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Optimizing of Fruit Yoghurt Formulation and Evaluating Its Quality During Storage

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Abstract: In this study, the effect of "Osmodehydrofrozen" fruits on sensory, physical, chemical and microbiological properties of yoghurt and its quality during storage was evaluated. This research was done in two stages. At the first stage, the fruit percentage, type and addition time (before and after of fermentation) was determined, the results indicated that yoghurts which contained 10% apple or 13% strawberry and added after fermentation had better quality. Because of high osmotic activity of apple, the synersis value was lower in apple yoghurt. According to osmotic activity in both fruits, the synersis value was very lower than fruit yoghurts which contained untreated fruits. Taste value was higher in strawberry yoghurt and texture and mouth feel values was higher in the yoghurt with high percentages of fruit. The results of second stage (quality evaluation during storage) indicated that storage had significant effect on pH, acidity, synersis, taste and texture ($p<0.05$). The sample contained apple didn't have any mold and yeast; Coliforms disappeared after 7 days of storage. In samples which contained strawberry, yeasts were grown and coliforms disappeared after 7 days of storage.

Key words: Fruit yoghurt . Osmodehydrofreezing process . Sensory . physical and chemical properties . Microbial quality . Storage

INTRODUCTION

Yoghurt is typical fermented milk consumed all around the world. This ‘‘biotechnological’’ food is considered by nutritionists as having high nutritional value (namely because it lacks lactose and has a significant concentration of Ca^{++}) and positive bio-active effects (namely in products added with prebiotic ingredients and probiotic bacteria). The ‘‘natural’’ plain yoghurt is produced by adding Lactic Acid Bacteria that increase the lactic fermentation. Between all milk fermented products, yoghurt is more well-known than others and has more acceptability in the world [1].

Consistency, taste and flavor of yoghurts are varying from one to another region. In one region tight form with high viscosity and in another one jelly and smooth form is preferred. Yoghurt is supplied in frozen form or as a dessert or drink in world's markets. Yoghurt's flavor is different from the other acidified products and its flavoring material mostly contains acetic acid and acetaldehyde [2].

According to Iranian Standard (No. 4046) fruit yoghurt is a product which is made by adding fruits and their nectars, jams, marmalade, fruit jellies, fruit drinks, fruit syrups and concentrated fruit drinks to yoghurt or cultured pasteurized milk.

A recent development in fruit processing is the use of the "osmodehydrofrozen" process which consists of osmotic treatment in sugar solution, limited air dehydration to reduce a_w, freezing and storage. Fruits processed using this technique require no preservatives, maintain their natural flavor and color and have an acceptable texture. Furthermore, when such fruits or dried pieces are added to yoghurt, they have the tendency to absorb some of the free or unbound water from the yoghurt gel and hence help to reduce whey separation of the product during storage [3]. Torreggiani *et al*. [6] reported that the sensory properties of yoghurt with added osmodehydrofrozen apricot or peach cubes of high solids content significantly improved the consistency of the product.

Stirred fruit yoghurt, luxury and low fat yoghurt are the most popular yoghurt types and appropriate about 70% of U.K markets. The other yoghurts are plain yoghurt, set yoghurt, stirred yoghurt, organic yoghurt, creamy yoghurt and yoghurts with high shelf-life [4].

It is reported that the addition of fruit flavor has no significant effect on the total bacteria and coliform counts. It has been also reported that fruit-flavored yoghurts, made using 1-day old yoghurt as a starter culture, could be stored for up to 7 days without losing its desired flavor qualities [5].

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Only Torreggiani *et al*. (1991) added osmodehydrofrozen fruits to yoghurt. They used osmodehydrofrozen apricot and peach cubes for producing fruit yoghurt to prevent whey separation via controlled amount of moisture absorbing by semi dried fruit cubes [6].

Zekai *et al*. [5] analyzed some kinds of fruit yoghurts for some physical, chemical, microbiological and sensory characteristics and concluded that the yoghurt containing grape molasses and morello obtained higher flavor scores in comparison to other flavoring agents.

The aim of this research was studying the effect of processed fruit addition on sensory, physical, chemical and microbiological properties of fruit yoghurt and evaluating changes in its quality during storage for 28 days in refrigerator.

MATERIALS AND METHODS

Pasteurized milk, starter culture (Lactina 36), strawberry, apple, sugar, ascorbic acid, citric acid and microbial mediums of Plate Count Agar, Eosine Methylene Blue and Potato Dextrose Agar were used in this study.

Fruit preparation: Apple and strawberry were used. The fruits were cut into small pieces about 10 mm cubes. Fruit cubes were dipped for 5 hours in 70º Brix sucrose syrup containing 1% ascorbic acid and 0.2% citric acid as antioxidants [6]. The syrup's Brix was continuously controlled and was stated at 70º Brix.

Osmodehydrated cubes were dried using normal air. After complete syrup separation, cubes were freezed at-18ºC and stored at freezer until use. Just before use, fruits were taken out of freezer and apple cubes were directly added while strawberry cubes were mixed with 70º Brix sucrose syrup in a 70:30 ratio and then were used.

Yoghurt preparation: Pasteurized cow's milk (milk fat 2.5%, protein 3.5%, TS 11% and pH 6.6-6.7) was used for yoghurt production. Milk was heated to 90-95ºC for 5 min and then rapidly cooled to 42ºC. 2% (w/v) starter culture (containing *Stereptococcus thermophilus* and *Lactobacillus delbruckii* subsp. *bulgaricus*) was added. Two groups of yoghurt samples were prepared; in group one, fruit cubes were added to cultured milk and in group two, fruit cubes were added to yoghurt when acidity reached to 0.7-0.8. Both groups were incubated at 42-45ºC. Incubation was terminated at acidity 1(% acid lactic) and then, fruit yoghurts were stored in a refrigerator (4ºC).

This research done in two stages: at the first stage (formulation optimizing) the treatments were fruit percentage (7, 10 and 13%), fruit type (apple and strawberry) and the time of fruit addition (at the same time with starter culture and when acidity reached to 0.7-0.8). At the second stage (storage period) the treatments were: storage time (1, 3, 7, 14, 21 and 28 days after production), fruit type and the time of fruit addition.

Analysis: The samples were analyzed in duplicate for pH, acidity and synersis and microbial analyses including total count enumeration, coliforms, yeast and mold determination were done during storage period in different time intervals.

The pH was measured with a (Metrohm 691) pH meter. Acidity was titrated by M/10 NaOH solution and expressed in terms of % lactic acid [8].

Degree of synersis, expressed as proportion of free whey, was measured by a small modification of method used by Al-Kadamany *et al*. [9]. A 10 gram sample of mixed fruit yoghurt was placed on a filter paper resting on the top of a funnel. After 10 min of drainage in vacuum condition, the quantity of remained fruit yoghurt was weighted and synersis was calculated as follow:

Free whey (g/100g) = (weight of initial sample - weight of sample after filtration /weight of initial sample)*100 [9].

To total count enumeration, coliforms, yeast and mold determination were done according to Standard Methods for the Examination of Dairy Product, using the Plate Count Agar (PCA), Eosine Methylene Blue (EMB) and Potato Dextrose Agar (PDA) respectively [5].

Sensory evaluation: The taste, mouth feel, body and texture of all fruit yoghurt samples were evaluated by a trained panel of 7 members using a five-point score system (5 excellent, 1 unacceptable) [5].

Statistical analysis: The results were submitted to the analysis of variance (ANOVA) using completely randomized blocks of Mstatc. The means were separated by use the least significant difference (LSD) test. Significance differences were determined at a = 0.05 [10].

RESULTS AND DISCUSSION

First stage: Optimization of fruit yoghurt formulation

Synersis: In apple yoghurt, as shown in Fig. 1, by increasing fruit amount, synersis decreased in both

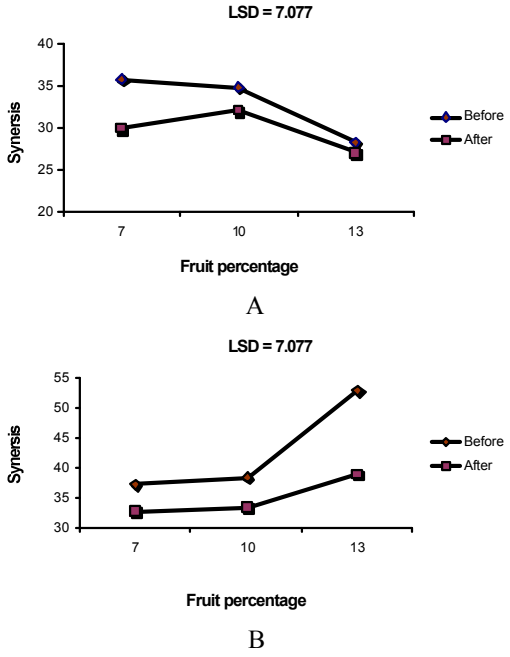

Fig. 1: Effect of apple percentage and its addition time on synersis value; a)Apple and b) Strawberry

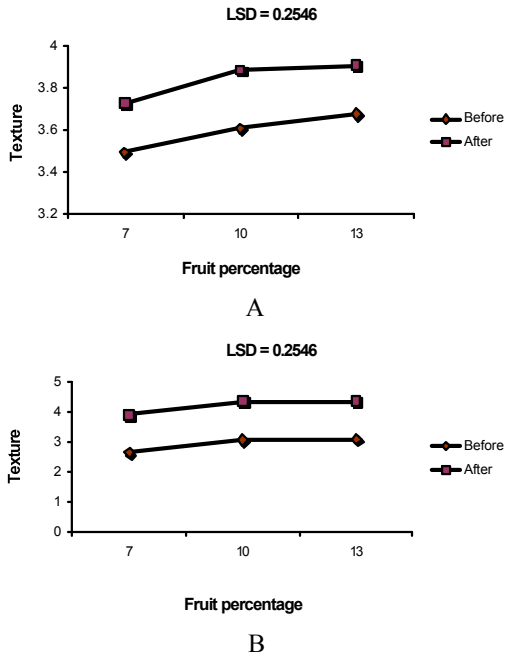

Fig. 2: Effect of apple percentage and its addition time on texture value; a) Apple and b) Strawberry

conditions (before and after fermentation). Synersis was lower in samples which fruit cubes were added to them after fermentation. By increasing fruit amount, more osmosis activity happened and synersis decreased. Apple's body was tougher than strawberry so they

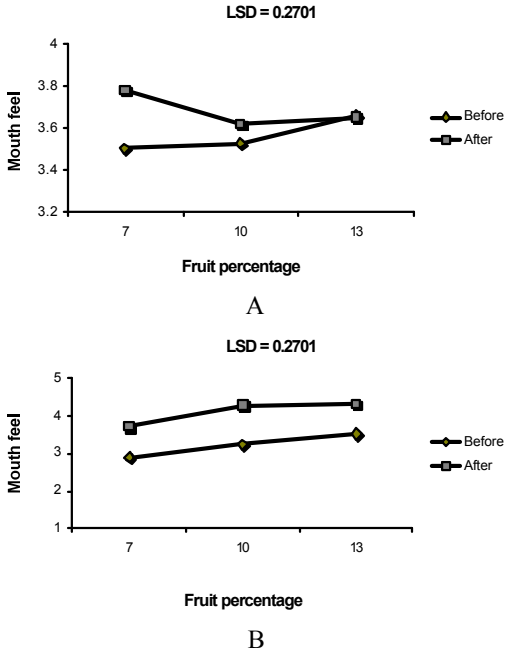

Fig. 3: Effect of apple percentage and its addition time on mouthfeel value; a) Apple and b) Strawberry

absorbed more water from yoghurt and it caused more decrease in synersis value.

In strawberry yoghurt, by increasing fruit amount, synersis increased in both conditions. Because of high acidity of strawberry, by increasing fruit amount, acidity increased too and starter's activity had affected and synersis increased

Body and texture: As shown in Fig. 2, by increasing apple amount, texture score increased but it was higher in samples which apple was added to them after fermentation.

In strawberry yoghurt, the results were the same as apple yoghurt.

Mouthfeel: As shown in Fig. 3, by increasing apple amount, in samples which fruit cubes were added before fermentation, mouthfeel score increased. But in samples which fruit cubes were added after fermentation, mouth feel score decreased at 10% fruit and increased at 13% fruit.

In strawberry yoghurt, by increasing fruit amount, mouthfeel score increased.

In general, mouthfeel score was higher in samples which fruit cubes were added to them after fermentation.

First stage conclusion: According to the results, 2 kinds of products were chosen for evaluating quality changes during storage:

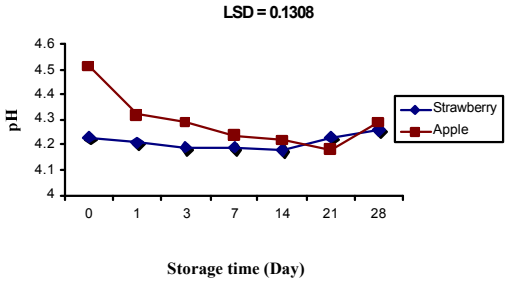

Fig. 4: pH value during storage

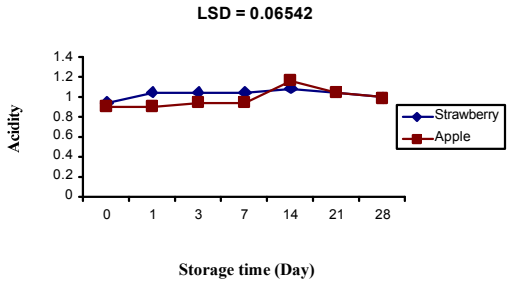

Fig. 5: Acidity value during storage

Fruit yoghurts which contained 10% apple or 13% strawberry which fruit cubes added to yoghurt when acidity reached to 0.7-0.8.

Second stage: quality evaluation during storage: During storage time from first day to 28th, quality parameters were changed as follow:

pH: As shown in Fig. 4, pH values decreased by passing time during storage. pH value increased after 14th day in strawberry and 21th day in apple yoghurt. Microorganism's activity caused pH decrease in fruit yoghurt. Yeasts also used sugar and organic acids and so pH value decreased. As sugar sources finish, microorganisms begin to consume proteins and producing some products by microorganisms, will result in pH increase [11, 12].

Acidity: Acidity increased until 14th day of storage but decreased in remained period.

Synersis: as shown in Fig. 6, synersis decreased until 14th day of storage but increased until 28th day of storage. Synersis value in whole period was lower than first day of production. Synersis reduction can be relating to absorption of unbound water by fruit cubes [5].

Taste: Taste's score didn't have special trend. The highest score was obtained for the third day of storage.

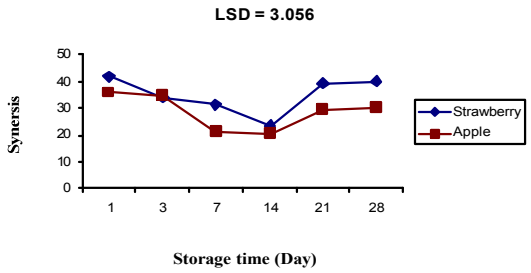

Fig. 6: Synersis value during storage

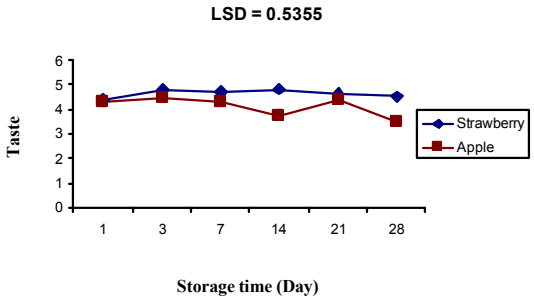

Fig. 7: Taste value during storage

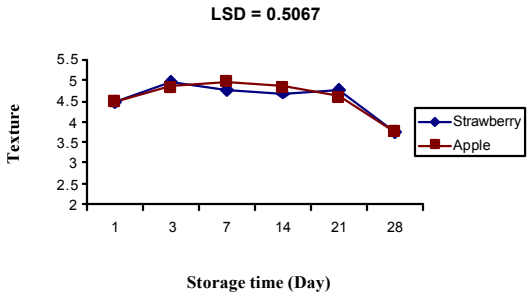

Fig. 8: Texture value during storage

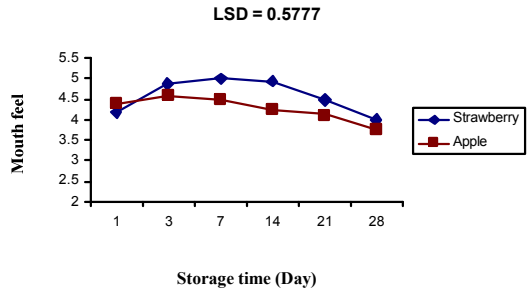

Fig. 9: Mouthfeel value during storage

Body and texture: Body's score increased by the 7th day of storage and the highest was in 7th day for apple ones and third day for strawberry ones (Fig. 8).

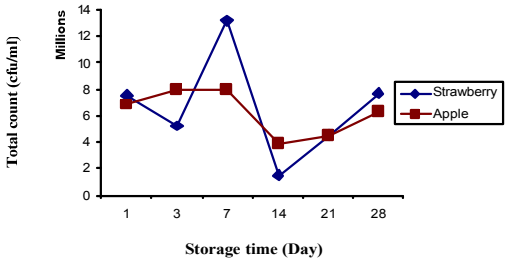

Fig. 10: Total count during storage

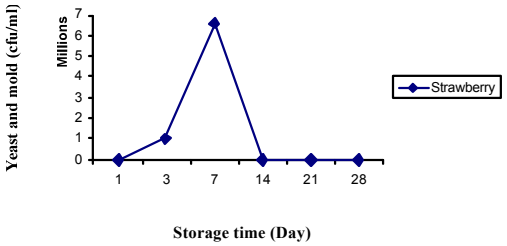

Fig. 11: Yeast and mold count during storage

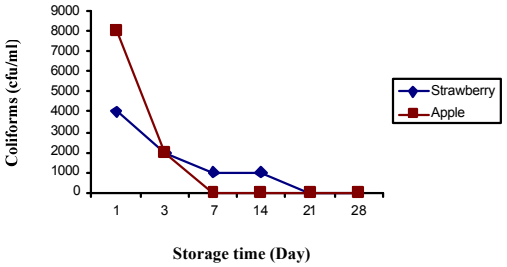

Fig. 12: Coliforms count during storage

Mouthfeel: As shown in Fig. 9, mouthfeel's score was the highest at third day of storage for apple yoghurt and 7th day of storage for strawberry yoghurt.

Total count: In the respect of apple yoghurt, total count increased until 21th day except 14th day. But in the case of strawberry yoghurt the most total count was at 7th day of storage. In addition to LAB, yeast were grown at PCA medium, too, but in different contents.

Yeast and mold: PDA medium contained chloramphenichole is specified for yeast and mold. No colony was grown in plates that were for apple yoghurt. In plates which were for strawberry yoghurt, yeast colonies increased until 7th day of storage but totally disappeared after 14 days as shown in Fig. 11.

Coliforms: As shown in Fig. 12, coliforms were grown until third day of storage in apple related plates and until 14th day of storage in strawberry ones. Coliforms prefer 7-44 ºC temperature and minimum initial pH 4.4-4.5. Both refrigerator conditions which used for yoghurt storage and pH reduction can make undesirable condition for coliforms to continue their growth. Competition with LAB cause difficult situation for coliforms' activity so these microorganisms were inactive [11, 12].

CONCLUSIONS

- Osmodehydration technique before freezing improves fruit yoghurt texture and it is as a new technique for producing high quality fruit contained products.
- Significant increase in yoghurt concentration and synersis reduction are the reasons for high sensorial acceptance of fruit yoghurts.
- Lactobacillus Spp. decreased vigorously during storage, however Streptococcus Spp. were high until the end. This result was similar to Canganella *et al*. [13] result that reported the viability of lactobacilli decreased sharply until the end of storage [13].
- Strawberry yoghurt in comparison to apple yoghurt, obtained more acceptance by panelists, this was due to coordination between strawberry flavor and dairy products.

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