Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 4, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE EFFECT OF COAGULANT TYPE AND CONCENTRATION ON THE QUALITY OF MILK TOFU

Sigit Muryanto SUDARMO[1], Hendronoto Arnoldus Walewangko LENGKEY[2]

[1]University of Boyolali, Faculty of Agriculture, Jl. Pandanaran no. 405, Boyolali 57314 Indonesia, Phone +62276 3212328. Email: sigitmuryanto@uby.ac.id, sigit.ms.2013@gmail.com
[2]Universitas Padjadjaran, Jl. Raya Bandung – Sumedang km 21, Sumedang 45363, Indonesia, Email: lengkeyhendronoto@gmail.com

Corresponding author: sigitmuryanto@uby.ac.id, sigit.ms.2013@gmail.com

Abstract

Curd is one of the dairy products into a product out using a coagulant, the curd is one source of calcium. The type of coagulant is one important factor in making the curd. This study aims to determine the level of calcium and the organoleptic properties of the curd with variations in the type coagulant treatment. This study uses Completely Randomized Design (CRD) factorial pattern 2 x 3. The first factor is of the type of coagulant calcium carbonate (CaCl2) – P1 and vinegar (CH_3COOH) – P2, and the second factor is three levels concentration : K1 = 0.2 M, K2 = 0.3 M , K3 = 0.4 M, so the following treatment combination are P1K1 = 0.2 M CaCl2, P1K2 = 0.3 M CaCl2, P1K3 = 0.4 M CaCl2, P2K1 = 0.2 M CH3COOH, P2K2 = 0.3 M CH3COOH, and P2K3 = 0.4 M CH3COOH.Each experiment carried out repeat 5 times. After getting/obtained a blob out, filtering and pressed to form the milk curd. The curd. will be used for organoleptic test, to analyze the deterioration the milk tofu quality, with sensory test every 24 hours using 25 student as panelist. This test is performed on color, odor, taste, and texture. ANOVA statistical test research results showed that the treatment that produces tofu milk with the most acceptable in terms of quality, storage capacity and preference test is the treatment (P1K2 - milk tofu made use CaCl2 coagulant with a concentration of 0.3M, has the following composition: 46.7% moisture content, 19.9% protein, 11.8% fat content, 2.8% ash content, 180.8 grams of wet weight and 78.8% yield.

Key words: *coagulant, curd, calcium chloride, vinegar, organoleptic properties*

INTRODUCTION

The population growth in the world is so fast, but the existing land area is relatively constant so that it will not be able to catch up the number of food needs for the world's population. That yet in only 50 years, our growing global population will require an estimated 100 percent more food than we produce today. Unfortunately, we will certainly not have 100 percent more high-quality land available to grow twice the amount of grain or two times more livestock. For that, a solution must be found so that all products can be used as a source of food for humans, without sacrificing the health of consumers [8]. Thus, this additional food supply should come from the use of efficiency-enhancing technologies; which can be done by using the concept of collaboration, choice and technologies.

On the other hand, the level of awareness or knowledge of the population is still not evenly distributed, especially in rural areas in developing countries which often still cause some food production to be unacceptable because it does not meet the requirements needed as food that is fit for consumption [9]. For example, the production of fresh milk, due to lack of attention or lack of awareness, so that during the gathering at the collector, there is a product that is not good enough, so that it will affect the quality of the whole milk, as a result, all production that day cannot be accepted for processing at the processing factory.

Even though the milk production is still suitable for consumption, due to an error in the initial collection, it does not meet the requirements to be processed as pasteurized milk or sterilized milk. For this reason, we can find ways to utilize the milk so that it is not wasted, but it is processed into food in other forms. So we need a technology that can help keep food affordable while ensuring maximum consumer choice, especially in developing nations. Thus, milk that does not meet the requirements to be processed as pasteurized milk or sterilized milk can be found ways to use it as an ingredient for human consumption, for example by producing it into milk products such as milk tofu or other milk-based products. As the dosage increase, it will influence the curd production [5].

Milk is a source of calcium, when making tofu uses some coagulant, pineapple juice, citric acid, vinegar, and CaCl2 [7]. From a nutritional point of view, the composition of milk has consequences for the dairy processing industry. In Table 1, the composition of cow's milk is listed, both Bos Taurus and Bos indicus [9].

Table 1. The composition of milk (g/100g)

Species	Fat	Casein	Whey protein	Lactose	Ash
Cow	3.65	2.5	0.6	4.77	0.7
Bos taurus	4.2	2.6	0.6	4.6	0.7
Bos indicus	4.7	2.6	0.6	4.7	0.7

Source: Own calculation for cow. For both Bos taurus and Bos indicus [9].

Milk tofu or curd is a dairy product obtained from curdling milk with rennet or acids such as lemon juice or vinegar and then removing the liquid part (whey), or processed products made with skim milk as raw material which have very good nutritional value, the shape and color resemble tofu. The curd is one of the dairy products and also the curd is one source of calcium. The curd is a product that using a coagulant, The type of coagulant is one important factor in making the curd.

Most of the needs of milk tofu in Indonesia are met by home industries. On the other hand, according to observations, there are still many home industries that have not implemented hygiene and sanitation standards by state regulation. Regarding the maximum limit of microbial contamination in food, it is said that for fresh, unpasteurized milk for further processing, with Total Plate Count (TPC) 30^0C, in 72 hours with a maximum limit of 1 x 10^6 colony/ml, coliform 2 x 101 colony/ml, the Most Probable Number (MPN) for *Escherichia coli* <3 / ml, *Salmonella* sp negative/25 ml, and *Staphylococcus aureus* 1 x 10^2 colony/ ml [2].

Milk contains two different groups of protein, the casein complex and the whey proteins. The protein milk consist for about 80% of casein. There are two different methods of precipitating the casein, by souring the milk, either by direct addition of acid or by bacterial acid production, and by coagulation using certain enzymes, CaCl2 or CH3COOH.

This study aims to determine the level of Calcium chloride (CaCl2) and vinegar (CH_3COOH), in the organoleptic properties of the curd with variations of coagulant concentration.

MATERIALS AND METHODS

Fresh milk, purchased from KUD - Boyolali Milk Cooperation, CaCl2 and CH_3COOH as coagulant, and chemicals for proximate analysis of milk and milk tofu.

Proximate analysis of fresh milk, determination of lactose content, protein content using the micro Kjeldahl method, fat content using Mojonary method, water content by heating and ash content by Burning method

Tofu milk making. Milk was heated to 90^0 C for 10 minutes and then added with coagulant according to the existing treatment, as much as 200 ml, then stirring slowly. The existing lumps were filtered, poured into tofu molds, and pressed for 10 minutes.

Proximate analysis of milk tofu, to determination protein content using micro Kjeldahl method, fat content using Mojonary method, water content by heating and ash content by Burning method.

Analysis the deterioration of milk tofu quality with sensory test every 24 hours using 25 student as panelist.

Observation data were analyzed with Analysis of variance (ANOVA), with the F test at 5% levels. If it is significantly different, continue with Duncan's multiple distance test at the 5% level.

Experimental Design

Completely Randomized Design (CRD) consisting of two factors, P1 = CaCl2, P2 = CH3COOH, as coagulant with three levels concentration: K1 = 0.2 M, K2 = 0.3 M , K3 = 0.4 M, with the following treatment combination: P1K1 = CaCl2 concentration of 0.2 M, P1K2 = CaCl2 concentration of 0.3 M, P1K3 = CaCl2 concentration of 0.4 M, P2K1 = CH3COOH, concentration of 0.2 M , P2K2 = CH3COOH concentration of 0.3 M, P2K3 = CH3COOH concentration of 0.4 M.

RESULTS AND DISCUSSIONS

Proximate analysis of fresh milk

The results of the proximate analysis of fresh milk, as presented in Table 2, were not significantly different from the composition of fresh milk according to van den Berg (1988).

Table 2. The composition of fresh milk analysis and according to van den Berg (g/100g) (g/100g)

Species	Fat	Casein	Whey protein	Lactose	Ash
Bos taurus	4.2	2.6	0.6	4.6	0.7
Bos indicus	4.7	2.6	0.6	4.7	0.7
Cow fresh milk	3.65	2.5	0.6	4.77	0.7

Notes: For Bos taurus and Bos indicus [9];
Source: own analysis for fresh milk.

Proximate analysis of milk tofu

The results of measuring the weight of milk tofu as can be seen in Table 3, it turns out that the highest average value was achieved in the P1K2 treatment (180.8 grams) and the lowest average value was achieved by P2K3 treatment (124.6 grams), while the total mean value was 148.9 gram.

Table 3. Proximate analysis of milk tofu

Treat-ments	Weight (gram)	Yields (%)	Water (%)	Protein (%)	Fat (%)	Ash (%)
P1K1	170.5 b	75.8 b	59.6 b	18.1 b	10.9 b	2.7 b
P1K2	180.8 a	78.8 a	60.7 a	19.9 a	11.8 a	2.8 a
P1K3	155.3 c	72.2 c	56.8 c	17.8 c	10.3 c	2.6 c
P2K1	126.6 e	65.9 e	49.8 e	13.4 e	8.7 e	1.4 e
P2K2	135.3 d	67.9 d	52.2 d	14.9 d	9.7 d	1.6 d
P2K3	124.6 e	58.5 f	46.7 e	12.9 e	8.4 e	1.3 e
Means	148.9	69.9	57.1	16.2	9.97	2.1

Source: Own analysis.

Whereas for the measurement of yield of milk tofu, the highest value was achieved in P1K2 treatment (78.8%) and the lowest average value was achieved by P2K3 treatment (58.5%), while the total mean value was 69.9%.

From the analysis of variance, it shows that the treatment has a significantly different effect on obtained weight and yield of tofu milk. Based on the Duncan’s test, the coagulant type factor (P) and the concentration factor (K) on the weight and yield of tofu milk, it shows that the coagulant type factor and the concentration both have a very significant effect on the difference in weight and yield of tofu milk obtained. This shows that the use of CaCl2 coagulant has provided a higher weight and yield of milk tofu than the CH3COOH. In addition, the use of a coagulant concentration of 0.3 M has resulted highest weight and yield of milk tofu compared to the concentration of 0.2 M or 0.4 M. ά-S-casein from milk is a part that is very sensitive to Ca ++ ions, meaning that the component will settle in the Ca salt solution [10]. This means that the volume of precipitation caused by the influence of the acid depositing at its isoelectric point is relatively much lower when compared to the use of Ca salt. Therefore, treatment (P1K2) showed the highest yield of wet weight and yield compared to the others [6].

The results of measuring the water content of milk tofu as can be seen in Table 3, the lowest average value was achieved in the P1K2 treatment (43.7%) and the highest average value was achieved by P2K3 treatment (69.8%), while the total mean value was 57.1. %. Whereas for measuring protein content of milk tofu, the highest value was achieved by P1K2 treatment (19.9%) and the lowest average value was achieved by P2K3 treatment (12.9%), while the total mean value was 16.2%. From the analysis of variance, it shows that the treatment has a significant effect on the water content and protein content of the milk tofu obtained. Based on the multiple distance test, the coagulant factor (P) and the concentration factor (K) on the water content and protein content of the tofu showed that the coagulant factor and the coagulant concentration had a very significant effect on the differences in water content and protein content of milk tofu which is obtained. This shows that the use of the CaCl2 coagulant has resulted in a more compact tofu because the water content is higher than the CH3COOH coagulant. Likewise for protein content, where the use of CaCl2 coagulant, results in higher protein levels compared to CH3COOH coagulant. In addition, the use of a coagulant concentration of 0.3 M also resulted in a more compact quality of milk tofu with a higher moisture content and protein content compared to concentrations of 0.2 M or 0.4 M.

According to the results of measuring the fat content of milk tofu as can be seen in Table 2, show that the highest average value was achieved in the P1K2 treatment (11.8%) and the lowest average value was achieved by P2K3 treatment (8.4%), while the total mean value was 9.9. %. Whereas for measuring the ash content of milk tofu, the highest value was achieved in P1K2 treatment (2.8%) and the lowest average value was achieved by P2K3 treatment (1.3%), while the total mean value was 2.1%. From the analysis of variance, the treatment has a significant effect on the fat content and ash content of the milk tofu obtained. Based on the multiple distance test, the coagulant type factor (P) and the concentration factor (K) on the fat content and ash content of the milk tofu showed that the type and concentration of coagulant, had a very significant effect on the differences in fat content and ash content of milk tofu which is obtained. This shows that the use of CaCl2 coagulant has provided a higher fat content and ash content of milk tofu than the CH3COOH coagulant. In addition, the use of a coagulant concentration of 0.3 M also resulted in higher levels of fat and ash content of milk tofu compared to concentrations of 0.2 M and 0.4 M. The isoelectric points of casein and β-lactoglobulin are not the same, so that the clumps caused by acids will have a relatively low β-lactoglobulin content, when compared to deposition by the influence of Ca ++ ions [4]. This means that the clots due to acid deposition are less compact and less able to bind water. The bond between casein and β-lactoglobulin causes the milk tofu obtained to be more compact, so that it is more able to bind water. The high milk casein that settles is caused not only by the use of Ca ++ ions for clotting, but also due to the iso-electrical point of the casein component [1]. Meanwhile, precipitation due to the influence of acid only occurs at the isoelectric point for certain casein components, because the isoelectric points of protein components in milk are different [3]. This is the reason why the protein content of milk tofu for treatment P1 (CaCl2) is relatively higher compared to treatment P2 (CH3COOH). In addition, the coagulation concentration of 0.3 M for each coagulator also causes a large amount of milk casein to settle.

Tofu milk quality deterioration during storage according to consumer preference test

The results of the consumer preference test for milk tofu during storage can be seen in Table 4.

The results of the preference test for the color, odor, taste and texture of tofu milk at the 48th hour as can be seen in Table 4, it turns out that the highest average value is achieved by the P1K2 treatment (CaCl2) and the lowest average value is achieved by P2K3 treatment (CH3COOH) in 48 hours, it can be seen that all samples can be accepted by consumers, although the most preferred is still the P1K2 treatment (CaCl2, 0.3 M). Likewise for the test results for color, odor, taste and texture at the 72th hour all samples can be accepted by consumers, except the treatment P2K3 (CH3COO-0.4 M) and P2K1 (CH3COOH-0.2 M) whose values were below the normal. From the analysis of variance showed that the treatment had a significantly different effect on the consumer test on color, odor, the taste and texture of the milk tofu.

Different types and concentrations of coagulant have a significant effect on the quality and shelf life of milk tofu. The use of CaCl2 coagulant with a concentration of 0.3 M in general, provides the best quality and shelf life of tofu.

The highest yield was 78.8% (P1K2-CaCl2 coagulant with a concentration of 0.3 M), while the lowest yield was 58.5% (P2K3), namely treatment with CH3COOH coagulant with a concentration of 0.4 M).

Table 4. Tofu milk quality deterioration during storage (0-72 hours) in room temperature, according to consumer preference test

Treatments	Color		Odor		Taste		Texture	
	0 hrs	24 hrs	0 hrs	24 hrs	0 hrs	24 hrs	0 hrs	24 hrs
P1K1	4.5 b	4.3 b	4.4 b	4.3 b	4.3 b	4.3 b	4.4 b	4.3 b
P1K2	4.7 a	4.6 a	4.6 a	4.6 a	4.5 a	4.6 a	4.6 a	4.6 a
P1K3	4.4 b	4.3 b	4.2 c	4.3 b	3.9 c	4.3 b	4.2 c	4.3 b
P2K1	4.2 c	2.9 c	3.9 c	2.7 c	3.8 c	2.6 c	3.6 d	2.6 c
P2K2	4.1 c	3.1 c	4.0 c	3.1 c	4.1 c	3.0 c	4.1 c	3.0 c
P2K3	3.9 c	2.8 c	3.8 c	2.7 c	3.9 c	2.6 c	3.8 d	2.4 c

Treatments	Color		Odor		Taste		Texture	
	48 hrs	72 hrs	48 hrs	72 hrs	48 hrs	72 hrs	48 hrs	72 hrs
P1K1	3.8b	3.6b	3.6b	3.4b	3.6b	3.4b	3.8b	3.6b
P1K2	4.3a	4.1a	4.0a	3.8a	4.2a	3.9a	4.3a	4.1a
P1K3	3.9b	3.5b	3.9b	3.3b	3.8b	3.5b	3.9b	3.5b
P2K1	3.5c	2.4c	3.5c	2.4c	3.5c	2.4c	3.5c	2.4c
P2K2	3.4c	2.6c	3.4c	2.6c	3.4c	2.6c	3.4c	2.6c
P2K3	3.3c	2.6c	3.3c	2.6c	3.3c	2.6c	3.3c	2.6c

Source: Own analysis.

Based on the multiple distance tests on the color, odor, taste and texture of milk tofu during the storage period, it shows that the coagulant type factor and concentrations, both have a very significant effect on consumer acceptance of milk tofu. This shows that the use of the CaCl2 coagulant for the milk tofu clumping process has provided higher consumer acceptance compared to the use of CH3COOH coagulant. In addition, the use of a coagulant concentration of 0.3 M also results in a higher level of consumer acceptance compared to concentrations of 0.2 M and 0.4 M. In general, it can be said that the value of consumer enjoyment of milk tofu during storage has decreased.

CONCLUSIONS

The longest shelf life of milk tofu is 72 hours (P1K2-CaCl2 coagulant with a concentration of 0.3 M), while the shortest is 72 hours (P2K3 - CH3COOH coagulant with a concentration of 0.4 M).

The treatment that produces tofu milk with relatively the most acceptable in terms of quality, storage capacity and preference test is the treatment (P1K2 - milk tofu made use CaCl2 coagulant with a concentration of 0.3M, has the following composition: 46.7% moisture content, 19.9% protein, 11.8% fat content, 2.8% ash content, 180.8 grams of wet weight and 78.8% yield.

REFERENCES

[1]Adnan, M., 1984. Kimia dan Teknologi Pengolahan Susu (Chemical and Milk Processing Technology), Andi Offset, Yogyakarta. In Indonesian.

[2]Badan Standar Nasional Indonesia (Indonesian National Standard), 2009, Batas Maksimum Cemaran Mikroba Dalam Pangan (Regarding the maximum limit of microbial contamination in food) SNI 7388, Jakarta, Indonesia. In Indonesian.

[3]Buckle, K. A., R. A. Edwards, G. H. Fleet and M. Wootton. 1978. Food Science. Australian Vice-Chancellor’s Committee. Brisbane. Pp. 105 – 111.

[4]Egziabher, A.G. and Summer, A.K., 1983. Preparation of high protein curd from field peas, Journal of Food Science vol 48 p 375-377.

[5]Lengkey, H. A. W., Balia, R.L., 2014, The Effect of Starter Dosage and Fermentation Time On pH and Lactic Acid Production. Biotechnology in Animal Husbandry, Vol. 30, 2. Institute for Animal Husbandry, Belgrade – Zemun, Serbia. p 339 – 348.

[6]Lu, J.Y., Carter, E. and Chung, R.A., 1980. Use of calcium salt for soys bean curd preparation, Journal of Food Science Vol 45 p 32-34.

[7]Nurhidayah and Agus Suyanto, 2012. Kadar Kalsium dan Sifat Organoleptik Tahu Susu dengan Variasi Jenis Bahan Penggumpal (Calcium levels and organoleptic properties of tofu with variations in clotting materials). Jurnal Pangan dan Gizi Vol. 3, No. 05. p. 39 – 47. In Indonesian.

[8]Simmons, J., 2014, Food Economics and Consumer Choice. Elanco Animal Health. p. 12.

[9]Van den Berg, J. C. T., 1988, Dairy Technology in the Tropics and Subtropics. Pudoc, Wageningen.

[10]Varusantin, S., Watanabe, K. dan Nakamura, 1983. Effect of ion Ca, Mg and Na on heat agregration of whey protein concentrate, Journal of Food Science vol 46, p. 42-46