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EFFECT OF SOME LACTIC ACID BACTERIA AND ZINC FORTIFICATION ON MANUFACTURE OF SOFT CHEESE

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ABSTRACT

Soft cheese was made from UF milk (retentate) and treated as follows (I) Rennet (control), (II) Rennet and mesophilic mixed strain culture (*Lactococcus lactic subsp. cremoris, Lactococcus lactis subsp. lactis, Leuconostoc mesenteroides subsp. cremoris* and *Lactococcus lactis subsp. lactis biovar diacetylactis*, (III) Rennet and *Streptococcus salivarius subsp. thermophilus* and *Lactobacillus helveticus*, (IV) Rennet and *S. salivarius subsp. thermophilus, Lactobacillus delbrueckii subsp. bulgaricus* and *L. helveticus* and (V) Rennet and glucono-delta-lactone (GDL). All treatments were fortified with zinc oxide and zinc sulphate at levels of 10 and 20 mg/Kg retentate, sodium chloride (NaCl) was added to all treatments at level of 2%.

The resultant cheeses were stored at 6±2°C for 15 days and analyzed for total solids (T.S), fat, lactose content, titratable acidity, pH value, total nitrogen (T.N), soluble nitrogen (S.N), salt, ripening indices (formol and shilovich), and organoleptic properties.

The obtained results revealed that no obvious differences were observed in the chemical composition of the resultant soft cheese fortified with various sources and levels of zinc either fresh or during storage. However, the differences were more clear in pH, acidity and ripening indices.

Sensory evaluation indicated that zinc sulphate was the most suitable source for zinc supplement with its two ratios. It produced soft cheese having favourite flavour while fortification with zinc oxide produced soft cheese with unacceptable rusty taste.

The addition of lactic acid bacteria with rennet is necessary to improve the organoleptic properties of soft cheese. The results revealed that fortification of soft cheese with zinc sulphate at levels of 10 or 20 mg Zn/Kg and the addition of thermophilic bacteria (*S. salivarius subsp. thermophilus* and *L. helveticus*) can be used to produce good quality soft cheese.

Keywords : soft cheese, retentate, zink fortification ,glucono-delta-lactone(GDL).

INTRODUCTION

Milk or other dairy products are considered as good sources of proteins, fat, carbohydrates as well as vitamins, calcium and phosphorus. However, they are generally poor sources for trace elements (Jayasekarel *et al.*, 1992). Among the various trace elements, e.g. zinc has a very important and effective role in human nutrition and body metabolism. It has structural and regulatory roles in many enzymes, e.g. alkaline phophatase, nucleic acid polymerases and others. It participates in mechanisms of major metabolic pathways and heme synthesis. Also, it is involved in tissue synthesis, gene expression and embryogensis, its deficiency will markedly affect the growth of human body (Fayed and Abou-Zikri, 1997).

Jarrstt (1979) reported that milk is considered to be deficient in zinc, however, it is one of the most essential components to the normal growth. Zinc is a normal constituent of milk and its level in cow's milk 3.017±0.217 ppm (Morsy, 1991).

Ultrafiltration (U.F) is well established now as a profitable method for making soft cheese varieties especially Feta cheese Abdel-Salam, 1987). The importance of U.F-technique is for avoiding whey drainage, saving rennet and increasing cheese yield (Pahkala *et al.*, 1985). In Egypt, application of U.F-technique in the manufacture of several types of cheese had been established (Omar, 1987).

Lactic acid bacteria are industrially important organisms recognized for their fermentative ability as well as their health and nutritional benefits (Speck, 1976 and Gilliand, 1990). They produce various compounds, which are not only desirable for their effects on flavour and texture of dairy products but also inhibits undesirable and pathogenic organisms (Lindgren and Dobrogosz, 1990). Lactic acid bacteria which used as starter, play an important role in the manufacture and ripening of cheese by producing lactic acid aroma compounds associated with proteolysis and lipolysis (Shalaby, 1973).

The production of coagulum in milk with direct acidification or hydrolysis of Glucono-Delta Lactone (GDL) caused a decrease in the time for acid development, and delay the growth of undesirable microorganisms. GDL, dissolved in milk hydrolyses slowly to gluconic acid, forming a suitable curd in the manufacturing of cheese (Bayoumi and Reuter, 1986).

The objective of this study is to manufacture different soft cheeses using some lactic acid bacteria (mesophilic and thermophilic) cultures, which were fortified with different sources of zinc salts (zinc oxide and zinc sulphate) at levels of 10 and 20 mg/Kg and study the effects of these treatments on the chemical and organoleptic properties of resultant soft cheese.

MATERIALS AND METHODS

A) Materials:

Ultrafiltered milk (retentate) was obtained by using concentration factor 4 atoC using a DDS Lab-20 ultrafiltration unit with 2m2 of GR 60 membrane filter using initial inlet pressure of 0.3 Mpa and outlet pressure of 0.1 Mpa. Zinc oxide and zinc sulphate were obtained from chemical Industries Developments (CID) company for drugs. Rennet powder (Halla) was obtained from (Chr. Hansen's Lab. A/S, Copenhagen, Denmark). NaCl was obtained from El-Nasr salt producing company. Glucono-delta-lactone GDL) was obtained from Roquette Freres of lestrem, France.

Starter culture : A ready set mesophilic lactic starter (*Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. lactis, Leuconostoc mesenteroides subsp. cremoris* and *Lactococcus lactis biovar subsp. diacetylactis*) and thermophilic lactic starter (*Streptococcus salivarius subsp. thermophilus, Lactobacillus delbrueckii subsp. bulgaricus* and *Lactobacillus*

helveticus) were obtained from Chr. Hansen's Lab. A/S Copenhagen, Denmark.

B) Experimental procedure :

Retentate (ultrafiltrate milk) was used in preparing soft cheese and five mixtures were carried out as follows :

I- Retentate + rennet (control)

II- Retentate + mesophilic mixed strain culture (*Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. lactis, Leuconostoc mesenteroides subsp. cremoris* and *Lactococcus lactis biovar subsp. diacetylactis*) with rennet

III- Retentate + *Streptococcus salivarius subsp. thermophilus,* and *Lactobacillus helveticus* with rennet

IV- Retentate + *Streptococcus salivarius subsp. thermophilus, Lactobacillus delbrueckii subsp. bulgaricus* and *Lactobacillus helveticus* with rennet

V- Retentate + glucono-delta-lactone (GDL) with rennet

All mixtures were fortified with zinc oxide and zinc sulphate at levels of 10 and 20 mg/Kg retentate, sodium chloride (NaCl) was added to all mixtures at level of 2%.

All mixtures were distributed into 500ml plastic containers which were completely filled, covered and left at (35±2°C) until complete coagulation. All the resultant cheeses were stored in the refrigerator (6±2°C) and analyzed when fresh and after 7 and 15 days of storage for chemical and organoleptic properties.

C) Methods of analyses :

Total solids, acidity, pH, fat, salt, total nitrogen (T.N), soluble nitrogen (S.N) were determined according to Ling (1963). Lactose content was colorimetrically determined as described by Barnett and Abd El-Rawab (1957), and ripening indices by formol and shilovich titration as described by Abdel-Tawab and Hofi (1966). Cheese samples, also, were scored organoleptically for colour & appearance, body & texture and flavour as described by El-Batawy (1992).

RESULTS AND DISCUSSION

Data presented in Tables (1 and 2) illustrate the chemical properties of soft cheese made from different treatments. It is obvious that, the zinc source or its concentration had no effect on the total solid (T.S) and fat content of the resultant cheese. Slight differences were observed in the total solids and fat between fresh and stored soft cheeses in all treatments, this is due to slow decrease in moisture content of cheese during storage at refrigeration. From the same tables it is apparent that no detectable changes occurred in the chemical composition of resltant cheeses due to the fortification with zinc salts and / or during storage except the changes in

Table (1) :Chemical composition of fresh and stored soft cheeses fortified with zinc oxide

Treat-ments	Storage period	10 mg zinc oxide/Kg					20 mg zinc oxide/Kg				
		T.S %	Fat %	Lactose %	T.A %	pH	T.S %	Fat %	Lactose %	T.A %	pH
Control (I)	Fresh	32.18	12.50	4.40	0.20	6.80	32.04	12.5	4.40	0.22	6.80
II		31.93	12.45	3.62	0.32	6.13	31.88	12.45	3.60	0.32	6.14
III		31.94	12.45	3.91	0.87	6.25	31.82	12.50	3.90	0.28	6.26
IV		32.02	12.50	3.90	0.30	6.19	32.11	12.45	3.85	0.30	6.18
V		31.86	12.50	4.30	0.62	5.79	31.72	12.5	4.30	0.63	5.77
Control (I)	1 wk	32.46	12.55	4.30	0.21	6.78	32.86	12.50	4.30	0.22	6.78
II		32.12	12.50	3.33	1.0	5.47	32.54	12.45	3.30	1.20	5.56
III		32.24	12.50	3.31	0.75	5.83	32.40	12.50	3.36	0.80	5.73
IV		32.75	12.60	3.27	0.80	5.80	32.63	12.50	3.26	0.80	5.81
V		32.18	12.50	4.20	0.81	5.89	32.14	12.55	4.19	0.82	5.89
Control (I)	2 wks	33.02	12.55	4.25	0.22	6.68	33.16	12.50	4.10	0.23	6.70
II		32.84	12.55	3.25	1.20	5.47	33.08	12.50	3.16	1.30	5.32
III		33.08	12.60	3.18	0.95	5.49	32.86	12.60	3.24	0.95	5.42
IV		33.11	12.60	3.12	1.10	5.42	33.05	12.60	3.20	1.00	5.36
V		32.76	12.50	4.17	0.85	5.69	32.82	12.55	4.15	0.89	5.58

Table (2) :Chemical composition of fresh and stored soft cheeses fortified with zinc sulphate

Treat-ments	Storage period	10 mg zinc sulphate/Kg					20 mg zinc sulphate/Kg				
		T.S %	Fat %	Lactose %	T.A %	pH	T.S %	Fat %	Lactose %	T.A %	pH
Control (I)	Fresh	31.92	12.45	4.40	0.21	6.82	32.23	12.50	4.38	0.22	6.83
II		31.78	12.50	3.56	0.36	6.11	32.04	12.45	3.52	0.40	6.10
III		31.96	12.50	3.74	0.30	6.27	31.89	12.50	3.70	0.31	6.22
IV		32.14	12.45	3.90	0.32	6.21	32.10	12.45	3.68	0.35	6.18
V		31.85	12.45	4.32	0.70	5.66	32.07	12.50	4.30	0.70	5.62
Control (I)	1 wk	32.42	12.50	4.30	0.22	6.75	32.64	12.50	4.32	0.23	6.79
II		32.30	12.50	3.33	1.20	5.17	32.52	12.50	3.32	1.20	5.47
III		32.67	12.50	3.30	1.10	5.63	32.44	12.55	3.24	1.00	5.67
IV		32.84	12.50	3.30	0.99	5.82	32.63	12.50	3.31	0.95	5.78
V		32.23	12.45	4.20	0.96	5.37	32.30	12.55	4.20	0.99	5.43
Control (I)	2 wks	33.03	12.50	4.20	0.22	6.70	32.98	12.60	4.30	0.25	6.75
II		32.96	12.60	3.10	1.30	5.12	32.81	12.50	3.22	1.30	5.42
III		33.06	12.55	3.15	1.10	5.43	32.93	12.60	3.20	1.10	5.56
IV		33.12	12.60	3.11	1.10	5.52	33.08	12.60	3.25	1.05	5.64
V		32.82	12.50	4.10	1.00	5.26	32.94	12.50	4.20	1.10	5.32

lactose content which might be due to the cultures activity. The addition of starters clearly enhanced the biochemical changes in soft cheese. In treatments (II, III, IV) lactose decrease more rapidly during storage than in control (I) and in cheese made from treatment (V).

Data in Tables (1 and 2) indicated that the acidity of all cheese samples gradually increased with increasing storage period as a result of fermentation of residual lactose and degradation of protein and fat (Hofi *et al.*, 1991). This means that adding lactic acid bacteria promoted the acidity development in soft cheese. The increase in acidity and decrease in pH values of fortified soft cheese with zinc sulphate were slightly higher compared with cheeses fortified with zinc oxide during the storage period. This finding might be due to the activation effect of zinc sulphate on the growth of microorganisms during the storage period (Jarrstt, 1979), while this increase was limited for zinc oxide. The changes in lactose content were paralleled to the changes in acidity but in an opposite trend.

Slight decreases were observed in pH values among all cheese samples during storage. This could be due to lactic acid which formed from the residual lactose fermentation.

Data in Tables (3 and 4) show that the zinc source or its concentration had no effect on the T.N and S.N of the resultant cheese. From the same tables, it could be noticed that the soft cheese made by using starter culture possessed slightly higher content of soluble nitrogen (S.N). Large variations in S.N were observed during storage owing to the differences of proteolysis rate of different starter cultures used.

On the other hand, the S.N content of cheese was found at lowest level in control (I) , followed by treatment (V). Same result was reported by Hofi *et al.*, (1973) they found that the proteinase activity increased in cheese by the added starter and this may be responsible for the increased formation of S.N in cheese. Nassib (1974) reported that the addition of aged *Lactobacillus helveticus* cells to Ras cheese increased protein breakdown and improved the organoleptic properties of cheese .

From the same tables, it could be observed that the T.N slightly increased in all treatments during storage, this is due to the loss of moisture from cheese during storage by whey drainage .

The ripening of soft cheese was measured by two indices, the formol and shilovich. Fortification with zinc sulphate caused an increase in the formol and shilovich indices compared with zinc oxide this increase was higher when adding level was 20 mg/Kg than that of level 10 mg/Kg. Degheidi and Abd Rabou (1998) reported that adding zinc salts during the manufacture of Ras cheese had accelerated the ripening process, and enhanced its flavour. However, the best results were achieved with using zinc sulphate. The changes in these two indices during storage are shown in Tables (3 and 4) the ripening indices increased gradually in all treatments during storage. The addition of starters increased the formol and shilovich values in fresh and stored soft cheeses compared with treatment I (control) .

Table (3) :Changes in total nitrogen (T.N), soluble nitrogen (S.N), formol number, shilovich index and salt during storage of soft cheese fortified with zinc oxide

Treat-ments	Storage period	10 mg zinc oxide/Kg						20 mg zinc oxide/Kg					
		T.N	S.N	S.N/T.N	F.N	S.I	salt	T.N	S.N	S.N/T.N	F.N	S.I	salt
Control (I)	Fresh	1.90	0.134	7.05	17	5	2.10	1.88	0.138	7.34	17	6	1.97
II		1.89	0.140	7.41	30	8	2.03	1.90	0.140	7.37	30	12	1.92
III		1.92	0.142	7.40	26	8	2.03	1.86	0.145	7.80	32	11	1.95
IV		1.87	0.146	7.81	25	8	2.05	1.90	0.148	7.79	25	12	1.95
V		1.90	0.138	7.26	16	5	2.10	1.92	0.135	7.03	17	7	2.00
Control (I)	1 wk	1.96	0.158	8.06	21	15	2.16	1.92	0.160	8.33	22	18	2.00
II		1.92	0.183	9.53	50	20	2.17	1.96	0.180	9.18	56	20	2.03
III		1.94	0.186	9.59	50	28	2.15	1.90	0.180	9.47	50	27	1.99
IV		2.01	0.192	9.55	45	30	2.16	1.95	0.185	9.49	50	36	2.00
V		1.94	0.165	8.51	26	18	2.16	1.95	0.160	8.21	30	23	2.00
Control (I)	2 wks	2.05	0.168	8.20	25	20	2.19	2.04	0.170	8.33	30	24	2.05
II		2.08	0.225	10.82	66	30	2.18	2.10	0.220	10.48	70	30	2.04
III		2.04	0.220	10.78	70	30	2.20	2.10	0.230	10.95	72	32	2.06
IV		2.10	0.230	10.95	60	35	2.18	2.08	0.220	10.58	65	40	2.04
V		2.04	0.182	8.92	35	26	2.19	2.00	0.175	8.75	40	28	2.06

F.N : Formol Number
S.I : Shilovich Index

Table (4) : Changes in total nitrogen (T.N), soluble nitrogen (S.N), formol number, shilovich index and salt during storage of soft cheese fortified with zinc sulphate

Treat-ments	Storage period	10 mg zinc sulphate/Kg						20 mg zinc sulphate/Kg					
		T.N %	S.N %	S.N/T.N %	F.N	S.I	Salt %	T.N %	S.N %	S.N/T.N %	F.N	S.I	Salt %
Control (I)	Fresh	1.92	0.140	7.29	20	5	2.05	1.90	0.135	7.11	22	7	2.06
II		1.86	0.145	7.80	35	11	2.06	1.87	0.143	7.65	35	12	2.06
III		1.94	0.142	7.32	30	11	2.06	1.84	0.148	8.04	31	12	2.05
IV		1.92	0.145	7.55	31	10	2.10	1.94	0.150	7.73	30	13	2.06
V		1.87	0.136	7.27	20	6	2.10	1.85	0.140	7.57	22	9	2.06
Control (I)	1 wk	1.96	0.160	8.16	22	17	2.15	1.94	0.170	8.76	25	20	2.13
II		1.98	0.182	9.19	50	25	2.10	1.96	0.186	9.49	60	30	2.11
III		1.93	0.190	9.85	50	30	2.10	1.90	0.186	9.79	55	30	2.00
IV		2.00	0.190	9.50	50	35	2.15	1.88	0.190	10.11	52	40	2.00
V		1.96	0.170	8.67	30	22	2.15	1.96	0.162	8.27	30	26	2.10
Control (I)	2 wks	2.00	0.168	8.40	25	20	2.17	2.01	0.170	8.46	35	25	2.16
II		2.04	0.230	11.27	70	30	2.18	2.04	0.242	11.86	70	30	2.15
III		2.10	0.230	10.95	72	35	2.17	1.98	0.230	11.62	75	37	2.05
IV		2.05	0.240	11.71	69	40	2.17	2.00	0.235	11.75	75	45	2.05
V		2.01	0.18	8.96	40	25	2.19	1.98	0.180	9.09	43	28	2.15

F.N : Formol Number
S.I : Shilovich Index

The effect of manufacturing soft cheese by different treatments on the salt content of cheese are shown in Tables (3 and 4). These results indicate that no differences could be observed in the salt content of fresh soft cheeses of all treatments. During storage, a slight increase in the salt content of all cheeses was observed, this is due to the loss of some moisture during storage. These results were in agreement with those reported by Gouda (1976) and Fayed (1977).

Tables (5 and 6) show the average scores of colour & appearance, body & texture and flavour of soft cheese from different treatments. Zinc source and its concentration had no effect on color and appearance of resultant soft cheese while, flavour was slightly affected by zinc source as zinc sulphate possessed the highest effect either in the fresh or in the stored cheeses, it had a moderate favourite flavour and acceptable acidic taste. Samples fortified with zinc oxide gained the lowest points because they seemed to have rusty or oxide taste; These results are in agreement with Degheidi and Abd Rabou (1998), they reported that adding zinc sulphate during manufacture of Ras cheeses had enhanced flavour.

Regarding of consistency evaluation, the same tables show that samples fortified with zinc sulphate gained also the highest points for their acceptable compact consistency. However, zinc oxide-fortified samples had a moderate and acceptable consistencies. Total acceptability points indicated that samples fortified with zinc oxide had been refused for their oxide taste while zinc sulphate fortified samples possessed the highest points and the highest acceptability either when fresh or during storage period. These results are in agreement with Degheidi and Abd Rabou (1998).

The use of starter culture in making cheese improved the organoleptic properties. Soft cheeses treatments II, III and IV ranked higher scores in fresh and stored products compared with other treatments. The addition of mesophilic or thermophilic bacteria improved the development of flavour in soft cheese, however, the addition of GDL had no further effect on the flavour development but resulted in softer curd compared with other treatments. It is obvious from these results that cheeses manufacture with *Streptococcus salivarius subsp. thermophilus* and *Lactobacillus helveticus* (treatment III) were ranked the highest total scores followed by cheeses made with mesophilic mixed strain culture (treatment II) followed by cheeses made with *S. salivarius subsp. thermophilus, L. delbruekii subsp. bulgaricus* and *L. helveticus*, (treatment IV), while soft cheese made with GDL (treatment V) gained low total scores

From the foregoing results, it may be concluded that fortification of retentate with zinc sulphate at levels of 10 or 20 mg Zn/Kg is recommended in manufacture of soft cheese and the addition of thermophilic bacteria as *S. salivarius subsp. thermophilus* and *L. helveticus* with rennet improved the resultant cheese ripening and flavour development to produce good quality of soft cheese.

Table (5) :Organoleptic properties of fresh and stored soft cheeses fortified with zinc oxide .

Trea-tments	Storage period	10 mg zinc oxide/Kg				20 mg zinc oxide/Kg			
		Colour & Appearance (15)	Body & Texture (35)	Flavour (50)	Total (100)	Colour & Appearance (15)	Body & Texture (35)	Flavour (50)	Total (100)
Control (I)	Fresh	13.5	33.2	42.0	88.7	13.0	32.0	42.0	87.0
II		14.0	33.2	46.6	93.8	13.5	32.8	44.2	90.5
III		14.0	33.5	47.0	94.5	14.0	33.0	45.0	92.0
IV		14.6	32.0	46.2	92.8	14.0	33.0	44.0	91.0
V		13.0	32.0	44.0	89.0	13.0	31.2	42.4	86.6
Control (I)	1 wk	13.0	34.0	45.2	92.2	13.0	33.0	43.2	89.2
II		14.0	34.0	45.0	93.0	14.0	33.5	45.0	92.5
III		14.5	33.5	45.5	93.5	14.0	33.5	45.2	92.7
IV		14.2	33.8	44.0	92.0	14.0	33.0	44.2	91.2
V		12.0	32.0	42.0	86.0	12.0	32.0	44.0	88.0
Control (I)	2 wks	12.5	32.8	42.2	87.5	12.0	30.6	42.4	85.0
II		13.0	33.0	43.0	89.0	13.0	32.4	42.5	87.9
III		14.0	33.0	44.0	91.0	13.0	32.8	43.0	88.8
IV		13.0	32.0	45.5	90.5	13.0	32.5	43.0	88.5
V		12.0	30.0	42.0	84.0	12.0	30.0	41.2	83.2

Table (6) :Organoleptic properties of fresh and stored soft cheeses fortified with zinc sulphate .

Treat-ments	Storage period	10 mg zinc sulphate/Kg				20 mg zinc sulphate/Kg			
		Colour & Appearance (15)	Body & Texture (35)	Flavour (50)	Total (100)	Colour & Appearance (15)	Body & Texture (35)	Flavour (50)	Total (100)
Control (I)	Fresh	13.0	34.0	42.0	89.0	13.5	33.0	42.5	89.0
II		14.0	34.0	46.0	94.0	13.0	35.0	47.0	95.0
III		14.0	35.0	46.5	95.5	14.0	34.5	47.0	95.5
IV		14.0	34.0	46.0	94.0	14.0	34.6	46.0	94.6
V		13.0	33.0	43.5	89.5	13.0	32.6	44.2	89.8
Control (I)	1 wk	13.5	33.0	44.0	90.5	14.0	33.4	45.0	92.4
II		14.0	33.8	45.4	93.2	14.0	35.0	47.2	96.2
III		14.0	35.0	46.0	95.0	14.0	34.8	47.8	96.6
IV		13.5	34.2	44.0	91.7	13.4	34.0	46.2	93.6
V		13.0	32.0	43.0	88.0	13.2	33.5	45.4	92.1
Control (I)	2 wks	12.0	33.0	44.0	89.0	13.2	32.4	44.2	89.8
II		13.5	32.0	45.5	91.0	12.4	32.8	43.2	88.4
III		14.0	34.2	46.0	94.2	13.8	34.2	45.8	93.8
IV		14.0	34.0	42.4	90.4	13.5	33.4	43.4	90.3
V		12.0	33.0	42.0	87.0	12.2	30.8	43.4	86.4

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تأثير بعض أنواع من بكتيريا حمض اللاكتيك والتدعيم بأملاح الزنك علي صناعة الجبن الطري

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إستخدم مركز اللبن المعامل بالـ Ultrafiltration في صناعة الجبن الطري بطرق مختلفة منها :
١- بالتجبن الإنزيمي فقط (الكونترول)
٢- بالتجبن الحامضي الإنزيمي وذلك بإستخدام سلالات مختلطة من البكتيريا الميزوفيلية مكون من *Lactococcus lactic subsp cremoris, Lactococcus lactis subsp. lactis,* and *Lactococcus lactis Leuconostoc mesenteroides subsp. cremoris* + *subsp. lactis biovar diacetylactis* المنفحة
٣- بالتجبن الحامضي الإنزيمي بإستخدام باديء مكون من *Streptococcus salivarius subsp. thermophilus* and *Lactobacillus helveticus* + المنفحة
٤- بالتجبن الحامضي الإنزيمي بإستخدام باديء مكون من *S. salivarius subsp. thermophilus, Lactobacillus delbrueckii subsp. bulgaricus* and *L. helveticus* + المنفحة
٥- بالتجبن الحامضي الإنزيمي عن طريق التحميض المباشر للبن بإستخدام الـ GDL (جلوكونو – دلتا – لاكتون) + المنفحة.

تم تدعيم جميع الخلطات بإضافة أملاح الزنك في صورة أكسيد زنك وكبريتات زنك بتركيز ١٠، ٢٠ مللجم/كجم وأضيف كلوريد الصوديوم بنسبة ٢% وبعد التصنيع حفظت جميع المعاملات على درجة حرارة الثلاجة لمدة أسبوعين وتم تحليلها لتركيبها الكيماوي وصفاتها الحسية وهي طازجة وخلال التخزين.
أظهرت النتائج أن التدعيم بأملاح الزنك المختلفة وكذلك النسب المختلفة لا يؤثر تأثيراً واضحاً علي التركيب الكيماوي للجبن الطري ولكن الإختلافات ظهرت في محتوي العينات من الحموضة والـ pH ودلائل التسوية وأوضح التقييم الحسي للعينات أن أفضل مصدر للتدعيم بالزنك هو كبريتات الزنك بنسبتيها ١٠ ، ٢٠ مللجم/كجم لأنها تعطي مذاق مقبول بينما رفضت العينات المدعمة بأوكسيد الزنك لظهور المذاق الأوكسيدي بها. كذلك وجد أن إضافة بكتيريا حمض اللاكتيك مع المنفحة في صناعة الجبن الطري يؤدي إلي تحسين في خواص الجبن الناتج سواء الطازج أو المخزن.
وعلي ذلك نوصي بالتدعيم بكبريتات الزنك بنسبة ١٠ أو ٢٠مللجم/كجم وكذلك إضافة باديء مكون من *S. salivarius subsp. thermophilus* and *L. helveticus* + المنفحة إلي اللبن المركز المعد لصناعة الجبن الطري للحصول علي ناتج جيد الصفات.