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Study of the physiochemical and sensory properties of milk protein gel manufactured by adding phosphate salts

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***Abstract*---**The structural and sensory properties of milk gel with added phosphate salt (di and triple) were studied at a concentration of (10.12.5.15.20) mM. Sensory studies showed that the gels were acceptable at a salt concentration of 12.5 mM, which gave the gel better properties. Induced by calcium prepared by heating skim milk by adding 13.5 mm M of calcium chloride at a temperature of 75 m to 95 m of diphosphate salts of phosphate trisulfate. Spontaneous whey exudation decreased, gel strength and water holding capacity increased during storage at 5 ° C for 14 days. Adding sugar and flavours did not affect formation of the gels but increased their sensory scores.

***Keywords*---**physiochemical properties, milk protein gel, phosphate salts.

Introduction

Milk proteins are essential components of the food industry because they contain all the essential amino acids needed for human health along with a wide range of dynamic functional properties, such as the ability to form network structures and stabilize emulsions and foams. Protein represents 3-3.5% of normal cow's milk and 80% of this protein is found in the form of complexes with inorganic salts in the form of spherical particles called casein particles. (Waugh, 1971; Swaisgood,

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1982). Milk proteins have excellent functional properties and nutritional value, and some of them have distinct physiological properties, which are widely used in the food industry (Swaisgood 1986)

The gel composition of the proteins in milk is the basis for the manufacture of dairy products. It can be produced when protein-protein interactions lead to the formation of a three-dimensional network that traps water molecules (Lucey and Singh, 1998). The emulsifying salts are ionic organic compounds consisting of monovalent cations with positive charges and polyvalent anions with negative charges. Emulsifying salts have two main functions in the manufacture of processed cheese, which are pH adjustment and calcium isolation (L. Chen and H. Liu 2012). And it works on dispersing protein and thus helping to dissolve it as well as emulsify fat, but some of them were found not suitable for use in cheese making for several reasons and economic considerations. Where the addition of emulsifying salts is summarized in its ability to dissolve casein and form a homogeneous liquid, as it works to stop the activity of divalent calcium, which leads to the formation of a solid gel (cheese curd) and makes it in an insoluble state - and the ability to dissolve varies according to the type of salt as it increases with the increase in the ability of the salt Upon union with calcium. As in the case of numerous and medium phosphates. The emulsifying salts used include types, including citrate salts, mono, di- and triple phosphates, and polyphosphate salts.

Research goals included

- Study of the effect of adding calcium ions on the physiochemical properties of milk protein gels
- Study of the physiochemical and sensory properties of sweetened calcium milk protein gel during storage at a temperature of 5 ± 1 ° C for 14 days

Materials and Methods

Used materials

- skim milk is recovered by 13%
- Phosphate salts for di and triple, at a concentration of 12.5 mmol
- calcium chloride by 13.5 mmol
- sugar by 5% and flavorings (cocoa by 1% _ banana and orange by 0.5%)

The sweetened and flavored milk gel was made after recovering the milk. Sorting into a solids ratio of 13% with a weight of 130 grams of it and completing the volume with water to 1 liter. The prepared quantity was divided into parts and a concentration of phosphate salts was added to it at a concentration of 12.5 mmoler because it was the lowest concentration of phosphate, which gave acceptable properties to the gel at a temperature of 75 m for salts of diphosphate salts and 95 The triple salts of phosphate and these concentrations and temperature were selected based on a previous study, with a concentration of 13.5 mmol of calcium chloride with the addition of sugar (5%) and cocoa flavor or banana or orange flavor (according to the instructions of the processing companies) to milk (Ali and Al-Saadi 2020). The physiochemical and sensory examinations of the gel samples were performed after 1 and 7 days of storage at (5) ± 1ْm

Physiochemical tests

Hardness determination. The stiffness was estimated using a Brookfield tissue analyzer using a synthetic plastic cylinder (15 mm in diameter) inserted into each product at a depth of 15 mm with 5.0 g pressure and a velocity of 1 mm / s (Bonczar et al., 2002)

Viscosity determination

Viscosity was estimated by a Brookfield DVII viscometer, where the samples were measured using a No. 4 spindle and the viscometer was adjusted at continuous rotations of 10 revolutions per minute for a period of 60 seconds. All measurements were taken on the basis of samples weighing 100 ml and the spindle was left to rotate inside the sample after The gel was broken by moving it 10 times clockwise and 10 times counterclockwise, and the results were taken with the Centipoise unit

Spontaneous whey separation

Auto Spontaneous whey separation was determined according to it (Sherkat et al. 2006) Where a container containing 100 ml samples of milk gel was placed at a 45 angle for 10 minutes in an oblique fashion. A needle connected to the syringe was used to withdraw the liquid hookah from the surface of the sample, then the sample was re-weighed again. The process took 10 seconds to avoid the whey separation

Water holding capacity

The water retention capacity was determined as described by (Harte .et al. 2003) by exposing 10 g of the sample milk protein gel to the strength of the centrifugation at a speed of 5000 g for a period of 10 minutes at a temperature of 10 C after which the filtrate was removed and the remaining substance was carefully weighed to determine the amount of excluded water and the water retention capacity was estimated. WHC) using the following formula
WHC% = [1- (w2 / w1)] x 100
[w1: the weight of the used gel w2: weight of the pulverizer after the central splice]

Sensory evaluation

The sensory properties test was conducted by 8 members of the faculty at the College of Food Sciences - Al-Qasim Al-Akhdar University to assess the extent of the sensory acceptance of the gel sample in terms of flavor, texture, appearance, and color and according to the sensory evaluation form developed by (Clark ,et.al2009)

Results and Discussion

The physiochemical properties (Spontaneous whey separation, stiffness, viscosity, and water holding capacity) of milk gel were studied after adding phosphate salts and for four treatments (T1) representing addition of bisphosphate salts before heat treatment, and T2) representing addition of bisphosphate salts after Thermal treatment, and (T3) represents the addition of triple phosphate salts before heat treatment, and (T4), which represents the addition of triple phosphate salts after heat treatment

The effect of calcium ions on milk gel formation

The functional properties of the produced gel were studied by using a concentration of 12.5 mmol and a temperature of 75 ° C for the diphosphate salts and 95 ° C for the triple phosphate salts for a period of 20 minutes after adding 13.5 mmM of calcium to it (Siamand et al. 2014 .(It is noted from the obtained results that the added calcium chloride concentration has a great effect on the production of milk gel and improving the properties and physiochemical properties of the milk protein gel (Spontaneous whey separation- hardness - viscosity - Water holding capacity). From Table (1) we note that the addition of calcium with diphosphate salts before the heat treatment at 75 ° C improved the properties of the resulting gel, as the values of spontaneous whey, hardness, viscosity and Water holding capacity of the resulting gel before the heat treatment reached 1.8 ml, 84 g, 1830 Centipoys and 79%, respectively, while the values of these properties of the resulting gel by addition of diphosphate salts after heat treatment were 1.6 ml, 35.3 g, 380 cP and 69%, respectively

the improvement in the properties of the gel when adding the two salts of phosphate and calcium together before the heat treatment of the milk can be due to the interplay between these two salts to form calcium phosphate, which is associated with caseins to form the gel (Al-Saadi and Deeth, 2011) as for the decrease in the physiochemical properties of the gel produced by adding di phosphates after the heat treatment, it may be due to the addition of calcium before the heat treatment, which led to its direct association with caseins and the loss of its ability to bind phosphates with caseins, which leads to a weakening of the resulting gel (Thomar et al., 2017). As for adding calcium with phosphate triphosphate salts before the heat treatment at 95 ° C, the values of spontaneous whey perfusion, hardness, viscosity, and water holding capacity of the gel produced before the heat treatment were 0.8 ml, 23.3 g, 230 cP and 75%, respectively, while the values of these properties were For the resulting gel by adding the triple phosphate salts after heat treatment 0.5 ml, 34.4 g, 920 cP and 72%, respectively. And based on the results of this experiment, T1 and T3 parameters were selected to manufacture the localized and flavored gel

Production of sweetened and flavored milk protein gel

The functional properties of milk protein gel were studied by adding di and triple phosphate salts at a concentration (12.5 mmoler) and calcium ions at a concentration (13.5 mmoler) and sweetened with sugar 5% and mixed with the addition of cocoa extract at a rate of (1%), or orange and banana extract at a percentage (0.5%). Observation of changes in the functional properties of milk protein gels during the storage period. Table (2) shows the Spontaneous whey separation of milk proteins with the addition of phosphate and calcium salts, as A represented the treatments added to the bisphosphate salts, and B represented the treatments added to the trisulfate salts. The results shown in Table (2) show that the spontaneous whey separation of the for the treatments A and B after the first day of manufacture and storage at a temperature of ± 5 ° C for cocoa jelly, banana and orange A was (4.2, 2 and 5) ml , B was (2.6, 8 and 2.2) ml respectively After 14 days of storage at ± 5 ° C, the values were treated as (5, 3.6 and 5) ml , B was (3.6,1.2 and 8) ml

The difference in the susceptibility of spontaneous whey separation between different treatments is due to the effect of sugar and different flavors on the cross-linkages forming the gel network, and therefore the water holding capacity ability (Ali and Al-Saadi, 2020). As for the hardness values of milk protein gel treatments after the first day of manufacture and storage at ± 5 ° C, A cocoa was 66.4 g, banana 47 g, orange 48.1 g, B cocoa (26.9) g, Banana (31.2) g and orange (25.6) g. In succession, after 14 days of storage, the hardness values of treatment A increased, so cocoa was 76.4 g, bananas 61.6 grams and oranges (73.5) g, respectively. As for treatment B, we notice a variation in the hardness values as it increased in the treatment of cocoa (28.2 g) and oranges (30.9 g And it decreased in bananas to (30.9) g

In general, the stiffness of the gel made with the diphosphate salts was higher than that of the gel made with the trisulfate salts. The increase in the hardness values during storage is due to the increase in the groupings per unit volume, the exit of the fluid from the gel network, the increase in the number and strength of the connections, and the accumulation of proteins within the three-dimensional network of the milk protein jelly, thus resulting in the production of a more homogeneous and solid gel (Siamand et al., 2014). The results in Table (2) show the viscosity values in centipoise for the transactions, and it was on the first day of manufacturing and storage at ± 5 m, as the A treatment of cocoa gel was 1500 ci, banana 1200 cp, oranges 420 cp, and B was for cocoa gel430 cp and banana gel 690 cpand banana ge lOranges are 310 cp, but after 14 days of storage at a temperature of 5 ± 1 ° C, we notice a variation in the viscosity values, as the values decreased for treatment A, so the values were for cocoa 1470 cp, for bananas 880 cp, and for oranges were 420 cp, and they increased for treatment B, so the viscosity values increased to 490 cp gel, 750 cp Banana gel, 750 cp Cocoa gel

The above results indicated that there are statistically significant differences (P <0.05) between the viscosity values of the parameters and that the increase in the values of the viscosity of the resulting gel with an increase in the storage period is due to the increase in the number of connections and random interactions between salts and proteins between the molecules of the gel network and the increase in the percentage of solids and the increase in accumulation and aggregation. Proteins, resulting in a more viscous, homogeneous and stable gel (Ali and Al-Saadi, 2020). The water holdin capacity of the resulting gels varied (Table 2), as it reached to treatment A after the first day of manufacture and storage at a temperature of 5 ± 1 ° C for milk protein jelly mixed with cocoa 73%, banana 72%, oranges 68%, and treatment B cocoa 67%, banana 68% and orange 72%

After storage for 14 days, the water holding capacity was in contrast to treatment A, so it decreased for cocoa gel (70%), and for banana gel (73%) and for orange gel (73%), and for treatment B, we noticed a gradual increase in the values, so cocoa gel was 71% and banana 77% And oranges are 77% .The increase in the ability to water holding during storage is due to the increase in the number and strength of the bonds between ions and proteins, and the increase in the percentage of solids in the case of adding cocoa extract, and thus the gel network becomes more stable and the bonds become more dense with the decrease in the size of the pores and the space is smaller between the molecules of the gel network, which leads to an increase The ability to water hold for milk protein gel(Simmons et al. 2002)

Table 1
The effect of adding calcium chloride (13.5 mmole) on the physiochemical properties of milk protein gels produced by using di and triple phosphate salts after storage for one day at 5 ± 1 ° C

Temperature C	Sample	SWS	Hardness	Visocity	WHC
75	T1	1.8	84	1830	79
	T2	1.6	35.3	380	69
95	T3	0.8	23.3	230	75
	T4	0.5	34.4	920	75
L.S.D. value		0.473 *	6.522 *	76.492 *	5.977 *

Table 2
The effect of adding di and triphosphate salts, calcium and flavorings on the properties Physiochemical of sweetened milk protein gel after 1 and 14 days of storage at 5 ± 1 ° C

Sample	Storage period (day)	SWS	Hardness	Vicosity	WHC
COCO A 1%	1	4.2	66.4	1500	73
	14	5	76.4	1470	70
B	1	2.6	26.9	430	67
	14	3.6	28.2	490	71
Banan 0.5 %A	1	2	47	1200	72
	14	3.6	61.6	880	73
0.5% B	1	8	31.2	690	68
	14	1.2	30.9	750	77
Orange 0.5 %A	1	5	49.1	420	68
	14	5	73.5	420	73
B 0.5%	1	2.2	25.6	310	72
	14	8	30.9	750	77
L.S.D		* 1.063	* 7.255	* 75.912	* 5.841

Conclusion

The best concentration of di and triple phosphate salts to yield milk gel was 12.5 mM which gave acceptable properties to the gel. The best temperature for producing milk jelly was 75 ° C for the diphosphate salts and 95 ° C for the triple phosphate salts using 13.5 mmM of calcium chloride. Adding sugar and flavorings to the milk did not affect the formation of the milk gel and it led to an increase in the of sensory scores of the gel. High sensory scores indicate that these gels may be an attractive new product For the dairy industry

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