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COMPARISON BETTWEEN DIFFERENT TYPES OF COAGULANT FOR HALLOUMI CHEESE PROCESSING

El-Zoghby, A.S. and Y.I. Abdel-Kader
Animal Production Research Institute, Dairy Technology Dept., Dokki, Cairo Egypt.

ABSTRACT

Halloumi cheese was processed from admixture of buffaloes' and cows' milk (1:1). Four types of coagulants namely, local commercial liquid calf rennet, HALA, Fromase and Maxiren powders were separately used to select among them the proper type which produces the best quality of Halloumi cheese. The concentration of each coagulant was added to the milk according to the instruction of the produced company.

Results showed that commercial liquid calf rennet gave the shortest renneting coagulation time (R.C.T.) and the highest syneresis, whereas HALA gave the longest (R.C.T.) and the lowest syneresis. The lowest fat and protein losses in whey were detected when commercial liquid calf rennet was used, followed by HALA, while the highest losses were detected when Maxiren powder was applied. HALA powder rennet gave the highest yield either for fresh or ripened cheese while liquid calf rennet gave the lowest yield.

The four types of coagulants had no marked effect on fat/DM, T.N/DM and the salt/D.M contents, while a marked effect on moisture content was observed. Cheese made with HALA coagulant had the highest moisture content, in the contrary of liquid calf rennet treatment which kept the lowest moisture content. The type of coagulant had marked effect on protein degradation during storage at room temperature. SN/TN was the highest for cheese made using HALA coagulant, while the lowest factor was detected in cheese made with liquid calf rennet. The same trend was found for NPN/TN and T.V.F.A.

On the other hand the best rheolgical and organoleptic properties were obtained for the cheese made with HALA coagulant either in the fresh or stored cheese. The other coagulants gave cheeses with less scores. HALA powder rennet is suitable for the manufacture of Halloum cheese.

Keywords: Calf liquid rennet, HALA, Fromase, Maxiren, Halloumi cheese, Meltability, Oiling off, Cheese processing.

INTRODUCTION

Halloumi is a semi-hard to a hard cheese. It is unripened cheese which should stretch and melt if heated sufficiently. The variety is popular in the Middle east, which is a part of the world where shortages of fresh milk may occur (Shaker *et al*., 1987). It tastes like immature Cheddar cheese. When heated, Halloumi cheese should melt and have the capacity to stretch and have tender mouthfeel (Robinson 1991). This variety of cheese is traditionally made from sheeps' or goats' milk.

Shaker *et al* (1987) succeeded in processing this variety from bovine milk. Also the properties of Halloumi cheese made from recombined milk was investigated by Lelievre *et al*., (1991).

Abdel-Kader and El-Zoghby (1999) manufactured this variety from buffaloes, cows' and goats' milk, or from mixtures from these milks. The

resultant cheese was stored in 15% brine solution at room temperature for 3 months. The menthe and grain of black peppers were used as flavours.

Normally this variety was processed using liquid calf rennet to have a compact texture and unyielding to applied presses, when heated, the sliced cheese should melt evenly, have the compactly to stretch, but should not be tough or "chewy".

The type of this cheese may find great acceptance from Egyptian processors, who like to process their cheese from raw milk and store the resultant cheese in brine solution out of the refrigerator. The cooking of the cheese is regarded as a good heat treatment for destroying most of the undesirable microorganisms.

Calf rennet is the traditional, ideal enzyme and the most important coagulant used in cheese manufacture (Scott, 1981 and Kosikowski 1988). However, because of a worldwide shortage of calf rennet, a large number of proteinases from plant, animal, bacterial and fungal sources have been used for coagulation of milk (Mrtens and Naudts 1979; Green, 1977 and Ward 1983). Calf rennet has the advantage of high milk clotting to proteolytic ability. Rennet substitutes showed higher to protyeolytic than clotting activity (De Koning 1978).

Different microorganisms are used for coagulant production. In this respect Fromase, Rennilase (*Mucor miehei*), Emporase (*Mucor Pusillus*), Suparen (*Endothia parasitica*), Mikrozyne (*Bacillus subtlis*) and Milcozyme (*Bacillus polymyxa*) are available in the market for cheese production (Budtz 1989).

Recently fermentation derived chymosin (Maxiren) from the yeast (*Kluyveromyces lactis*). This preparation has been used experimentally in the manufacture of different types of cheese (Prokopek *et al.*, 1988; Bines *et al.*, 1989; Van den Ber and Koning 1990, and Peps *et al.*, 1994).

Demerdash *et al.* (1977) studied the thermostability of Maxiren and they found that clotting activity decreased rapidly above 30 °C, and at 55 - 60 °C the enzyme exhibited its maximal coagulation activity. The activation energy of FDC was found to be 11700 cal./mol.

This investigation is carried out to study the possibility of using four different types of available rennet to process Halloumi cheese from admixture of buffalo's and cow's milk (1:1), and to study the effect of each coagulant on the chemical, rheological and organoleptic properties of the resultant cheese, to recommend the best among them for Halloumi cheese manufacturing.

MATERIALS AND METHODS

- Fresh buffalos' and cows' milk were abtained from Gemmeza Animal Production Research Station, Ministry of Agriculture, Gharbieh Governerate. The admixture of both milk (1:1) has 13.80 T.S, 4.7% fat, 3.388% protein, 0.16% acidity and pH 6.56.
- Yoghurt starter was obtained from Ch. Hansens Laboratories, Denmark. The starter containing *Streptococcus salvarius* subsp. *thermophilus* and *Lactobacillus delbruckii* subsp. *bulgricus* (1:1) was used at a rate of 0.5%.

- Local commercial liquid calf rennet was obtained from local market, was added to the milk at a rate of 40 ml./100 l.
- HALA powder, calf rennet (75% chymosin + 25% pepsin) was obtained from Hansens, Laboratories of Denmark, was added at a rate of 3 gm/100 L of milk. It is dissolved in 100 ml distilled water before using.
- Fromase prepared from pure culture of the fungi *Mucor miehei* produced by Gist-brocades of Holland, was added at a rate of 3 gm/100 l of milk. It was also dissolved in distilled water before being used.
- Maxiren is a pure chymosine preparation derived from a special strain of the dairy yeast *Kluyveromyces lactis* produced by Grist-brocades of Holland. It was used at a rate of 3 gm/100 l of milk.
- Sodium chloride brine solution (15%) was prepared from pure kitchen salt, which was obtained from El-Nasr company.

Halloumi cheese was made as described by Robinson (1991). The mixed buffaloes' and cows' milk (1:1) was warmed at 35 °C and the 0.5% (w/w) yoghurt starter was added, then the milk was divided into 4 equal portions 50 Kg each. To the first portion, 20 ml calf liquid rennet was added. To the second 1.5 gm of HALA powder was dissolved into 100 ml distilled water and then, renneting took place. To the third 1.5 gm of Fromase powder was dissolved into 100 ml of distilled water, then added to milk. Similarly the fourth portion was coagulated with 1.5 gm Maxiren.

All portions were left to complete curdling. The resultant cheese was stored individually in 15% brine solution at room temperature (20-25 °C) for three months. The experiment was done in three replicates.

Samples of fresh mixed milk were separately coagulated by the four coagulants to determine R.C.T., curd tension and syneresis for each rennet, while another samples of milk and whey representing each treatment were chemically analysed for pH, acidity, moisture content, fat and total nitrogen determinations.

Fresh samples and samples from cheese after 1, 2 and 3 months was chemically analysed for moisture, titratable acidity, pH value, fat, total nitrogen, soluble nitrogen, non protein nitrogen (NPN) and total volatile fatty acids (TVFA), parallely meltability, oiling off and organoleptic properties were evaluated.

Rennet coagulation time (RCT) was tested according to the methiod of Ekenstron (1958), curd tension was determined by the method of Abd El-Salam *et al*., (1991) Syneresis according to Lowernce (1959). Moisture, titratable acidity, pH value, fat, soluble nitrogen and non protein nitrogen (NPN) were determined according to Ling (1963), Total nitrogen according to Rowland (1938). Total volatile fatty acids and sodium chloride as described by kosikowski (1966). Meltability and oiling off were determined as described by Kindsted and Rippe (1990), while the organoleptic properties score of the cheese according to Nelson and Trout (1965).

RESULTS AND DISCUSSION

Data given in table (1) showed the effect of different types of coagulant on rennet coagulation time (R.C.T.), curd tension and synersis. Local liquid rennet took only 185 seconds for complete coagulation, followed

by Maxiren. The longest coagulation time (260 sec.) was detected by HALA powder rennet.

On the other hand, the highest value of curd tension was in calf rennet, while the lowest value was found by HALA powder rennet. Syneresis was the highest for calf liquid rennet (32.5 ml), followed by Maxiren, and the lowest value (14.5 ml) was for HALA powder rennet.

Table (1). Effect of different types of coagulant on rennet coagulation time (RCT), curd tension and syneresis.

Treatments	Rennet Coagulation time (RCT) (Sec.)	Curd tension (gms)	Syneresis (ml. of filtrated whey at 30 minutes intervals)			
			First 30 min.	Second 30 min.	Third 30 min.	Total 90 min
Calf rennet (A)	185	38.50	25.50	4.50	2.50	32.50
HALA (B)	260	17.65	10.50	2.50	1.50	14.50
Fromase (C)	228	21.40	12.00	3.00	2.00	17.00
Maxiren (D)	205	26.15	18.50	4.00	2.50	25.00

A: Liquid calf rennet B: HALA powder rennet C: Formase D: Maxiren

Anis *et al.*, (1983) studied the milk clotting activity of different rennet types, calf rennet (CR), Adult bovine rennet (ABR), HALA, Habo (bovine rennet), and Fromase. They found that the clotting time in seconds was 100, 150, 105, 130 and 110 sec. for CR, HBR, HALA, Habo and Fromase, respectively. While respective curd tension values for buffalo and cow were 33/61, 25/52, 29/54, 22/44 and 31/58 gr for cows' and buffaloes' milk, respectively.

Results noted in table (2) revealed the effect of type of rennet on fat and protein losses in whey during cheese processing. The highest losses of fat and protein in whey were for Maxiren treatment, while the lowest losses values were for liquid calf rennet. As sequence the fat and protein recoveries will be higher in liquid calf rennet treatment followed by HALA powder rennet treatment.

Anis *et al.*, (1983) found that HABO rennet gave slightly higher whey protein content followed by adult bovine rennet, Fromase, HALA and calf rennet in a descending order.

Table (3) showed the yield of Halloumi cheese as affected by the different types of rennet during storage periods. The highest yield (14.2%) was obtained in cheese made with HALA rennet, while the lowest yield was obtained from commercial calf rennet treatment (11.84%). The decrease of weight or loss in yield was noticed in all cheese treatments. This rate of decrease was similar in all treatments and ranged between 2.53 and 2.68, especially, after one-month storage. This might be due to the changes in moisture content, the degree of proteolysis and loss some component into the brine solution during pickling.

Corradini (1980) studied the effect of different animal rennets and microbial coagulants on curd tension, yield and rheology of Grana cheese and found that in all trials the curd obtained with calf rennet was firmer than curds obtained with the other coagulants.

Table (2): Effect of coagulant type on fat and protein recoveries during Halloumi cheese manufacturing.

properties	Treatments			
	A	B	C	D
Amount of Whey (Kgs)	17.562	16.805	17.173	17.340
Total solids of whey %	5.427	4.253	4.661	5.210
Fat of whey %	0.550	0.680	0.700	0.750
Total nitrogen of whey %	0.146	0.160	0.163	0.168
Total protein of whey %	0.931	1.021	1.040	1.072
Amount of fat in milk (kgs)	0.940	0.940	0.940	0.940
Fat loss in whey %	10.277	12.128	12.766	13.830
Fat recovery %	89.723	87.872	87.234	86.170
Amount of protein in milk (Kg)	0.676	0.676	0.676	0.676
Protein loss in whey %	24.260	25.444	26.479	27.515
Protein recovery %	75.740	74.556	73.521	72.485

A: Liquid calf rennet B: HALA powder rennet C: Formase D: Maxiren

Table (3): Yield of Halloumi cheese as affected by different types of coagulant during storage periods (3 months).

Properties	Storage period (months)	Treatments			
		A	B	C	D
Yield as DM %	Fresh	11.84	14.20	13.52	12.35
Yield %	1	11.54	13.82	13.17	12.03
Weight loss %		2.53	2.68	2.59	2.59
Yield %	2	11.39	13.61	12.98	11.86
Weight loss %		3.80	4.15	3.99	3.97
Yield %	3	11.29	13.46	12.85	11.75
Weight loss %		4.65	5.21	4.96	4.86

A: Liquid calf rennet B: HALA powder rennet C: Formase D: Maxiren

Kandeel *et al.* (1991) used four types of coagulants for Domiatti cheese processing from goats' milk, and found that the highest yield of fresh and 90 days old cheese was with HALA rennet and the lowest with Hannilase.

At the end of storage period, the weight loss was higher (4.65-5.21%) and this could be due to the calculation regarding the fresh cheese as a losses. Cheese processor is looking for the yield of the cheese and will search for the rennet which give higher yield.

From the data in table (4), no pronounced differences were detected in the acidity and pH values of Halloumi cheese as a result of using different types of coagulants. In general, acidity values of all Halloumi cheese increased as the storage time increased. HALA rennet cheese scored the highest value and calf rennet cheese gave the lowest values being 1.05 and 0.88% respectively, similar trend of results were obtained by Blassy (1999) when she studied the use of different coagulant for the processing of Mozzarella cheese . pH values took opposite trend of the acidity.

The type of rennet had no clear effect on salt content of all produced cheeses. The differences between treatments are owing to the moisture content. In general, the obtained results of salt content are similar to those obtained by Anifantakis and Kaminarides (1982, 1983) and Abdel-Kader and El-Zoghby (1999). Blassy (1999) stated that no clear effect in salt/DM of Mozzarella cheese made from different coagulants.

Table (4). The effect of coagulant type on acidity development, pH value and salt content of Halloumi cheese during storage periods (3 months).

Properties	Storage period (months)	Treatments			
		A	B	C	D
Acidity %	Fresh	0.40	0.57	0.48	0.45
	1	0.58	0.83	0.76	0.72
	2	0.77	0.98	0.93	0.80
	3	0.88	1.05	1.02	0.90
pH values	Fresh	5.45	5.19	5.23	5.39
	1	5.20	4.90	5.02	5.10
	2	4.95	4.68	4.73	4.82
	3	4.83	4.56	4.62	4.70
Salt %	Fresh	1.510	1.215	1.287	1.363
	1	1.783	1.408	1.504	1.615
	2	2.005	1.553	1.676	1.807
	3	2.187	1.656	1.798	1.956
Salt/DM %	Fresh	2.831	2.392	2.498	2.610
	1	3.223	2.653	2.802	2.973
	2	3.552	2.851	3.048	3.251
	3	3.825	3.002	3.216	3.466

A: Liquid calf rennet B: HALA powder rennet C: Formase D: Maxiren

Data in table (5) showed the effect of different types of coagulant on the chemical composition of Halloum cheese. Some difference in moisture content when four coagulants were detected. HALA rennet hold the highest percentage of moisture (49.2%) while calf liquid rennet cheese kept the lowest moisture content (46.66%). Abdel-Kader (1981) made a comparitive study between local rennet, Rennilase and HALA powder rennet during Kachkaval cheese making. The ripened cheese made with HALA rennet contained higher moisture content and accepted flavour as compared with Rennilase.

Table (5). Effect of using different types of coagulant on some chemical properties of Halloumi cheese during storage periods (3 months).

Properties	Storage period (months)	Treatments			
		A	B	C	D
Moisture %	**Fresh**	46.66	49.20	48.48	47.77
	1	44.68	46.92	46.33	45.68
	2	43.55	45.52	45.01	44.41
	3	42.83	44.51	44.10	43.56
Fat %	**Fresh**	27.50	25.90	26.00	26.00
	1	28.50	27.20	27.40	27.60
	2	29.30	28.10	28.20	28.40
	3	29.80	28.80	28.80	29.00
Fat/DM %	**Fresh**	51.25	50.98	50.47	50.16
	1	51.52	51.24	51.05	50.81
	2	51.90	51.58	51.28	51.09
	3	52.13	51.90	51.52	51.38
Total Nitrogen (TN) %	**Fresh**	3.401	3.180	3.188	3.201
	1	3.653	3.442	3.430	3.448
	2	3.817	3.625	3.597	3.605
	3	4.011	3.815	3.786	3.800
TN/DM %	**Fresh**	6.376	6.260	6.188	6.129
	1	6.603	6.485	6.391	6.348
	2	6.762	6.654	6.541	6.485
	3	7.016	6.875	6.773	6.733

A: Liquid calf rennet B: HALA powder rennet C: Formase D: Maxiren

In general, moisture content of all Halloumi cheese clearly decreased as the storage time increased. The remarkable notice was, the rate of moisture decrease which was approximately the same for powder rennets, but lower for the liquid calf rennet being 3.83, 4.69, 4.38 and 4.21% for A, B, C and D treatments, respectively. The obtained results disagreed with those obtained by Blassy (1999), which might be due to the type of cheese has certain effect on moisture content, since results of Blassy (1999) was on Mozzarella cheese. Using different coagulants in making Halloumi cheese had no pronounced effect on the fat and total nitrogen content.

It could also be noticed from the same table (5) that fat/DM and T.N/D.M for all cheese increased as the storage period increased. This might be due to the decrease of moisture content and decomposition of some cheese solids. After 3 months Fat/DM ranged between (51.38-52.13) while respective TN/DM were (6.733-7.016).

It is clear from table (6) that the type of coagulants had a pronounced effect on the protein degradation and ripening indices although all cheese is stored in 15% brine. The highest rate of proteolysis as indicated by SN/TN ratio of 3 months Halloumi cheese was recorded for HALA treatment, followed by Fromase, while the lowest ratio was for calf liquid rennet. However, it is reported that many of rennet substitutes from fungi and bacterial origin had a higher proteolytic activities than that of calf rennet, (De Koning 1978). Quarne *et al.* (1968) reported that the proteolysis as measured by SN level at pH 4.4, is greatest in cheese made with fungal rennet and least in cheese made with bovine pepsin. The relative low proteolytic activity of cheese made by maxiren may be due to purity of chymosin (100%, the brochure of the company). On the other hand, the fresh cheese of all treatments had a lower NPN content, by the end of storage HALA cheese contained the highest value. Also, the NPN, NPN/TN and TVFA took the same trend of SN and SN/TN. The above values increased as the storage time increased and were the highest for the HALA treatment and were the lowest for calf liquid rennet. NPN/TN were 4.164, 5.710, 5.230 and 4.737% for three months old cheese A, B, C and D treatments respectively. Respective values for T.V.F.A were 14.3, 17.3, 16.5 and 15.61 respectively.

In middle east this type of cheese is consumed after melting into bread, however rheological properties provide numerical indices for the quality evaluation of the final products. The rate of coagulant has a marked effect on meltability and oilling off of Halloumi cheese (Table 7). The sort of rennet affected the meltability properties of Halloumi cheese and the increase in meltability with storage time was generally linear (Blassy 1999). As storage period of Halloumi cheese increased meltability and oiling off increased. These results were in agreement with Abdel Kader and El-Zougby (1999). HALA cheese scored the highest meltability value, while calf rennet cheese scored the lowest meltability value.

Table (6): Effect of using different types of coagulant on ripening indices of Halloumi cheese during storage periods (3 months).

Properties	Storage period (months)	Treatments			
		A	B	C	D
SN %	Fresh	0.140	0.178	0.165	0.152
	1	0.236	0.336	0.310	0.258
	2	0.295	0.398	0.384	0.320
	3	0.327	0.443	0.415	0.352
SN/TN %	Fresh	4.116	5.597	5.176	4.749
	1	6.460	9.762	9.038	7.483
	2	7.729	10.979	10.676	8.877
	3	8.153	11.612	10.961	9.263
NPN %	Fresh	0.088	0.107	0.096	0.090
	1	0.123	0.162	0.148	0.131
	2	0.149	0.201	0.185	0.158
	3	0.167	0.256	0.198	0.180
NPN/TN %	Fresh	2.587	3.365	3.011	2.812
	1	3.367	4.707	4.315	3.799
	2	3.904	5.545	5.143	4.383
	3	4.164	5.710	5.230	4.737
TVFA	Fresh	5.0	8.0	7.2	6.7
	1	8.9	12.0	11.3	10.5
	2	12.0	14.6	14.0	13.5
	3	14.3	17.3	16.5	15.6

A: Liquid calf rennet **S.N = Soluble nitrogen**
B: HALA powder rennet **T.N. =Total nitrogen**
C: Formase **N.P.N. = Non-protein nitrogen**
D: Maxiren **T.V.F.A.= total volatile fatty acids (ml NaoH N/50 / 100 gr cheese)**

Table (7):Effect of using different types of coagulant on some rheological properties of Halloumi cheese during storage periods (3 months).

Reheological Properties	Storage period (months)	Treatments			
		A	B	C	D
Metability %	Fresh	10.142	19.150	15.510	12.235
	1	23.256	30.430	26.367	24.890
	2	35.715	42.921	40.035	37.213
	3	37.641	49.870	45.146	42.735
Oiling-off* %	Fresh	50.736	38.795	45.356	48.103
	1	55.110	40.136	48.017	52.045
	2	57.975	43.504	50.846	55.729
	3	72.354	48.978	54.450	69.810

A: Liquid calf rennet B: HALA powder rennet
C: Formase D: Maxiren
*** Area of fat diffusions**

Cheese made by HALA coagulant scored the lowest oiling off, while the highest oiling off value was for cheese made by using calf liquid rennet. The increasing of the meltability values indicates higher quality cheese while the increasing of oiling off indicates lower quality cheese. On the other hand as storage time increased the oiling off of cheese increased. This results with fully agreement with those obtained by Blassy (1999). Abdel-Kader and El-Zoghby (1999) found that a significant increase in the oiling off of Halloumi cheese as storage period increased.

The results in table (8) showed the sensory evaluations of the Halloumi cheese produced from different types of coagulants. Although, the cheese was stored in 15% brine, the scores of organoleptic properties were higher for 3 months old cheese than that for fresh cheese. Similar observations were noticed by Abdel-Kader and El-Zoghby (1999).

Table (8):Effect of using different types of coagulant on some organoleptic properties of Halloumi cheese during storage periods (3 months).

Organoleptic	Score	Storage period (months)	Treatments			
			A	B	C	D
Appearance	15	**Fresh**	12	12	12	12
Body & Texture	35		25	30	28	25
Flavour	50		30	40	36	32
Total	100		67	82	76	69
Appearance	15	**1**	12	12	12	12
Body & Texture	35		26	32	31	28
Flavour	50		32	42	39	38
Total	100		70	86	82	78
Appearance	15	**2**	12	12	12	12
Body & Texture	35		27	34	33	30
Flavour	50		37	45	41	40
Total	100		76	91	86	82
Appearance	15	**3**	11	11	11	11
Body & Texture	35		29	35	32	31
Flavour	50		40	48	45	42
Total	100		80	94	88	84

A: Liquid calf rennet B: HALA powder rennet
C: Formase D: Maxiren

Cheese produced by using HALA rennet scored the highest score for cheese quality, while local liquid rennet treatment gained the lowest score. It seems that the four types of coagulant had no effect on the cheese colour while their effect was on body & texture and flavour. Scores of organoleptic properties were 67, 82, 76 and 69 points over total score of 100 for fresh cheese A, B, C, and D respectively. Respective values for three months old cheese were 80, 94, 88 and 84 for A, B, C, and D treatments respectively.

CONCLUSION.

From the obtained results, the using of HALA powder rennet is suitable for the manufacture of Halloumi cheese since it gave proper rheolical and satisfactory organoleptic properties, if it is not avaliable Fromase, coagulant can be also used. Nasr (1982) studied the effect of five different types of rennet, i.e. Calf, HALA, Habo, Stabo, Rennilase (S) and Rennilase (L) in the manufacture of Edam cheese. He recommended the use of HALA as a rennet substitute for Edam cheese processing.

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مقارنة بين أنواع مختلفة من المنافح لتصنبع الجبن الحلوم

عبد القادر محمود الزغبى و يحيى إبراهيم عبد القادر
معهد بحوث الانتاج الحيوانى، قسم تكنولوجيا الألبان ، الدقى ، القاهرة.

الجبن الحلوم يصنع اساسا من لبن الاغنام باستخدام المنفحة السائلة المستخلصة من معدة العجول الرضيعة وقد اجريت تجارب عديدة على استخدام البان و طرق مختلفة لتطوير هذا النوع من الجبن، و رغم تزايد انواع بدائل المنفحة الحيوانية المطروحة فى الاسواق فلم يستخدم اى نوع منها فى صناعة الجبن الحلوم وخلال هذا البحث تم اختيار اربعة انواع من المنافح المتوفرة فى السوق المحلى و هى:
-1المنفحة الحيوانية السائلة HALA -2 وهى فى صورة بودر و مستخلصة من معدة العجول (75% كيموسين و 25% ببسين).
Formase -3و هى مستخلصة من الفطر *Mucor miehei*
Maxiren-4و هى مستخلصة من الخميرة *Kluyveromyces lactis*عن طريق الهندسة الوراثية و هذه المنفحة 100% كيموسين.
وأجريت الدراسة على استخدام هذة المنافح مع اللبن الخليط الجاموسى و البقرى بنسبة (1:1) و صنع جبن حلوم ثم حفظ الجبن الناتج لكل معاملة على حدة فى محلول ملحى تركيز 15% لمدة ثلاثة اشهر. وأثناء الصناعة تم قياس زمن تمام التجبن وصلابة الخثرة و معدل انفصال الشرش لكل معاملة على حدة و كذلك تم تحليل عينات اللبن و الشرش كيماويا. و تم تحليل الجبن كيماويا خلال مرحلة التسوية يالاضافة الى هذا تم تحليل الجبن ريولوجيا كما تم اختباره حسيا.
وقد بينت النتائج ما يلى:
ان البن المعامل بالمنفحة الحيوانية السائلة تم التجبن فى اقل وقت و كان معدل انفصال الشرش اعلى ما يكون عن المعاملات الاخرى بينما سجلت المعاملة ياستخدام منفحة HALAاطول زمن للتجبن و اقل معدل لانفصال الشرش. أما عن فقد الدهن و البروتين فى الشرش فكان اقل فقد فيهما فى المعاملة المستخدم فيها المنفحة الحيوانية السائلة تلى ذلك استحدام منفحة HALAبينما اعطت المعاملة المستخدم فبها Maxiren اعلى نسبة فقد فى الشرش من الدهن و البروتين.
أما فيما يخص الريع فأن المعاملة المستخدم فيها HALA اعطت اعلى ريع سواء فى الجبن الطازج او المخزن لمدة ثلاثة اشهر بينما كان اقلهم فى الريع تلك المعاملة المستخدم فيها المنفحة الحيوانية السائلة. ولم يظهر تأثير واضح لجميع المعاملات على الدهن والبروتين و الملح و الاختلافات فى النتائج يرجع الى نسبة الرطوبة فى هذا الجبن
بينما كان لنوع المنفحة تأثير واضح على المحتوى الرطوبى حيث كان اعلاها فى نسبة الرطوبة المعاملة المستخدم فيها المنفحة HALA و اقلهم المعاملة المستخدم فيها المنفحة الحيوانية السائلة. أيضا كان لنوع المنفحة تأثير واضح على تحلل البروتين فمثلا فى النسبة بين البروتين الذائب الى البروتين الكلى كان اعلى مايمكن فى المعاملة المستخدم فيها المنفحة HALA و اقلهم المعاملة المستخدم فيها المنفحة السائلة و كان ذلك ايضا بالنسبة الى البروتين الغير نتروجينى و الاحماض الدهنية الطيارة.
هذا النوع من الجبن قيم ايضا على اساس الخواص الريولوجية من حيث القابلية للانصهار و التى كلما زادت دل ذلك على جودة الجبن و كذلك انفصال الدهن أثناء الانصهار و الذى اذا زاد قلت جودة الجبن. و يبين هذا البحث أن استخدام منفحة HALA أعطى اعلى قيمة للقابلية للانصهار و اقل قيمة لاتفصال الدهن أثناء الانصهار و كان اقلهم فى القابلية للانصهار و اعلاهم قيمة فى انفصال الدهن اثناء الانصهار هى المعاملة المستخدم فيها المنفحة الحيوانية السائلة.
كذاك الجبن المستحدم فية منفحة HALA اعطى أفضل خواص حسية سواء للجبن الطازج او المخزن و ينصح فى حالة تصنيع هذا الصنف من الجين استخدام منفحة HALA و اذا كانت غير متوفرة يستخدم الFormase .س