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Effect of selected dried dairy ingredients on the nutritional and sensory properties of non-fat yogurt

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Abstract: Nutritional and sensory factors influence food acceptance and choice. Improvement in sensory and nutritional properties of non-fat yogurt made from sodium caseinate and calcium caseinate were investigated over a period of 21 days of storage. The sensory evaluation of flavor and body texture was carried out by the panel of five judges. Various chemical parameters of the prepared yogurt samples such as protein, lactose, total solids, pH and acidity were carried out. Results of non-fat yogurt samples made from non-fat milk Olwell with 0.5% calcium caseinate showed minimum synersis and maximum flavor. Also non-fat yogurt samples made from non-fat milk Nesvita of Nestle and Olwell of Olpers with both dried dairy ingredients i.e., 0.5% calcium caseinate + 0.5% sodium caseinate showed maximum body texture and better nutritional properties.

Keywords: Sodium caseinate, calcium caseinate, culture, non-fat yogurt, nutritional properties, sensory properties.
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INTRODUCTION

Fermented milk products are popular in most parts of the world and are subjected to many modifications through the history. There exist many distinct forms of fermented milk products, yogurt being one of the most popular fermented milk products[1].

Yogurt is a very popular fermented milk product produced by lactic acid fermentation of milk by addition of a starter culture containing *Streptococcus salivarius* species *thermophilus* and *Lactobacillus delbrueckii* species *bulgaricus*[2,3]. In Pakistan yogurt is known as "Dahi." It is the most frequently consumed milk product in Pakistan and is used throughout the year either alone or with rice and bread. Yogurt is a semi fluid fermented milk food having a smooth texture and mildly sour flavor because of its lactic acid content. Yogurt may be made from the milk of cows, sheep, goats, or buffalo[4].

It is a very versatile product that suits all meal occasions. Yogurt has many forms including drinkable (liquid) or solid, low fat or fat free, fruity or cereal flavored, healthy and nutritious food[2,3]. Yogurt is the most frequently consumed dairy product in Turkey. Turkish people mostly prefer to consume, as a meal, plain yogurt with no additional flavoring ingredients[5].

Low-fat and fat-free yogurts have gained popularity because of the increasing demands of consumers who seek healthy options across product categories. Production of low-fat and non-fat yogurt demands a careful control of texture and flavor attributes[6]. One of the most important steps in the production of low-fat and a fat-free yogurt is to increase total solids content in order to prevent specific textural defects such as poor gel firmness and surface whey separation[7]. It is common to use skim milk powder to fortify yogurt milk, but other dried dairy ingredients such as calcium caseinate, sodium caseinate, whey protein concentrate or isolate, and other milk protein-based ingredients have gained acceptance as a viable way to increase total solids in fat-free or low-fat yogurts.[2] Dried dairy ingredients can be converted into two groups, *casein based* (skim milk powder, sodium caseinate and calcium caseinate) or *whey protein based* (whey protein isolate and whey protein concentrate) ingredients. The fortification with casein based ingredients tended to increase firmness and reduce synersis in set yogurt and increase viscosity in stirred yogurt[8].

Caseinates are used as sources of protein for nutrition. Sodium caseinate is a modified protein extracted from pure farm milk. Sodium caseinate is an animal protein. As such, sodium caseinate contains the essential eight amino acids considered to be the daily standard requirements for living. Today, there is broad interest in high quality food proteins. Utilizing sodium caseinate supplements a higher nutritional value in processed food products.[9] Caseins are used as food colors, where they make a nice opaque white color, which can then be tinted with other colors as required[9].

Sodium caseinate is a valuable food ingredient with its high protein content and functional properties of emulsification, water binding, and texture improvement. These functional attributes make this ingredient ideally suited for use in coffee whiteners, baked goods, whipped toppings, infant formulas, and cheese analogs[10]. Many of the nutrients and bioactive compounds in milk are wasted with whey during cheese making. They are being used in the form of whey powder, demineralized whey, whey protein concentrate or isolate[2]. Whey proteins concentrate or isolate, and sodium caseinate improve nutritional values and biological effects of yogurt on health. These additional properties may affect consumer acceptability and preference[11,12].

Guzman, Morais, and Amigo[8] studied some physical properties of set-style, low-fat yogurts fortified with different dried dairy ingredients such as caseinates, co-precipitate (contains all protein fractions of milk), and blended dairy powders up to 4.3% protein content. According to their results, yogurt enriched with caseinates had higher viscosity and syneresis index than the others. The present experimental research is conducted to find out the effect of dried dairy ingredients i.e. sodium caseinate and calcium caseinate on the nutritional and sensory properties of non-fat yogurt. The addition of sodium caseinate and calcium caseinate can improve the flavor and body texture of non-fat yogurt. Their addition can also prevent the formation of water whey liquid i.e. synersis and enhances the nutritive value of non-fat yogurt. The improvement in non-fat yogurt may affect the consumer acceptability and preference.

MATERIALS AND METHODS

Preparation of non-fat yogurt

Skim milk (Nesvita and Olwell) was used for the preparation of non-fat yogurt. 1 liter of liquid milk of each Nesvita and Olwell was pasteurized at 85°C for 30 minutes. 50 gram sugar was added with constant stirring. Milk was removed from the flame and 0.5 gram gelatin was added while stirring it constantly. Milk was cooled to 42°C and 50 gram culture was added. Now the non-fat milk was divided into 8 parts which were labeled as T1, T2, T3, T4, S1, S2, S3 and S4. The label T1, T2, T3 and T4 represented Nesvita non-fat yogurt whereas S1, S2, S3 and S4 were labeled for Olwell non-fat yogurt. T1 and S1 were taken as control in which no treatment was done. 0.5% sodium caseinate was added in T2 and S2. 0.5% calcium caseinate was added in T3 and S3. 0.5% sodium caseinate + 0.5% calcium caseinate was added in T4 and S4. All treatments were homogenized after being inoculated. Every treatment was filled in 8 cups each and stored at 4°C. One sample from each treatment was tested for different parameters after 7 days interval up to 21 days.

Nutritional analysis

The nutritional analysis of non fat yogurt included the chemical and physical analysis.

Chemical analysis

The chemical analysis was carried out by the method given by A.O.A.C[13].

Determination of pH

Electrode method was used for determination of pH. pH meter was standardized with the solutions of pH 4 and 9. The 10-gram of each yogurt sample was taken in 8 beakers. 50ml volume of each sample was made by adding distilled water. Electrode was inserted in each sample. After reading was taken the electrode was rinsed with distilled water and dried with a tissue paper.

Determination of acidity

Titrimetric method was used. 10 gram of each yogurt sample was taken. 100 ml solution was made with distilled water. 10 ml of solution was taken in separate beakers. Three drops of phenolphthalein were added. The sample solution was neutralized with 0.1N sodium hydroxide.

Determination of protein

Kjeldhal method was used for protein analysis. 10 gram of yogurt samples of T1, T2, T3, T4, S1, S2, S3 and S4 were taken into 8 digestion bulbs. These samples were placed in oven at 50°C overnight. Then 18ml concentrated sulfuric acid and one digestion tablet was added in each bulb. These samples were digested until the samples became transparent. Then distilled water was added to prepare a 100 ml volume of digested material. 5ml of sample solution (digested material) was taken in distilled flask along with 10ml sodium hydroxide. 10ml boric acid was taken in 8 separate beakers. Then each sample was distilled up to 40ml volume in boric acid beaker. The distilled samples of T1, T2, T3, T4, S1, S2, S3 and S4 were titrated with N/70 hydrochloric acid.

Determination of lactose

Benedict method was used for determining the lactose content of yogurt. 10 gram of T1, T2, T3, T4, S1, S2, S3 and S4 samples were taken into each beaker. 45ml of distilled water and 1ml of 6N hydrochloric acid were added in each sample and boiled for 5 minutes. Then the samples were cooled down and neutralized with 20% sodium hydroxide. 100 ml volume was made. Then the solutions were filtered and taken into burette.

In other eight beakers 5ml Benedict reagent was taken for T1, T2, T3, T4, S1, S2, S3 and S4 samples and 45ml distilled water was added in Benedict reagents respectively. The Benedict solution was boiled on hot plate. When the Benedict solution started boiling it was titrated with sample solution until it became white in color.

Determination of total solid content

Oven dry method was used to determine the total solid content of nonfat yogurt. 6 gram of each yogurt sample i.e. T1, T2, T3, T4, S1, S2, S3 and S4 were taken separately into preweighted crucibles. The crucibles were placed overnight in oven at a constant temperature of 100°C. The crucibles were cooled in desiccators.

Determination of ash content

Burning method was used for determining the ash content. 6 gram of yogurt samples from T1, T2, T3, T4, S1, S2, S3 and S4 were taken separately into preweighted crucibles. They were placed in oven at 100°C overnight. Then the crucibles were cooled in desiccators and heated for 15 minutes for incineration. After that the samples were placed in Muffle furnace at 550°C until the white ash was obtained.

Physical method

Determination of synersis

Measuring method was used for determining the synersis.[14] 50 gram of each yogurt sample i.e. T1, T2, T3, T4, S1, S2, S3 and S4 were taken in separate beakers and were filtered. The filtered solution of each sample was measured separately in measuring cylinder.

Sensory analysis

Sensory evaluation was carried out to analyze flavor and body texture through the method given by Nelson and Trout.[15] It involved scorecards filled by 5 judges. Those judges involved one principal scientific officer, two scientific officers, one senior research officer and one junior technical officer.

RESULTS AND DISCUSSION

Synersis, flavor and body texture

Syneresis of all yogurts decreased during storage. Studies have reported that as the casein to whey protein ratio decreases, the network becomes finer, cross links become denser, and the pores smaller, leading to decreasing amounts of syneresis[16,17].

The synersis increased with a passage of time. The increase in synersis was due to the breakdown of lactose (milk sugar) to lactic acid by bacteria. S3 (Olwell: 0.5% calcium caseinate) was observed with minimum synersis i.e. 14. (Table 1)

The addition of sodium caseinate and calcium caseinate in different combinations caused an increase in flavor of non-fat T3 (Nesvita: 0.5% calcium caseinate) and S3 (Olwell: 0.5% calcium caseinate) got the maximum flavor. (Table 1). Yogurt. The flavor of all non-fat yogurt samples was decreased from 1st to 21st days.

The addition of sodium caseinate and calcium caseinate in different combinations caused an increase in body texture of non-fat yogurt. The body texture of all non-fat yogurt samples decreased with the passage of time. T4 (Nesvita: 0.5% sodium caseinate and 0.5% calcium caseinate) and S4 (Olwell: 0.5% sodium caseinate and 0.5% calcium caseinate) got the maximum body texture i.e. 29 and 28 respectively (Table 1).

Total solid content, ash content, pH content

The total solids in non-fat yogurt samples increased due to the loss of moisture. T4 (Nesvita: 0.5% sodium caseinate and 0.5% calcium caseinate) and S4 (Olwell: 0.5% sodium caseinate and 0.5% calcium caseinate) were observed with maximum amount of total solid content (Table 2).

The ash content of all non-fat yogurt samples increased with the passage of time. T1 (control) were observed with maximum ash content (Table 2). The decrease in pH was due to the breakdown of lactose into lactic acid. An overall decrease in the pH of the non-fat yogurt samples was observed. T1 and S1 (control) got the maximum pH (Table 2).

Acidity, protein content, lactose content

The increase in acidity was mainly due to the bacterial action during which lactose was broken down to lactic acid. During the storage period the acidity in non-fat yogurt samples increased continuously. T3 (Nesvita: 0.5% calcium caseinate) and S3 (Olwell: 0.5% calcium caseinate) got the maximum acidity (Table 3).

Guzman, Morais and Amigo[8] observed that yogurts containing caseinate showed higher viscosity than those made with blended dairy powders and coprecipitate.

The level of protein present in milk affected the consistency of non-fat yogurt. An overall increase in protein content of all non-fat yogurt samples was observed. T4 (Nesvita: 0.5% sodium caseinate and 0.5% calcium caseinate) and S4 (Olwell: 0.5% sodium caseinate and 0.5% calcium caseinate) were observed with maximum amount of protein (Table 3).

Lactose content was decreased because lactose was broken down into lactic acid by bacteria. With the passage of time i.e. from 1st to 21st days of storage the lactose content was observed to decrease due to the breakdown of lactose to lactic acid. T4 (Nesvita: 0.5% sodium caseinate and 0.5% calcium caseinate) and S4 (Olwell: 0.5% sodium caseinate and 0.5% calcium caseinate) were observed with maximum amount of lactose content (Table 3).

Table 1: Physiochemical changes (Mean ±SD) in moisture, fat and coagulation time of yogurt samples during storage.

Treatment	Starter Culture	Coagulation Time	Moisture % Days				Fat % Days			
		Hrs	0	4	8	12	0	4	8	12
T1 (control)	Un known	6:25	86.40 (±0.75)	86.26 (±0.86)	86.17 (±0.93)	86.02 (±1.10)	3.61 (±0.56)	3.62 (±0.56)	3.63 (±0.56)	3.64 (±0.56
T2	3%	5:50	86.29 (±0.83)	86.20 (±0.83)	86.12 (±0.83)	86.05 (±0.87)	3.99 (±0.14)	4.00 (±0.14)	4.01 (±0.14)	4.02 (±0.14)
T3	4%	5:35	85.87 (±1.03)	85.80 (±1.07)	85.70 (±1.07)	85.89 (±1.04)	3.76 (±0.69)	3.77 (±0.69)	3.78 (±0.69)	3.79 (±0.69)
T4	5%	4:50	85.29 (±0.85)	85.16 (±0.88)	85.06 (±0.95)	85.00 (±0.96)	4.29 (±0.61)	4.30 (±0.61)	4.31 (±0.61)	4.32 (±0.61)
T5	3%	6:15	86.26 (±0.87)	86.22 (±0.87)	86.18 (±0.87)	86.14 (±0.87)	3.8 (±0.89)	3.86 (±0.89)	3.87 (±0.89)	3.88 (±0.89)
T6	4%	5:55	84.71 (±0.74)	84.66 (±0.74)	84.62 (±0.74)	84.58 (±0.74)	3.58 (±0.53)	3.58 (±0.53)	3.59 (±0.53)	3.60 (±0.53)
T7	5%	5:10	85.35 (±0.66)	85.32 (±0.66)	85.27 (±0.65)	85.22 (±0.64)	4.36 (±0.54)	4.37 (±0.54)	4.38 (±0.54)	4.39 (±0.54)

Table 2: Physiochemical changes (Mean ±SD) in ash and protein of yogurt samples during storage.

Treatment	Starter Culture	Ash % Days				Protein % Days			
	Hrs	0	4	8	12	0	4	8	12
T1 (control)	Unknown	0.70 (±0.10)	0.70(±0.10)	0.71 (±0.10)	0.72(±0.10)	4.89(±0.88)	4.90(±0.88)	4.91(±0.88)	4.92(±0.88)
T2	3%	0.81 (±0.10)	0.81(±0.09)	0.82(±0.10)	0.83(±0.10)	4.61(±0.55)	4.62(±0.55)	4.63(±0.54)	4.65(±0.54)
T3	4%	0.87 (±0.10)	0.88(±0.10)	0.89(±0.10)	0.89(±0.10)	4.45(±0.59)	4.46(±0.60)	4.48(±0.60)	4.50(±0.60)
T4	5%	0.79 (±0.12)	0.80(±0.12)	0.80(±0.12)	0.81(±0.12)	4.62(±0.58)	4.64(±0.59)	4.65(±0.58)	4.67(±0.58)
T5	3%	0.70 (±0.17)	0.70(±0.17)	0.71(±0.17)	0.72(±0.17)	4.50(±0.52)	4.51(±0.52)	4.53(±0.52)	4.54(±0.53)
T6	4%	0.94 (±0.09)	0.94(±0.08)	0.95(±0.08)	0.96(±0.08)	4.50(±0.56)	4.52(±0.56)	4.54(±0.56)	4.55(±0.56)
T7	5%	0.87 (±0.10)	0.87(±0.10)	0.88(±0.10)	0.89(±0.10)	4.60(±0.62)	4.61(±0.62)	4.63(±0.61)	4.65(±0.61)

Table 3: Physiochemical changes (Mean ±SD) in total solids and pH of yogurt samples during storage.

Treatment	Starter Culture	Total solids % Days				pH Days			
	Hrs	0	4	8	12	0	4	8	12
T_1 (control)	Unknown	14.32(±0.83)	14.36(±0.83)	14.40(±0.83)	14.44(±0.83)	3.64(±0.65)	3.63(±0.65)	3.62(±0.65)	3.61(±0.65)
T_2	3%	13.75(±0.91)	13.97(±0.75)	13.90(±0.91)	13.95(±0.92)	3.48(±0.53)	3.46(±0.53)	3.45(±0.54)	3.43(±0.54)
T_3	4%	15.14(±0.91)	15.18(±0.91)	15.22(±0.91)	15.26(±0.91)	4.24(±0.68)	4.22(±0.68)	4.20(±0.68)	4.18(±0.68)
T_4	5%	14.64(±0.60)	14.68(±0.61)	14.72(±0.60)	14.76(±0.60)	3.58(±0.53)	3.56(±0.52)	3.54(±0.52)	3.51(±0.52)
T_5	3%	14.44(±0.88)	14.48(±0.88)	14.52(±0.88)	14.56(±0.88)	4.35(±0.61)	4.33(±0.61)	4.31(±0.61)	4.29(±0.61)
T_6	4%	14.70(±0.84)	14.74(±0.84)	14.78(±0.84)	14.82(±0.85)	4.04(±0.87)	4.01(±0.87)	3.99(±0.86)	3.96(±0.86)
T_7	5%	15.49(±0.56)	15.52(±0.55)	15.56(±0.56)	15.60(±0.56)	4.33(±0.65)	4.30(±0.65)	4.27(±0.66)	4.24(±0.66)

Table 4: Physiochemical changes (Mean ±SD) in acidity and lactose of yogurt samples during storage.

Treatment	Starter Culture	Acidity Days				Lactose % Days			
		0	4	8	12	0	4	8	12
T_1 (control)	Unknown	0.57(±0.11)	0.61(±0.12)	0.65(±0.13)	0.69(±0.13)	4.57(±0.72)	4.59(±0.71)	4.61(±0.71)	4.62(±0.71)
T_2	3%	0.68(±0.09)	0.71(±0.10)	0.74(±0.10)	0.78(±0.12)	4.60(±0.60)	4.61(±0.59)	4.63(±0.60)	4.65(±0.61)
T_3	4%	0.73(±0.08)	0.79(±0.08)	0.84(±0.09)	0.89(±0.09)	4.85(±0.94)	4.86(±0.94)	4.87(±0.94)	4.88(±0.94)
T_4	5%	0.83(±0.10)	0.88(±0.09)	0.93(±0.08)	0.97(±0.07)	5.15(±0.48)	5.17(±0.48)	5.19(±0.47)	5.21(±0.47)
T_5	3%	0.64(±0.10)	0.71(±0.10)	0.78(±0.10)	0.84(±0.09)	4.63(±0.57)	4.65(±0.57)	4.66(±0.57)	4.67(±0.57)
T_6	4%	0.71(±0.09)	0.77(±0.09)	0.82(±0.09)	0.80(±0.12)	4.54(±0.66)	4.56(±0.66)	4.57(±0.65)	4.59(±0.64)
T_7	5%	0.66(±0.12)	0.70(±0.12)	0.75(±0.12)	0.80(±0.12)	4.57(±0.77)	4.58(±0.77)	4.59(±0.77)	4.61(±0.77)

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