is %. This value is the average.

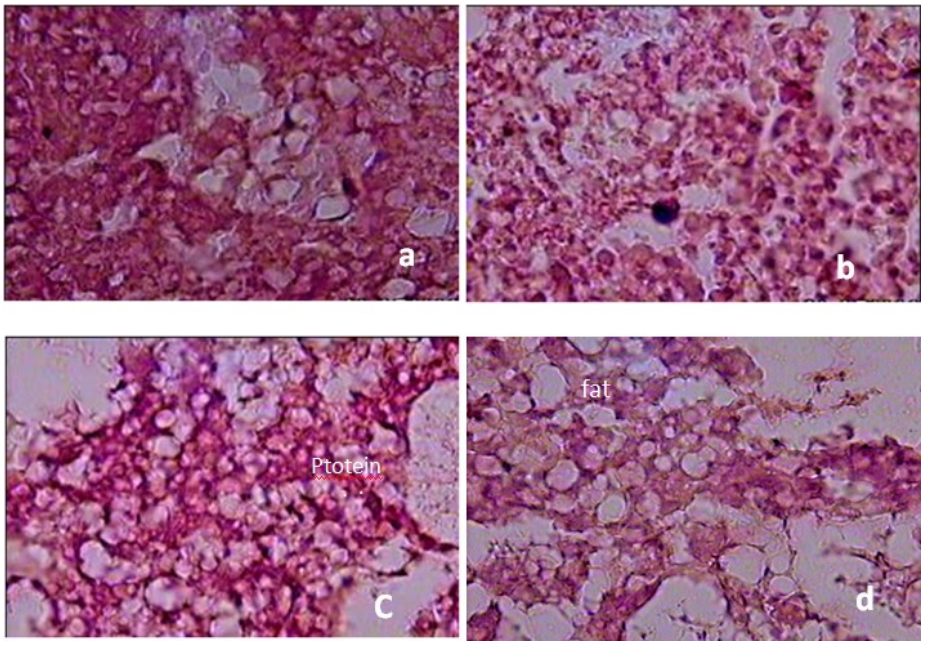

Fig. 1. Light micrographs by HE dye (1000 x magnification) of coagulated fresh cheese by passion fruits juice with a comparison of the two different techniques. Coagulated by 7.5% passion fruits juices: a) 14 days of ripening, c) 28 days of ripening, Coagulated by 10% marquise juice: c) 14 days of ripening, d) 28 days ripening.

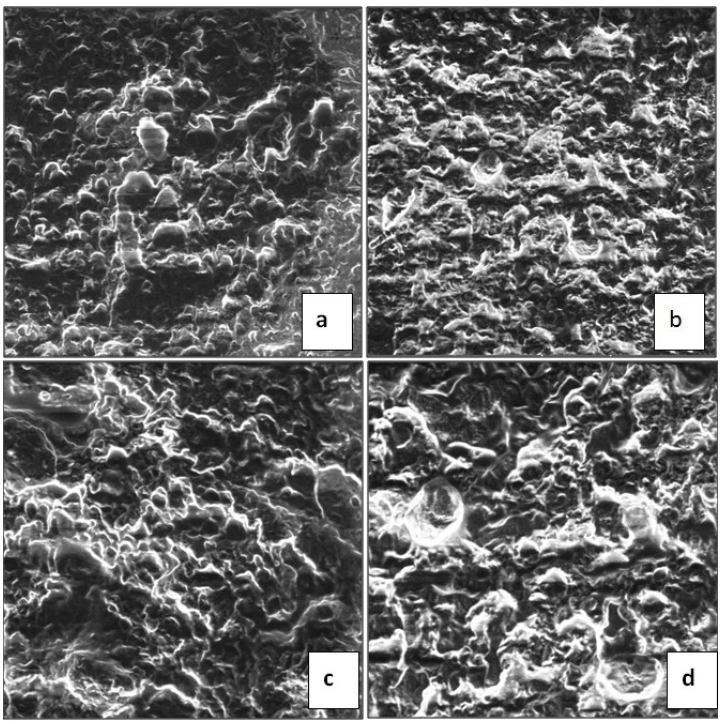

Fig. 2. Scanning Electron Microscope (10.000 x magnification) of coagulated fresh cheese by passion fruits juice with a comparison of the two different techniques. Coagulated by 7.5% passion fruits juices: a) 14 days of ripening, c) 28 days of ripening, Coagulated by 10% marquise juice: c) 14 days of ripening, d) 28 days ripening.