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Article

Production and characterization of flavored goat milk gels using zinc and calcium salts Producing functional foods

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ABSTRACT

Goat milk gels were prepared using calcium and zinc salts. The viscosity of gel prepared by adding zinc chloride and flavored with banana and orange was higher than that of gel prepared using calcium chloride. WHC of gels prepared using zinc chloride and calcium chloride was high on the first day and then gradually decreased during storage time at 7 °C. The hardness of the sweetened, flavored goat milk gel prepared with calcium chloride was lower than that of the gel prepared with zinc chloride. The Sensory evaluation study showed that, in general, flavoring gels prepared from goat milk using zinc and calcium salts had a high degree of acceptability.

Keywords: flavored gel; Zinc chloride; Goat milk; Rheological properties

INTRODUCTION

Goat's milk is similar to cow's milk in its elemental composition 1. Goat milk contains 12.2% total solids, consisting of 3.8% fat, 3.5% protein, 4.1% lactose, and 0.8% ash. It has more fat, protein, ash, and less lactose than cow's milk 2. Goat milk contains less total casein but higher non-protein nitrogen than cow's milk 3. Goat milk has less αs-CN fraction and more κ-CN and β-CN fractions than cow milk 4. Milk protein gel formation is an essential and fundamental process in the dairy industry. This phenomenon occurs when protein-protein interactions form a three-dimensional network capable of trapping water molecules. Several types of protein gels are produced from milk and its components. The formation of acid gels is the most important because of its role in the formation of yogurt and similar products 5. Whey proteins form a gel substance due to exposure to a temperature higher than 70°C 6. While gels containing both whey proteins and casein can form during high-temperature storage of UHT milk 7. Heating milk after adding calcium chloride at concentrations ranging from 7 to 20 mM results in a gel similar to yogurt's but with a pH close to natural milk's pH of 8. Despite extensive studies on the effect of added calcium salts on casein particles, pure caseins, or pure whey protein systems, information about the effect of heat treatments on the interactions of added calcium with casein and whey proteins present in milk is limited. The effects of calcium ion activity, pH, temperature, and ionic strength on the physicochemical and rheological properties of the gel produced by adding calcium to skim milk were previously reported 9,10,11. The rheological properties of this type of gel were also indicated by some researchers 11. This study aimed to prepare flavor gels from goat milk using calcium and zinc salts and identify their textural and sensory properties.

MATERIALS AND METHODS

Milk samples

Samples of mixed local goat milk were collected from several farms in Al-Hilla-Babil - Iraq, and fat was separated from milk using a milk separator to obtain skim milk.

Preparation of goat milk gels using calcium and zinc salts

Several preliminary experiments were established to determine the best conditions to form goat milk protein gel. Skimmed goat milk samples (100 ml) were heated at 85 °C for 20 minutes, sugar (7.5%) and flavoring materials (banana, orange, and cocoa flavors used according to manufacturing companies (made in China) were added to milk samples, mixed, and cooled to 22 °sC. Calcium chloride and zinc chloride (13.5 mM) were added separately within the normal pH of milk. After that, the milk samples were heated to 85°C for 20 minutes and left without stirring to produce a gel. Gels were stored at 7 °C for 28 days.

Gel hardness

Textural properties were evaluated using a texture analyzer (CT3(4500), Brookfield engineering lab). The hardness of the samples was measured. The operation conditions were an artificial plastic cylinder (20 mm in diameter) inserted into each product to a depth
of 20 mm with a 10.0 g trigger and speed of 1 mm/s [12].

Water Holding Capacity (WHC)

Water-holding capacity (WHC) of sweetened flavored gel samples was determined as described by [13]. Briefly, 10 g of gel sample was centrifuged at 5000xg for 10 min at 5oC. The resulting supernatant was carefully weighted to determine the amount of excluded water, WHC % = [1-(w2 / w1)] ×100

WHC% = [1-(w2 / w1)] ×100

whereas:

W1: Weight of the gel used

W2: Whole weight after centrifugation

Spontaneous Whey separation (SWS)

Spontaneous whey separation was determined according to the procedure described by [14]. A cup of flavored gel was removed from the refrigerator and placed at a 45º angle. A needle connected to a syringe was used to withdraw the liquid whey from the sample's surface, and the whey's volume was measured. The process lasted for less than 10s to avoid further leakage of whey from the gel. The spontaneous whey separation was expressed as the percentage volume of whey over the initial weight of the gel sample.

Viscosity

The gel was broken by stirring with a glass rod (10 times clockwise; 10 times anticlockwise). Rotational viscosity measurements were done utilizing a Brookfield viscometer (model DV- E; Brookfield Engineering laboratories) utilizing spindle No 3. Separately, measurement was caused at room temperature at 50 rpm for 1 minute, as described by [15].

Sensory evaluation

Eight panelists did a sensory evaluation among the College of Food Science/ Al-Qasim Green University staff for flavored goat milk gels to estimate the acceptability of gel samples. Gel specimens were assessed for flavor, body, texture, bitterness, and appearance/color on a 100-point scale according to the ensuing: flavor 40, body 15, texture 15, bitterness 20, and appearance/color 10. Mid scores from the eight panelists were documented[16].

RESULTS

Viscosity of flavored goat milk gels

Figure (1) shows the storage effect on the viscosity of flavored goat milk protein gel. The viscosity of gel prepared by adding zinc chloride and flavored with banana, orange, and cocoa were 2110, 1395, and 1154 cp, respectively, while the viscosity for gel prepared using calcium chloride were 303, 296, and 301 cp, respectively, at day 1 of storage. The viscosity values gradually changed after 28 days of storage at 7 °C, and they were 1630, 1882, and 786 cp for gel prepared with zinc chloride and 223, 190, and 200 cp for gel prepared with calcium chloride, respectively.

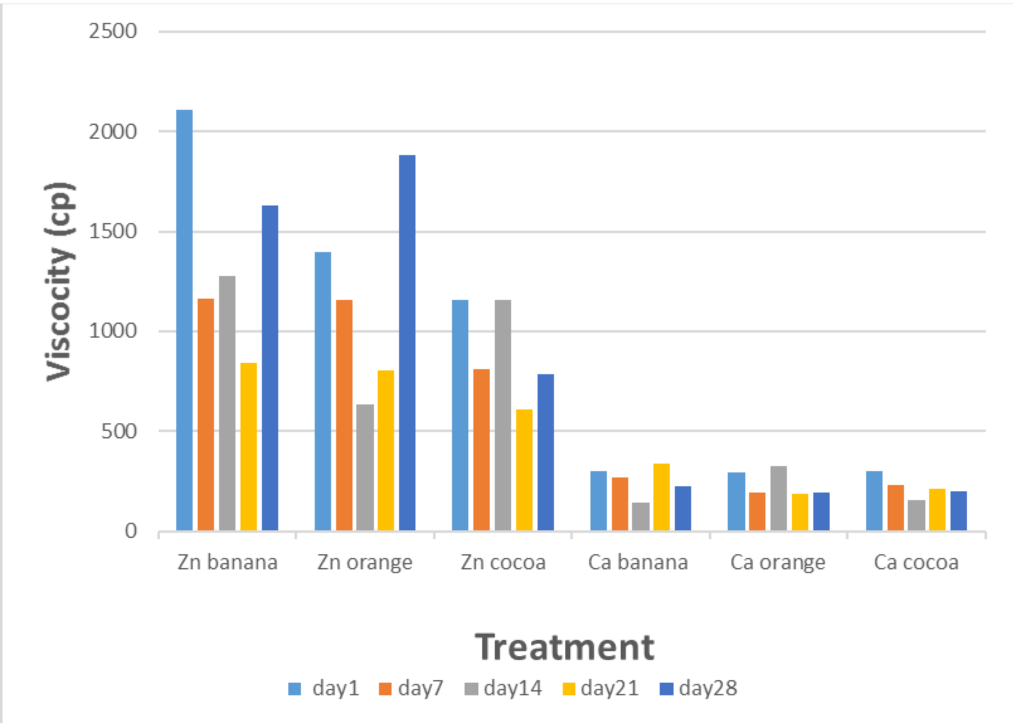

Figure 1. Changes in viscosity of flavored goat milk gel prepared using 13.5 mM of zinc and calcium chloride during storage at 7 °C for 28 days.

Water holding capacity of flavored goat milk gels

Water holding capacity is the ability of the gel to hold water within its structure. Figure (2) shows that the WHC of gels prepared using zinc chloride and calcium chloride was high on the first day and then gradually decreased during the progress of storage time at 7 °C. WHC on the first day for goat milk gels prepared using zinc chloride and flavored with banana, orange, and cocoa flavors were 31, 29, and 28%, respectively, while WHC for gels prepared with calcium chloride was 25, 28, and 29 % respectively. These values gradually decreased to 16, 19.5, 21.4%, 21.4, 22.1, and 24.6%, respectively, after 28 days of storage at 7 °C.

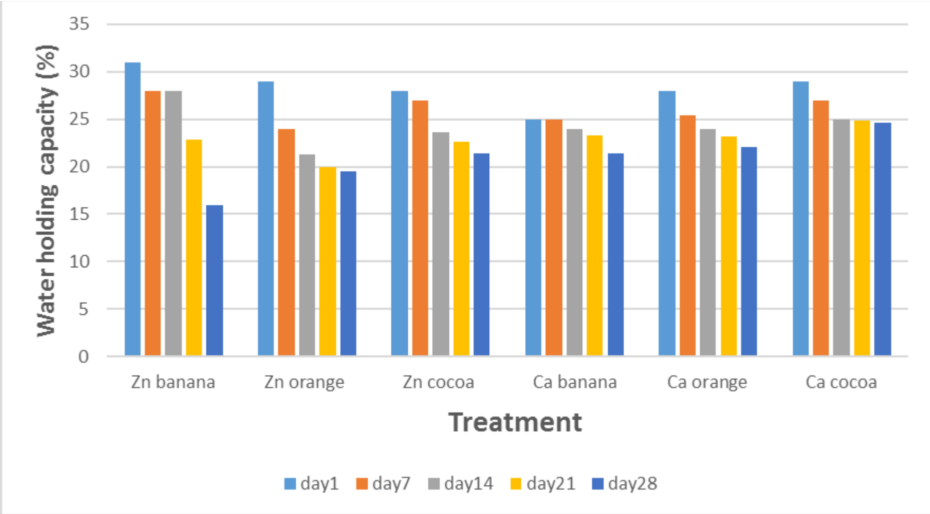

Figure 2:.Changes in water holding capacity of flavored goat milk gel prepared using 13.5 mM of zinc and calcium chloride during storage at 7 °C for 28 days.

Spontaneous whey separation of flavored goat milk gels.

Spontaneous whey separation means liquid exudation at the top of the gel, which is one of the common defects of yogurt and sweetened gel. Figure (3) showed that SWS in goat milk gels prepared with zinc chloride and flavored with banana, orange, and cocoa were 0.9, 1, and 1.1 % in the first-day storage, while these values in the gel prepared with calcium chloride were 0.5, 0.2, and 0 %, respectively. These values changed after 28 days of storage to reach 1.4, 1.2, and 0.2 % for the gel prepared with zinc chloride and 1.5, 1, and 1.2 % for the gel prepared with calcium chloride, respectively.

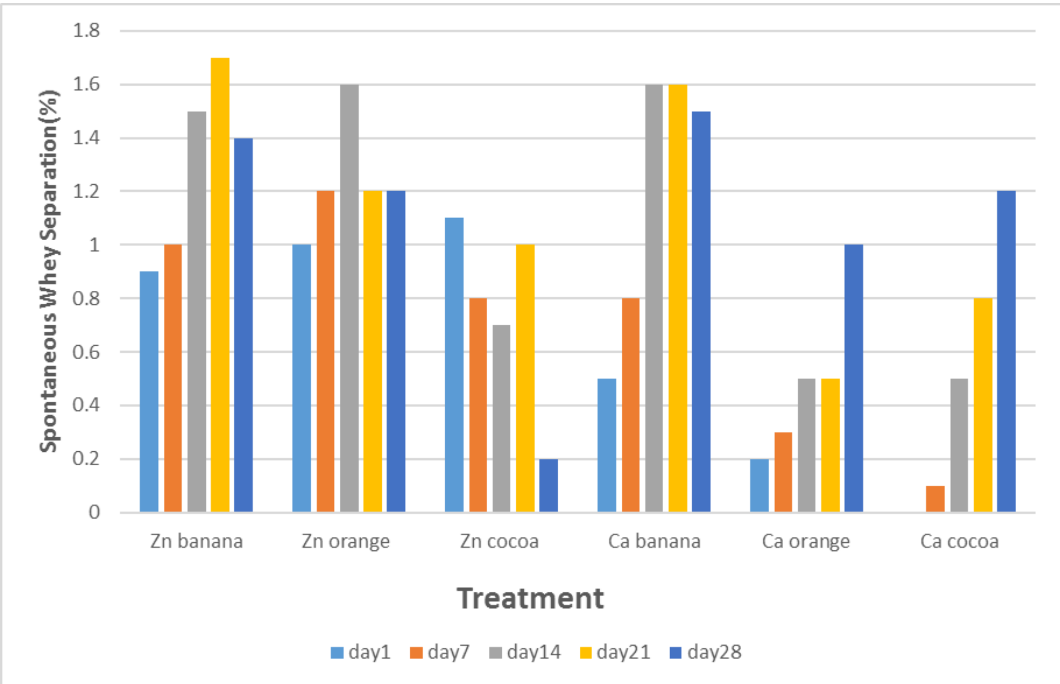

Figure 3. Changes in spontaneous whey separation of flavored goat milk gel prepared using 13.5 mM of zinc and calcium chloride during storage at 7 °C for 28 days.

Hardness of flavored goat milk gels

Hardness is the force needed to induce deformation in a gel, and it is a standard measure to indicate the strength of the gel network being analyzed. Figure No. (4) showed that the hardness of the sweetened flavored goat milk gel prepared with calcium chloride was lower than the hardness of the gel prepared with zinc chloride, where the hardness values for calcium gels flavored with banana, orange, and cocoa were 64.3, 57.9, 47.6 g, while the hardness in zinc gels where 207.3, 178.6, 158.4 g, respectively in the 1 day of storage, and these worth's altered after warehouse for 28 days at 7 ° C to 63.7, 54.4, 30 g for calcium gel and 237.2, 209.4, 147.3 g for zinc gels, respectively. The difference in the hardness of the gel prepared using different ions is due to the different ability of these minerals to interfere with milk proteins and the difference in their binding sites with proteins, which causes a difference in the three-dimensional structure of the gel network 17.

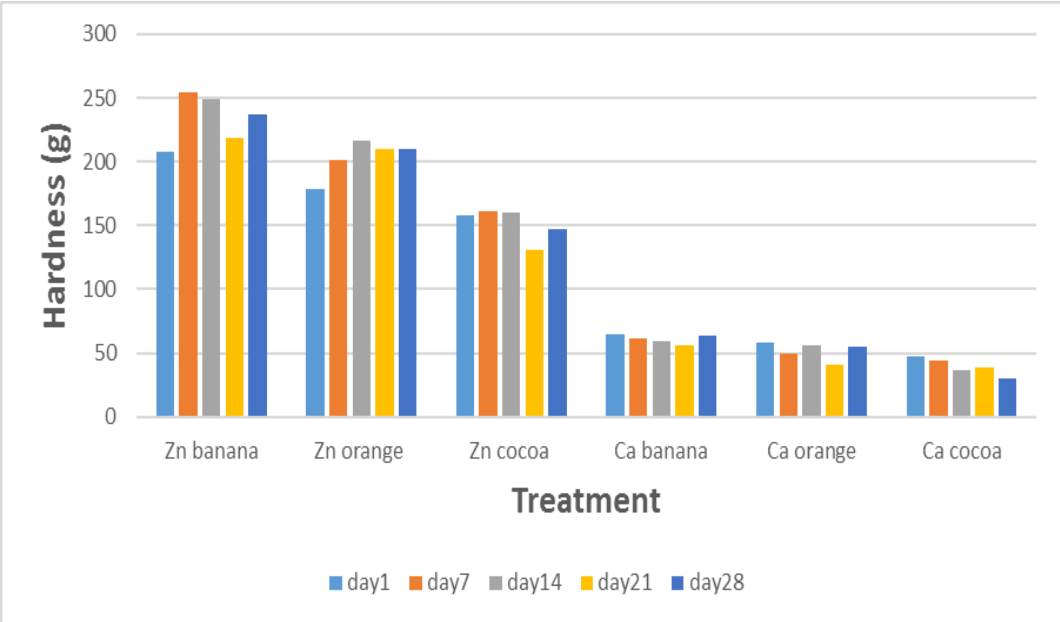

Figure 4. Changes in flavored goat milk gel hardness were prepared using 13.5 mM of zinc and calcium chloride during storage at 7 °C for 28 days.

Sensory evaluation of flavored goat milk gels

In general, flavoring gels prepared from goat milk using zinc and calcium salts were highly accepted (Figure 5). The total sensory evaluation scores for the goat milk proteins gel prepared with zinc chloride and flavored with banana, orange and cocoa on the first day were 90.6, 88.1, and 92.75, while the scores for gel prepared with calcium chloride were 86, 85.75, 89.25, respectively. These values changed during storage to reach after 28 days to 94.25, 89.5, and 94.75 for gel prepared with zinc chloride and 94.25, 90.25, and 90 for gel prepared with calcium chloride. The gels produced in this study were distinguished by their delicate texture and acceptable hardness.

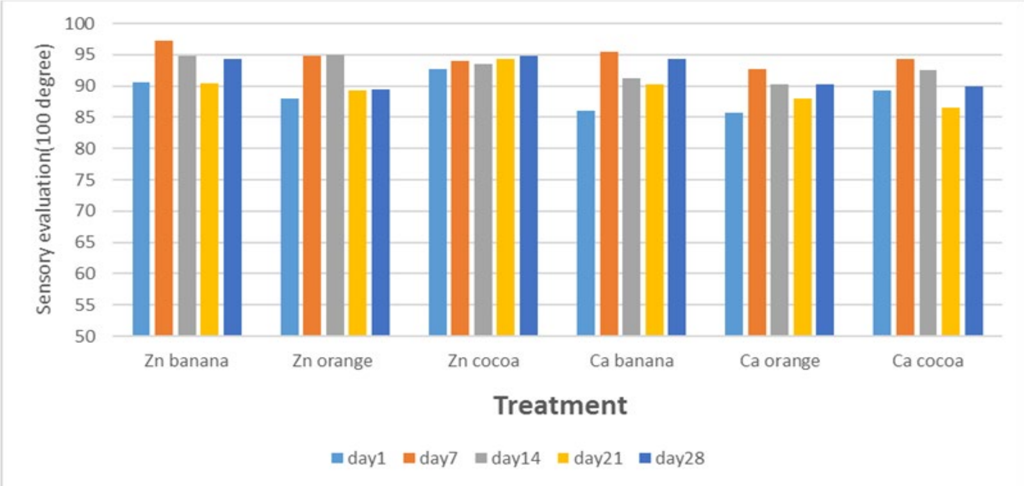

Figure 5. Sensory evaluation score of flavored goat milk gel crafted utilizing 13.5 mM of zinc and calcium chloride during storage at 7 °C for 28 days.

DISCUSSION

In general, the viscosity values for the sweetened flavored gel prepared with zinc chloride were higher than the gel prepared with calcium chloride, and this was due to the extensive loss of water from the gel prepared by adding zinc chloride. Besides, the change in viscosity values is due to the change in the properties of the sweetened gel during storage resulting from increasing interactions between milk proteins and salts. These results are consistent with what was indicated by [17,18], who indicated that the hardness of the cow milk gel increased during the storage period, accompanied by an increase in viscosity. Concerning WHC values gradually decreased respectively after 28 days of storage at 7°C, and this is due to the increase in the interaction between salts, caseins, and whey proteins, which causes caseins to lose their net charges and increase their hydrophobicity, which leads to a decrease the ability of the gel to hold water. These results are consistent with the results found by [5,18], and overall, we notice an increase in SWS during the storage period. It has an inverse relationship with the water retention capacity of the protein network[21], and this can be due to the increase in the bonds between proteins and minerals in the gel network, which increases its hydrophobicity and allows the exudation of whey [18]. as well as the difference in the hardness of the gel prepared using different ions is due to the different ability of these minerals to interfere with milk proteins, as well as the difference in their binding sites with proteins, which causes a difference in the three-dimensional structure of the gel network [18]. The differences between the hardness of milk protein gel produced with different flavors during the storage period are related to the reactions between these flavors and milk proteins and ionic salts that affect the interaction between milk proteins, which affects the hardness6. This may be due to the addition of sugar during the preparation of the gel, which causes a reduction in the interactions between milk proteins [19]. Panelists did not notice any undesirable taste in the resulting gels, and although the gels were crafted from skim goat milk, multiple panelists related them to be creamy. Hence, it may be achievable to utilize this technique to make quiet-fat dairy outputs with identical textures to those with more increased fat content.

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CONCLUSIONS

the study investigated the effects of different salts on the properties of sweetened goat milk gels. The results showed that the viscosity of the gels was higher when zinc chloride was used instead of calcium chloride. This was due to the more extensive water loss from the gels prepared with zinc chloride. The WHC of the gels gradually decreased over time, and the SWS increased. This was due to the increase in the interactions between the salts, caseins, and whey proteins, which caused the caseins to lose their net charges and increase hydrophobicity. The panelists did not notice any undesirable taste in the resulting gels and found them creamy. Therefore, this technique could produce low-fat dairy products with the same texture as those with higher fat content.

Goat milk protein gels were constructed from skim milk utilizing heat therapy and 13.5 mM calcium chloride and zinc chloride. Flavoring gels prepared from goat milk using zinc and calcium salts were highly accepted.

Author Contributions: Qausar ALKaisy and Jasim Al-Saadi: Methodology, Resources, Writing-Original Draft. Ali Alrikabi: Conceptualization Writing-Review & Editing.Jasim Al-Saadi: Writing-Review & Editing. All authors have reviewed the final manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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