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A Comparative study the effect of mango (Mangifera India L.) and pomegranate (Punica granatum L.) juices on probiotic yogurt

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Abstract

The present study aimed to investigate the effects of adding mango and pomegranate juices to probiotic yogurt. Mango (*Mangifera indieaL*.) and pomegranate (*Punica granatum L*.) juices were added at a ratio of 10 % to yogurt with and without probiotic bacteria over storage periods of 1, 7 and 14 days at 4^{o}C. The chemical composition, syneresis, viscosity, total phenol, total flavonoids, antioxidant activity and organoleptic evaluation for all yogurt treatments were analyzed after 1, 7, and 14 days of storage.

The results showed that the fat, protein, ash, phenolic compounds, flavonoids and antioxidant activity of pomegranate juice were higher than mango juice. Yogurt fortified with pomegranate juice had a significantly lower PH (4.29±0.02) and significantly higher acidity (0.93±0.01). Total solids increased when *Bifidobacterium* was added to yogurt as a probiotic. Also, mango juice fortification increased T.S (16.26±0.03) and viscosity (161±10Centipoise (cP) more than pomegranate juice (13.95±0.03% and 150±12 (cP) respectively) In general, all parameters decreased gradually during storage periods. Gallic acid and catechin were the most present phenolic compoundsin pomegranate-fortified yogurt and pomegranate-fortified probiotic yogurt. It could be concluded that mango and pomegranate juices can be used at a rate of 10% as a source of bioactive components for probiotic yogurt, which enhances its physicochemical, microbiological, antioxidant and sensory properties. Adding pomegranate juice to probiotic yogurt was better than adding mango juice because it contains phenolic compounds, flavonoids, and antioxidant activity higher than mongo juice.

KeyWords:Mango and Pomegranate juices,Phenolic compound,Probiotic,Antioxidant activity,Viscosity and Syneresis.

Introduction

Probiotic bacteria are earning significance in human nutrition due to their multifaceted health benefits and are included in functional foods. Probiotic supplementation is useful in mitigating inflammatory stress andimmune senescence ***(Sharma and Padwad, 2020)***. Also, it is beneficial for improving cognitive and mental health ***(Kim et al., 2021)***. It also improves blood glucose profiles in type II diabetes and gestational diabetes patients ***(Wang et al., 2022).*** Probiotic/synbiotic supplementation can significantly increase serum total antioxidant capacity, glutathione and nitric oxide levels, as well as reduce malondialdehyde levels in adults. Therefore, probiotic/synbiotic supplementation plays a role in improving antioxidant indices and reducing oxidative stress in the body ***(Pourrajab et al., 2022).*** A synbiotic is defined as a “mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and activity of beneficial microorganisms in the gut”***(Gourbeyre et al., 2011).***

Symbiotic promote the growth of native, beneficial microflora like *Bifidobacterium* after ingesting prebiotics alone***(Rabin et al.,***

2019). Additionally, probiotic bacteria guard the gut epithelium's mucosal barrier against harmful pathogens ***(Zommiti et al., 2020).*** As an illustration, lactic acid bacteria (LAB) produce mucin and decrease intestinal permeability to stop pathogen growth and access to intestinal epithelial cells. Another defense mechanism is the lactic fermentation carried out by LAB, which results in the generation of lactate and acetate as byproducts. This process produces an acidic environment that prevents the growth of infections ***(Tachedjian et al., 2017).***

Probiotics can reduce cholesterol, and their metabolites, known as "postbiotics" such as lactic acid, bacteriocins, and hydrogen peroxide, work as antimicrobials against different pathogenic bacteria ***(Silva et al., 2017).****Bifidobacterium* species are among the most common microorganisms in the natural microflora of the colon. Gram-positive *Lactobacillus* bacteria are the most prevalent probiotic it functions as probiotic, giving it the advantages of biological therapy***. (Muhammad et al., 2019).***

Fermented milk and yogurt contain probiotics, especially *Lactobacillus* and *Bifidobacterium*, which are commercially available. They are very well suited to various types of
food matrixes because of their physiological functions ***(Fonteles et al., 2011).***

Two types of yogurts can be categorized: regular cultured yogurt and probiotic or "bio" yogurt. The activity of *L. bulgaricus* and *S. thermophilus* produces standard yogurt. Bio-yogurts are those prepared with probiotic strains of *Bifidobacterium* and *L. acidophilus*, which offer several health benefits. These bacteria can promote the friendly microflora found in yogurt, helping to maintain overall gastrointestinal health ***(Banerjee et al., 2017).***Yogurt has many beneficial actions in improving human general health by reducing the following: gastro-intestinal discomfort and symptoms of lactose intolerance and, lessening the severity of various infectious diseases ***(Nachbar et al., 2020 and Nyanzi et al., 2021).***

Numerous fruits or their pulps are regularly included in the preparation of yogurt***(Abdeldaiem and Blassy, 2019)*.**Fruits are abundant sources of dietary fiber, vitamins, and minerals, as well as carbohydrates. Fruits are known to include a variety of beneficial components, including anthocyanins, phenolics, sterols, carotenoids, procyanidins, and flavonoids, according to phytochemical studies***(Abdeen, 2019).***

Fruits in a variety of forms, such as fresh, dried, powder, juice, puree, pulp, fiber, and extract, give food manufacturers a way to enhance their nutritional value. ***(Satorabi et al., 2021).*** Fruits and vegetables effects on various dairy product features result in functional dairy products with excellent nutritional contents, health advantages, and marketability ***(Salehi, 2021).***Mango (*Mangifera indica* L) is considered a nutritional source of micronutrients (vitamins and minerals), reducing sugars, proteins, essential amino acids, polyphenols, anthocyanins, organic acids, volatile constituents, pigments (chlorophylls a and b) and carotenoids ***(Maldonado-Celis et al., 2019; Veeranjaneya et al., 2021).***

The mango contains fiber, carbohydrates (10-32% in ripe pulp), proteins (0-5%), amino acids (alanine, arginine, glycine, serine, leucine, and isoleucine), lipids (0.75% to 1.7%), and vitamins (vitamin C, from 9.79 to 186 mg/100 g of mango pulp; vitamin A equivalent, from 1,000 to 6,000 IU/100g) and organic acids (citric being the main organic acid, 0.13% to 0.71% of fresh weight). In addition, mango fruit is an important source of polyphenols (catechins, quercetin, kaempferol, rhamnetin, anthocyanins, tannic acid, and mangiferin;

carotenoids, organic acids, and volatile compounds***) (Maldonado-celis et al., 2019),***useful for pharmaceutical applications as anti-diabetic, anti-inflammatory, antimicrobial, antioxidant and anti-carcinogenic effects ***(Bchir et al., 2019; Hallim et al., 2019; Veeranjaneya et al., 2021).***

The pomegranate (*Punica granatum*) has numerous nutritional and bioactive compounds such as sugars, proteins, crude fibers, pectin, vitamins, minerals, phenolic compounds, isoflavones, flavonoids, and primarily anthocyanins ***(Elfalleh et al., 2011; Aruna et al., 2016; Rafraf et al., 2017).***Studies have shown the pomegranate's numerous physiological activities, including its antibacterial and anti-inflammatory characteristics, in addition to its antioxidant activity***(Kandylis and Kokkinomagoulos, 2020).***

Therefore, the main purpose of this study was to investigate the effects of adding mango and pomegranate juices on probiotic yogurt.

Materials and methods

Materials

Fresh cow's milk was obtained from Animal Production Research Stations in the Gharbia governorate. It contained 3.82% protein, 3.50% fat, 13.59% total solids (T.S) and 0.94% ash.

Bacterial strains *Streptococcus thermophilus* (*S.thermophiles*), *Lactobacillus bulgaricus* (L.*bulgaricus*) and *Bifidobacterium infantis* were obtained from Cairo Microbiological Resources Center in Egypt. These strains were consecutively transferred twice into skim milk (12 % T.S), and they were activated at 42 °C for 24 h before to the yogurt-making process ***(Jayalalitha et al., 2015 and Saleh et al., 2018)***

Mango (*Mangifera indiea L*) and pomegranate (*Punica granatum L.*) fruits were obtained from the local market in Fayoum governorate, Egypt.

El-GomhoriyaCo. for Trading Drugs, Chemicals and Medical Instruments, Egypt, was used to purchase all of the chemicals.

Methods

Preparation of mango and pomegranate juices

Mango and pomegranate fruits were washed and the juice was obtained according to the method described by***Chavan et al., (2013).*** The Juice was pasteurized at 90 °C for 15 sec then immediately cooled in an ice bath to below 10 °C and kept in sterilized glass bottles in the refrigerator (4°C) until use.

Yogurt producing

The ***IDF (1988)*** was used for yogurt production as follows: heating the milk at 95 °C for 5 minutes, then cooling it to 42 °C and dividing it into the following sex formulas (three replicates each). After that 10 % of pasteurized mango and pomegranate juices were added, stirred quickly after the immediate addition of the 2 % (v/v, *S. thermophilus* and *L.bulgaricus* in a1:1 ratio starter culture) with or without *Bifidobacterium infantis* of 24 h old culture. Samples were incubated in a plastic cup (100 ml) at 37 °C for 6 h until the pH reached 4.3 or 0.8 % acidity. The samples were then kept at 4 °C until they were analyzed.

Experimental treatments:

1st Formula: (Control yogurt): Milk inoculates with 2 % of yogurt culture, which is *L. bulgaricus* and *S. thermophilus culture* (1:1v/v) ***(Kumar and Kumar, 2016).***

2nd Formula: (Yogurt fortified with 10% mango juice): Milk inoculates with 2 % of *L. bulgaricus* and *S. thermophilus culture* (1:1v/v), with the addition of 10% mango ***juice (Teshome et al., 2017).***

3rd Formula: (Yogurt fortified with 10% pomegranate juice): Milk inoculates with 2 % of *L. bulgaricus* and *S. thermophilus culture*(1:1v/v), with the addition of 10% pomegranate ***juice (Hallim et al., 2019).***

4th Formula: (Probiotic yogurt): Milk inoculates with 2 % of yogurt culture, which are *L. bulgaricus, S.thermophilus* and *Bifidobacterium infantis culture* (1:1: 0.3v/v) ***(Çakmakçi et al., 2012).***

5th Formula: (Probiotic yogurt fortified with 10% mango juice): Milk inoculates with 2% of *L. Bulgaricus, S. thermophilus* and *Bifidobacterium infantis culture* (1:1:0.3v/v), with the addition of 10 % mango juice.

6th Formula: Probiotic yogurt fortified with 10% pomegranate juice): Milk inoculates with 2% of *L. Bulgaricus, S. thermophilus* and *Bifidobacterium infantis culture* (1:1:0.3v/v), with the addition of 10% pomegranate juice

Chemical composition of mango and pomegranate juices

The total solid, moisture, fat, protein and ash of mango and pomegranate juices were determined according to the method by ***The Association of Official Analytical Chemists A.O.A.C. (2000).***Total phenol, total flavonoids and antioxidant activity ofmango and pomegranate juices were determined according to ***Singleton and Rossi, (1965); Ordonez et al., (2006) and Akowuah et al., (2005)***

Determination of the total phenolic and flavonoid contents of different yogurt

The total polyphenols contents of different yogurt were measured using the "colorimetric method" of Folin–Ciocalteau according to ***Singleton and Rossi, (1965)***using A UV/Vis spectrophotometer (HITACHI U900, Japan) as gallic acid mg/100g at 765 nm. Also, the total flavonoids of the samples were determined calorimetrically using the aluminum chloride method according to ***Ordonez et al., (2006)*** using UV/Vis spectrophotometer (HITACHI U900, Japan), as quercetin (mg/100g sample).

Determination of the antioxidant activityof different yogurt samples

The antioxidant capacity of yogurt samples using the stable 2,2-diphenyl-1-picrylhydrazyl radical (DPPH•) radical, samples' capacity to scavenge radicals was assessed by***Akowuah et al., (2005).*** UV-spectrophotometer was used to detect the absorbance at 515 nm.

Chemical analysis of different yogurt samples

The chemical analyses include the following: total solids, moisture, fat, protein, ash, pH and acidity as total titratable acid (TTA) were analyzed at an interval of 1, 7 and 14 days according to ***A.O.A.C. (1995).*** The pH measurement for all samples was done using a digital pH meter (Model pH-Kent EIL 7020). The TTA was determined according to ***A.O.A.C. (2000)*** using sodium hydroxide 0.1mol/L. Then, the TTA of the yogurt samples was expressed as the lactic acid percentage.

Rheological Properties

Thesyneresis of the different yogurt samples was determined according to the method described by***Lawrence, (1959).***

Viscosity of the different yogurt samples was determined by ***Arana, (2003).***

Sensory evaluation

After being kept in the refrigerator for 1, 7, and 14 days, yogurt samples were evaluated according to ***Kasimoğlu et al.,***

(2004).Thesensory attribute was evaluated based on body and texture (30%), acidity (10%), appearance (15%), flavor (45%) and overall acceptability using a 100 point.

HPLC analysis of yogurts and juices treatments

An Agilent1260 series, Infinity, II LC, Waldron, Germany, was used for the HPLC analysis of identification of phenolic compounds according to ***Maraud et al., (2012).***

Microbiological analysis:

The bacteria in the yogurt samples were cultured and counted according to ***Terzaghi and Sandrine (1975); Dave and Shah (1996), and Marshall, (1992)*** for *Lactobacillus Bulgaricus, Streptococcus thermophilus* and *Bifidobacterium infants,* in triplicate at 1, 7 and 14 days of the storage. The enumeration condition of each strain is indicated as follows: *Lactobacillus Bulgaricus,* MRS agar at 37 °C for 72 h in anaerobic condition, *Streptococcus thermophilus,* M17 agar at 37°C for 48 h in aerobic condition and *Bifidobacterium infants* count was done using M17 agar at 30 °C for 72 h in anaerobic condition. The counting of these bacteria is expressed as colony-forming units/ gram (log CFU/g) of each sample.

Statistical analysis:

Statistical analysis of the data was conducted using one-way analysis of variance (ANOVA) followed by Duncan's multiple range test using the SPSS statistical software program version 19 (SPSS Inc., USA). Results were indicated by mean ± SD. The significant differences among treatments' means were explored at a ≤ 0.05 probability level using a statistical software package (Info State) according to ***Casanovas' et al., (2012).***

Results and Discussion

Chemical analysis of mango and pomegranate juices

The chemical properties of mango and pomegranate juices are indicated in Table (1). The T.S, moisture, fat, protein, ash, total phenolic, flavonoid contents and antioxidant activity of mango juice values are as follows: 30.2±0.02, 68.8±0.02, 0.07±0.01, 0.11±0.01, 0.20±0.02, 38.055±0.19 mg/100g, 3.405±0.08 mg/100g and 91.95±0.11, respectively. Previous research ***by Makawi and Abdel Razig, (2016)***, who reported that mango juice, had the highest content of total solids (28.80), protein (9.60), fat (14.60), ash (2.50) and fiber (1.20g/100g).

Similar results obtained by ***Maldonado-Ceils et al., (2019),***found that moisture content and total carbohydrate (78.9-82.8% and 16.20-17.18%) were major contents mango, while minor contents were total fat, total protein and ash (0.30-0.53%, 0.36-0.40% and 0.34- 0.52% respectively).

The T.S, moisture, fat, protein, ash, total phenolic, flavonoid contents and antioxidant activity of pomegranate juice values are as follows: 21.9±0.03, 78.1±0.03, 0.32±0.02, 1.31±0.02, 0.37±0.02, 103.691±0.22 mg/100g, 4.405±0.10 mg /100g and 94.11±0.13, respectively. So, these results indicated that total solid was higher in mango juice than in pomegranate juice. But pomegranate juice was higher in fat, protein and ash than mango juice. Also, pomegranate juice was higher in total phenolic, flavonoid content and antioxidant activity than mango juice.

Different results were obtained by ***Dyab et al., (2021)*** found that the moisturecontent, T.S, Total phenol, total flavonoids, and antioxidant activity of pomegranate pulp was (85.08%, 14.30%, 29.66 mg/100g, 21.44 mg/100g, and 87.24%) respectively. Recent research by ***Kupnik et al., 2021*** reported that the total phenolic content, antioxidant activity and total protein of pomegranate fresh juice were 3.64mg/100g, 5.34%, and 0.44%) respectively.

The results of T.S, fat and protein of pomegranate juice in the present study were higher than that mentioned by ***Hallim et al., 2019,*** who found that the total solid%, total protein%, fat% and ash% of pomegranate juice were (14.06%, 1.34%, 0.49 % and 0.07%) respectively.

Determination of total phenolic, flavonoids contents and antioxidant activity of yogurt fortified with mango and pomegranate juices samples

The data in Table (2) indicated that the probiotic yogurt showed higher values of antioxidant activity, total phenolic and flavonoid contents than the control yogurt. Furthermore, probiotic yogurt fortified with mango juice showed higher values for these parameters than yogurt fortified with mango juice only.

The same manner was observed for yogurt fortified with pomegranate juice and probiotic yogurt fortified with pomegranate juice. Probiotic yogurt fortified with pomegranate juice, showed the highest total phenolic, flavonoid contents and antioxidant activity overall treatments. In addition, this treatment during storage times of 1, 7, and 14 days showed antioxidant activity as DPPH inhibition of 93.15±0.66, 88.51±1.05 and 82.67±0.59, respectively. Considerably, as mentioned before in Table (1) that pomegranate juice has higher values of antioxidant activity, total phenolic and flavonoid contents than mango juice.***Arjmand et al., (2013),***referred to the higher antioxidant activity of pomegranate juice to its high content of anthocyanins, hydrolyzable tannins, ellagic acid derivatives along with other flavonoid compounds.**Table (2)** showed that total phenolic, flavonoid contents and antioxidant activity values gradually decreased along with the storage for all treatments. This could be due to the oxidation of phenolic compounds or their reaction with casein of yogurt. Also, the presence of lactic acid which is secreted by the cultural bacteria causes phenolic compounds to be decomposed as well ***(Cho et al., 2017; Han et al., 2019).***

Chemical analysis of yogurt fortified with mango and pomegranate juices samples

The chemical composition of yogurt samples fortified with mango and pomegranate juices is shown in Table (3). Data in Table (3) revealed that control yogurt has the lowest T.S. (13.53±0.01) and highest fat (3.29±0.02). In contrast, adding *Bifidobacterium* to control yogurt as probiotic yogurt resulted in an increased T.S. percentage, but there was no significant difference in fat or protein percentages. Also, fortifying fortification yogurt with mango juice raised the percentage of the total solids and lowered both the fat and protein percentages when compared with control yogurt. In addition, probiotic yogurt fortified with mango juice showed the highest T.S. percent compared to all treatments.

The elevation of the total solids in mango yogurt may be due to the higher solid content of the fruit juice itself than the used milk***(Ronak et al., 2016).*** However, yogurt fortified with pomegranate juice has more T.S. percent than control yogurt, but it was lower than yogurt fortified with mango. This may be a normal result since mango juice has more T.S. percent than pomegranate juice.

In general, all the chemical composition parameters of T.S., fat, protein and ash percent are gradually increasing with time of storage.Furthermore, during yogurt fermentation with a long storage time of two weeks, the pH is decreasing gradually and the syneresis is elevated, thus causing of losing the moisture of yogurt and causing all the previous parameters to increase over time ***(Hernández-Herrero and Frutos, 2014; Christopher et al., 2009; Ronak et al., 2016; Hallim et al., 2019; Ismail et al., 2020).***

Previous results by ***Hassanein et al., (2014),*** found that fortifying yogurt with fruit juice may lower its chemical composition parameters due to the high moisture and low fat and protein contents of the fruit itself, and these treatments are causing the syneresis to elevate by storage and losing the moisture by evaporation, resulting in increasing the % of the yogurts' chemical parameter. The pH and acidity of yogurt fortified with mango and pomegranate juices showed in Table (4). Yogurt fortified with pomegranate juice had a significantly lower pH (4.29±0.2) and a significantly higher acidity (0.93±0.01) than yogurt fortified with mango juice (4.41±0.01 and 0.91±0.02) compared to the control group (4.69±0.2 and 0.84±0.01) of pH and acidity respectively. The decrease in pH and increase in acidity may be due to the lower content of pomegranate juice pH and higher acidity than mango juice. Similar results were obtained by ***Ismail et al., (2014)*** found that the pH of two types of pomegranates ranged (from 4.28 - 3.15) and the acidity ranged (from 0.74-1.52) of juice extracted by blending of seed.

The same results were observed in probiotic yogurt when compared to control yogurt. Probiotic yogurt showed a significant decrease in pH $p \leq 0.05$ (4.52±0.01) and a significant increase in acidity (0.89±0.01) compared to control yogurt that using regular starter culture (4.69±0.02 and 0.84±0.01respectively). The effect *Bifidobacterium* on both pH and acidity is contributed by the acidity caused by the regular starter culture, which is a critical factor for *Bifidobacterium* growth *Bifidobacterium* produces metabolites, especially acetic acid that lowers the pH and increases the acidity as well ***(Sarvari et al., 2014 and Meenakshi et al., 2018).***

Also, data in the same table revealed that there is significantly different between probiotic yogurt fortified with pomegranate juice and probiotic yogurt fortified with mango juice during the storage period. The lowest pH values of probiotic yogurt fortified with pomegranate juice showed a significant decrease during the storage period.

So, it was clear that pH values declined during storage for all treatments. The decrease in pH during the storage time at a low temperature of 0: 5 °C is caused by the starter culture bacteria which is responsible for the post acidification of yogurt ***(Christopher et al., 2009).*** Many researchers reported that the pH of yogurt and milk-

fermented products decreased with cold storage time, whereas the TTA value increased ***(Barakat and Hassan 2017; Dabija et al., 2018; Hallim et al., 2019; Atwaa et al., 2020; Ismail et al., 2020).***
Starter bacteria of *L. bulgaricus* and *S. thermophilus* in cold conditions are responsible for the secretion of beta-galactosidase enzyme which converts lactose to lactic acid ***(Christopher et al., 2009).***

Rheological properties of yogurt fortified with mango and pomegranate juices' treatments:

Syneresis is the loss of liquid from yogurt during the storage period and is used as an indicator or a key to the quality of yogurt itself ***(Vital et al., 2015; Dabija et al., 2018).*** Results indicated in Table (5) showed that the syneresis amount increased gradually during the storage period. The lowest whey syneresis was for control yogurt which ranged from 6.6±0.07 ml on day 1 up to 11.9±0.07 ml on day 14.

However, the addition of pomegranate juice to yogurt caused the highest syneresis amount of all treatments, which varied from 7.50±0.6 ml on day 1 up to 13.80±1.2 ml on day 14.
Also, the yogurt cultured with *Bifidobacterium* along with regular culture as probiotic yogurt, probiotic yogurt fortified with mango, and probiotic yogurt fortified with pomegranate treatments showed higher syneresis amounts when compared to control yogurt. Furthermore, results in Tables (1 and 2), indicated that mango juice and yogurt fortified with it have lower acidity and a higher total solid content than pomegranate juice and its fortified yogurt.Both acidity and total solid contents affect the syneresis and viscosity parameters of yogurt ***(Hassanein et al. 2014; Shahbandari et al., 2016).***

Also, many studies have indicated that syneresis amount is increasing with storage progress due to yogurt acidity development, which causes the water holding capacity to be reduced during storage progress ***(Silva et al., 2017; Atwaa et al., 2020; Blassy et al., 2020; Ismail et al., 2020).***

According to the data in the same table, there was no significant difference in viscosity ($p > 0.05$) between yogurt fortified with mango juice and probiotic yogurt fortified with mango juice. Also, there is no significant difference between yogurt fortified with pomegranate juice and probiotic yogurt fortified with pomegranate juice. However, the viscosity of mango-fortified yogurt was higher (159±10) than that of pomegranate-fortified yogurt (155±11). The water-soluble fiber present in mango may be absorbed by water and increases the viscosity ***(Mahmoud et al., 2008).***

The viscosity of probiotic yogurt fortified with pomegranate juice was the lowest (150±12) while, control yogurt had a higher viscosity (163±11). Fortifying yogurt with fruit juices led to a significant decrease $p \leq 0.05$ in viscosity. The decrease in viscosity may be due to fruit juice's declining water-holding capacity of protein, which lowers the viscosity ***(Celik et al., 2017).***

In general, there is a gradually significant decrease $P \leq 0.05$ in viscosity during the storage period. Several previous types of research by ***Hassanein et al., 2014; Shahbandari et al., 2016,***reported that when syneresis values were raised by storage, viscosity values declined. These value changes during storage may be related to the increased changes in casein particle rearrangement (protein-protein pound) caused by the acidity fermentation of yogurt ***(Hassanein et al., 2014; Shahbandari et al., 2016).***

Sensory evaluation of yogurt fortified with mango and pomegranate juices' treatments:

From the data illustrated in Table (6) it is noticeable that, control yogurt was negatively affected by the addition of pomegranate juice. However, control yogurt almost has the same sensory evaluation when yogurt is fortified with mango juice. Data from Table (3) indicated that pomegranate yogurt has more moisture percent and less total solids percent than yogurt fortified with mango juice. This was attributed to the texture scores of these yogurts and these scores were improved by the addition of probiotics to the culture. The addition of *Bifidobacterium* to yogurt's regular starter culture improved many sensory properties ***(Vitheejongjaroen et al., 2021; Ma et al., 2022).***

Also, results showed that all the sensory properties indicators decreased gradually with storage for up to 14 days. As shown in Table (4), the yogurt fortified with pomegranate juice had a lower pH and higher acidity values. This may be attributed to the acidity of the fruit because of the high content of phenolics, flavonoids, sugar and vitamins which affect the texture of the yogurt ***(Barakat and Hassan 2017; Meenakshi et al., 2018).***

However, fortifying yogurt with mango juice affects its overall acceptability and proved to be the most favorable yogurt, with nearly equal overall acceptability to the control yogurt. ***Kebary et al., (2020)***indicated that mango was the most popular and favorable fruit tested in Egypt when used in the fortification of ice cream.

HPLC analyses of yogurt fortified with mango and pomegranate juices' treatments:

Table (7) showed that both gallic and chlorogenic acids were the predominant phenolic compounds found in all yogurt treatments. The main phenolic component in control yogurt is gallic acid (0.87±0.01µg/ml). The major phenolic compound found in probiotic yogurt and yogurt fortified with mango juice treatments is chlorogenic acid (1.55 and 1.10 µg/ml respectively). Also, gallic acid was found to be the principal phenolic compound of the following treatment: probiotic yogurt fortified with mango juice, yogurt fortified with pomegranate juice and probiotic yogurt fortified with pomegranate juice with an amount of (1.73±0.01, 2.27±0.01 and 2.36±0.01 µg/ml), respectively.

Phenolic compounds such as gallic acid, chlorogenic acid, syringic acid, ferulic acid and quercetin were found to be abundant compounds in yogurt fortified with both probiotics and mango juice. Caffeic acid, catechin, methyl gallate, rutin, coumaric acid, daidzein, pyrocatechol, and naringenin were not detected in this treatment.

(Palafox-Carlos et al., 2012; Peng et al., 2019),reported thatthe most prominent phenolic constituents of mango were gallic acid, chlorogenic acid, quercetin, syringic acid and catechin. Also, gallic acid and chlorogenic acid were found to be the highly contributed compounds in mango. These findings led to the observation that the addition of *Bifidobacterium* (probiotic) to yogurt fortified with mango juice resulted in increasing its phenolic compounds contents. So, the addition of fruit juices to yogurt led to increases in the total phenolic and flavonoid contents and antioxidant activity of these yogurts fortified with fruit juices ***(El-Samahy et al., 2014; Kumar and Kumar 2016; Bchir et al., 2019; Hallim et al., 2019; Atwaa et al., 2020).***

While the yogurt fortified with probiotic and pomegranate juice was found to have more varieties of phenolic components such as: gallic acid, chlorogenic acid, catechin, methyl gallate, coumaric acid, ferulic acid and quercetin. Caffeic acid, syringic acid, pyro catechol, rutin and ellagic acid were not detected in this treatment. ***Hmid et al., (2017),***illustrated that pomegranate has an abundant amount of the following polyphenols: quercetin, gallic acid, chlorogenic acid, ferulic acid, caffeic acid, ellagic acids, rutin and phloridzin.

Microbiological examination of yogurt fortified with mango and pomegranate juices.

Results in Tables (8 and 9) showed the viable count of *Lactobacillus,Streptococcus* and *Bifidobacterium* (CFU×10^6/g) in yogurt fortified with mango and pomegranate juices. The addition of mango juice elevated the total viable counts of bacteria in all treatments. Yogurt fortified with mango juice showed a viable count of *Lactobacillus* during storage times of 1, 7 and 14 days of 8.53±0.02, 8.67±0.04 and 8.82±0.02, respectively.

Also, yogurt fortified with mango juice showed a viable count of *Streptococcus* during storage times of 1, 7 and 14 days of 8.61±0.01, 8.68±0.02 and 8.74±0.02, respectively. These viable counts of bacteria were higher than the count for the control yogurt.
The fortification of yogurt with fruits is causing the total bacterial count to elevate as a result of the presence of fruits' metabolites,

which are used by the bacteria and enhance their growth ***(Jin et al., 2018; Atwaa et al., 2020; Blassy et al., 2020).***

However, the addition of pomegranate juice to regular yogurt decreased the total viable counts of bacteria in all treatments. Yogurt fortified with pomegranate juice showed a viable count of *Lactobacillus* during storage times of 1, 7 and 14 days of 8.32±0.02, 8.27±0.03 and 6.56±0.03, respectively. Also, yogurt fortified with pomegranate juice showed a viable count of *Streptococcus* during storage times of 1, 7 and 14 days of 8.36±0.01, 8.31±0.02 and 7.48±0.01, respectively. Yogurt fortified with pomegranate juice had a lower pH and higher acidity values. This may be attributed to the acidity of the fruit because of the high content of phenolic compounds, flavonoids, sugar and vitamins, which results in a low bacterial count ***(Al-Farsi and Lee, 2008; Barakat and Hassan 2017; Meenakshi et al., 2018).***

Also, the indicated results showed that yogurt culture with *Bifidobacterium* causes the total viable count of all bacteria to elevate, and the total count of all bacteria is decreased by storage. This may refer to the anaerobic preference nature of these bacteria, with a long storage period there is a reduction in the oxygen percent in yogurt ***(Tripathi and Giri, 2014).*** However, it was stated that acidity is a main factor for *Bifidobacterium* growth, and the acidity of the fruit and starter culture metabolism causes a reduction in the viable count of *Bifidobacterium* during long storage ***(Dave and Shah 1998; Meenakshi et al., 2018).***

Conclusion

Control yogurt has lower T.S., acidity, syneresis, total phenol, total flavonoids, antioxidant activity, the number of phenolic compounds detected, and a viable count of *lactobacillus* and *streptococcus*. Adding *Bifidobacterium* to control yogurt resulted in higher T.S., total phenolic, total antioxidant activity, pH, viscosity, and lower overall acceptability compared to control yogurt.

Probiotic yogurt fortified with pomegranate juice increased total phenol, total flavonoid, antioxidant activity, acidity and syneresis compared to probiotic yogurt fortified with mango juice, which revealed an increase in T.S., fat, protein, PH, viscosity, overall acceptability, number of phenolic compounds detected by HPLC and viable count of *Bifidobacterium,Lactobacillus* and *Streptococcu*s compared to probiotic yogurt fortified with pomegranate juice. In general, the fortification of yogurt with probiotic bacteria with pomegranate juice is better than fortification with mongo juice because the higher antioxidant activity, total phenolic compounds, and flavonoids, which have a protective effect against many diseases.

Table (1):

Mean ±SD of chemical composition of mango and pomegranate juices

Chemical composition	Mango juice	Pomegranate juice
Total solids g/100g	30.2 ± 0.02^{a}	21.9 ± 0.03^{b}
Moisture g/100g	68.8 ± 0.02^{c}	78.1 ± 0.03^{d}
Fat g/100g	0.07 ± 0.01^{e}	0.32 ± 0.02^{f}
Protein g/100g	0.11 ± 0.01^{g}	1.31 ± 0.02^{h}
Ash g/100g	0.20 ± 0.02^{i}	0.37 ± 0.02^{j}
Total phenolic content asG.A(mg/100 g sample)	38.055 ± 0.19^{k}	103.691 ± 0.22^{l}
Total flavonoid content as Catechin (mg/100 g sample)	3.405 ± 0.08^{m}	4.405 ± 0.10^{n}
Antioxidant activity as % DPPH inhibition	91.95 ± 0.11^{o}	94.11 ± 0.13^{p}

The means in each column with similar superscript (s) is non- significantly different while different letters are significantly different at $p \leq 0.05$

Table (2):

Mean ±SD of total phenolic, flavonoid content and antioxidant activity of yogurt treatments fortified with mango and pomegranate juices during storage at refrigerator temperature (4 °C) for 1,7 and14 days

Parameters	Storage period (d)	Control yogurt	Yogurt fortified with mango	Yogurt fortified with pomegranate	Probiotic yogurt	Probiotic yogurt fortified with mango	Probiotic yogurt fortified with pomegranate
Total phenolic content* (mg/100 g sample)	1	11.464 ± 1.18^{h}	16.555 ± 1.51^{d}	17.645 ± 1.63^{c}	11.952 ± 1.85^{a}	16.645 ± 1.13^{d}	18.555 ± 1.65^{b}
	7	9.122 ± 1.13^{j}	12.768 ± 1.33^{g}	13.638 ± 1.45^{f}	9.338 ± 1.24^{e}	12.824 ± 1.27^{g}	13.784 ± 1.38^{f}
	14	2.631 ± 1.17^{k}	10.645 ± 1.12^{i}	11.284 ± 1.26^{h}	2.873 ± 1.46^{f}	10.817± 1.07i	11.536 ± 1.18^{h}
Total flavonoid content* (mg/100 g sample)	1	1.607 ± 0.13^{i}	1.615 ± 0.14^{i}	1.937 ± 0.16^{f}	1.952 ± 0.16^{b}	1.937 ± 0.15^{f}	2.582 ± 0.16^{c}
	7	1.371 ± 0.17^{j}	1.265 ± 0.11^{k}	1.695 ± 0.12^{h}	1.559 ± 0.28^{d}	1.592 ± 0.11^{i}	2.116 ± 0.09^{e}
	14	1.245 ± 0.14^{k}	1.054 ± 0.12^{l}	1.359 ± 0.09^{j}	1.398 ± 0.16^{fg}	1.389 ± 0.11^{a}	1.798 ± 0.13^{g}
Antioxidant activity as (DPPH) %	1	46.44 ± 0.92^{o}	66.01 ± 0.88^{k}	89.77 ± 0.80^{c}	50.31± 0.27a	77.00 ± 0.72^{h}	93.15 ± 0.66^{b}
	7	38.76 ± 1.40^{p}	59.60 ± 1.12^{m}	83.93 ± 1.09^{e}	38.93 ± 1.63^{d}	70.82 ± 1.10^{j}	88.51 ± 1.05^{d}
	14	20.18 ± 0.69^{q}	52.75 ± 0.75^{n}	75.43 ± 0.89^{i}	20.79 ± 0.92^{g}	64.89 ± 0.79^{l}	82.67 ± 0.59^{f}

The means in each column with similar superscript (s) is non- significantly different while different letters are significantly different at $p \leq 0.05$

Table (3):

Mean ±SD of chemical composition for yogurt treatments fortified with mango and pomegranate juices during storage at refrigerator temperature (4 °C) for 1,7 and 14 days

Chemical composition	Storage period (d)	Control yogurt	Yogurt fortified with mango	Yogurt fortified with pomegranate	Probiotic yogurt	Probiotic yogurt fortified with mango	Probiotic yogurt fortified with pomegranate
Total solid g/100g	1	13.53± 0.01^{p}	16.23± 0.02^{f}	13.92± 0.02^{j}	13.62± 0.02^{o}	16.26± 0.03^{e}	13.95± 0.02^{i}
	7	13.61± 0.02^{o}	16.46± 0.03^{d}	13.85± 0.02^{kl}	13.69± 0.02^{n}	16.49± 0.03^{c}	13.86± 0.01^{k}
	14	13.82± 0.02^{c}	16.74± 0.02^{b}	14.28± 0.03^{h}	13.88± 0.02^{k}	16.77± 0.02^{a}	14.32± 0.02^{g}
Moisture g/100g	1	78.52± 0.02^{a}	75.94± 0.02^{g}	78.81± 0.01^{e}	78.42± 0.03^{c}	75.92± 0.03^{g}	78.76± 0.02^{e}
	7	78.17± 0.02^{b}	75.46± 0.03^{h}	78.69± 0.02^{d}	78.06± 0.03^{j}	75.43± 0.03^{h}	78.59± 0.01^{b}
	14	77.61± 0.06^{g}	74.84± 0.02^{i}	77.79± 0.02^{r}	77.54± 0.07^{gf}	74.80± 0.02^{i}	77.64± 0.02^{gf}
Fat g/100g	1	3.29± 0.02^{f}	3.26± 0.01^{fg}	3.05± 0.02^{j}	3.27± 0.01^{f}	3.22± 0.01^{gh}	3.07± 0.02^{j}
	7	3.48± 0.03^{d}	3.44± 0.03^{de}	3.16± 0.03^{i}	3.48± 0.02^{d}	3.40± 0.02^{e}	3.19± 0.03^{hi}
	14	3.65± 0.01^{a}	3.59± 0.01^{b}	3.48± 0.01^{d}	3.66± 0.01^{a}	3.57± 0.01^{bc}	3.54± 0.03^{c}
Protein g/100g	1	3.74± 0.02^{de}	3.63± 0.02^{g}	3.29± 0.01^{l}	3.77± 0.02^{d}	3.65± 0.01^{g}	3.28± 0.02^{l}
	7	3.81± 0.03^{c}	3.69± 0.02^{f}	3.37± 0.02^{k}	3.85± 0.02^{b}	3.73± 0.01^{e}	3.41± 0.02^{j}
	14	3.96± 0.01^{a}	3.85± 0.01^{b}	3.49± 0.01^{i}	3.95± 0.01^{a}	3.88± 0.01^{b}	3.54± 0.02^{h}
Ash g/100g	1	0.92± 0.01^{e}	0.94± 0.01^{cde}	0.93± 0.01^{de}	0.92± 0.01^{e}	0.95± 0.01^{bcd}	0.94± 0.01^{cde}
	7	0.93± 0.01^{de}	0.95± 0.01^{bcd}	0.93± 0.01^{de}	0.92± 0.01^{e}	0.95± 0.03^{ab}c	0.95± 0.03^{bcd}
	14	0.96± 0.01^{bc}	0.98± 0.01^{a}	0.96± 0.01^{abc}	0.97± 0.01^{ab}	0.98± 0.02^{a}	0.96± 0.01^{abc}

This means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at p ≤ 0.05

Table (4):

Mean ±SD of pH and acidity values of yogurt fortified with mango and pomegranate juices during storage at refrigerator temperature (4 °C) for 1,7 and 14 days

Treatment	Storage period (d)	pH	Acidity (%)
Mango Juice	0	4.51 ± 0.01^{o}	0.46 ± 0.01^{l}
Pomegranate Juice	0	3.86 ± 0.01^{p}	1.04 ± 0.01^{m}
Control yogurt	1	4.69 ± 0.02^{a}	0.84 ± 0.01^{k}
	7	4.44 ± 0.02^{c}	0.90 ± 0.01^{i}
	14	3.98 ± 0.03^{k}	0.96 ± 0.02^{c}
Yogurt fortified with mango	1	4.41 ± 0.01^{d}	0.91 ± 0.01^{h}
	7	4.29 ± 0.02^{f}	0.93 ± 0.02^{f}
	14	3.90 ± 0.02^{m}	0.97 ± 0.02^{b}
Yogurt fortified with pomegranate	1	4.29 ± 0.02^{f}	0.93 ± 0.01^{f}
	7	4.15 ± 0.03^{g}	0.94 ± 0.02^{e}
	14	4.08 ± 0.02^{i}	0.95 ± 0.01^{d}
Probiotic yogurt	1	4.52 ± 0.01^{b}	0.89 ± 0.01^{j}
	7	4.41 ± 0.01^{d}	0.91 ± 0.01^{h}
	14	3.89 ± 0.01^{m}	0.97 ± 0.01^{b}
Probiotic yogurt fortified with mango	1	4.34 ± 0.01^{e}	0.92 ± 0.01^{g}
	7	4.05 ± 0.03^{j}	0.95 ± 0.02^{d}
	14	3.63 ± 0.02^{n}	0.99 ± 0.01^{a}
Probiotic yogurt fortified with pomegranate	1	4.13 ± 0.02^{h}	0.94 ± 0.01^{e}
	7	4.05 ± 0.03^{j}	0.95 ± 0.02^{d}
	14	3.92 ± 0.02^{l}	0.97 ± 0.01^{b}

This means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at $p \leq 0.05$

Table (5):

Mean ±SD of syneresis and viscosity values of yogurt treatments fortified with mango and pomegranate juices during storage at refrigerator temperature (4 °C) for 1,7 and 14 days

Sensory Parameters	Storage period (d)	Control yogurt	Yogurt fortified with mango	Yogurt fortified with pomegranate	Probiotic yogurt	Probiotic yogurt fortified with mango	Probiotic yogurt fortified with pomegranate
Whey syneresis (ml)	1	6.6± 0.7^{j}	7.10± 0.5^{ghi}	7.50± 0.6^{g}	6.6± 0.7^{ij}	6.90± 0.7^{hi}	7.30± 0.6^{gh}
	7	9.6± 0.6^{f}	10.50± 0.5^{e}	11.60± 0.5^{cd}	9.4± 0.5^{f}	10.30± 0.9^{e}	11.30± 1.0^{d}
	14	11.9± 0.7^{c}	13.00± 0.9^{b}	13.80± 1.2^{a}	11.9± 0.9^{c}	12.90± 1.1^{b}	13.40± 1.3^{ab}
Viscosity (cP)	1	163± 11^{a}	159± 10^{ab}	155± 11^{bc}	165± 15^{a}	161± 10^{ab}	150± 12^{c}
	7	137± 14^{f}	135± 13^{e}	128± 11^{f}	143± 12^{d}	137± 12de	125± 13^{f}
	14	88±9^{gh}	82±8^{hi}	80±10^{ij}	89±8^{g}	84±9^{ghi}	75±9^{j}

The means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at p ≤ 0.05

Table (6):

Mean ±SD of organoleptic evaluation of yogurt treatments fortified with mango and pomegranate during storage at refrigerator temperature (4 °C) for 1,7 and 14 days

Sensory Parameters	Storage period (d)	Control yogurt	Yogurt fortified with mango	Yogurt fortified with pomegranate	Probiotic yogurt	Probiotic yogurt fortified with mango	Probiotic yogurt fortified with pomegranate
Body and texture (30%)	1	29.0± 0.23^{a}	29.0± 0.22^{a}	26.0± 0.24^{f}	28.1± 0.22^{c}	29.0± 0.22^{a}	28.5± 0.23b
	7	28.0± 0.22^{d}	28.0± 0.20^{d}	25.0± 0.22^{g}	26.8± 0.22^{e}	28.0± 0.21^{d}	25.0± 0.23^{g}
	14	25.0± 0.21^{g}	26± 0.21^{f}	24.0± 0.22^{h}	22.5± 0.22^{i}	25.0± 0.20^{g}	22.0± 0.22^{j}
Acidity (10%)	1	9.5± 0.19^{a}	9.5± 0.21^{a}	9.2± 0.21^{b}	9.2± 0.20^{b}	9.0± 0.2^{c}	9.0± 0.20^{c}
	7	8.1± 0.20^{g}	8.0± 0.18^{h}	7.8± 0.19^{i}	8.7± 0.21^{d}	7.8± 0.19^{i}	7.8± 0.21^{i}
	14	8.5± 0.20^{e}	8.2± 0.19^{f}	6.5± 0.19^{k}	8.5± 0.19^{e}	7.5± 0.20^{j}	6.0± 0.20l
Appearance (15%)	1	14.3± 0.17^{ab}	14.5± 0.17^{a}	13.0± 0.16^{e}	13.8± 0.18^{bc}	14.0± 0.19^{cd}	13.0± 0.17^{e}
	7	13.8± 0.15^{d}	14.0± 0.16^{cd}	12.5± 0.15^{f}	13.0± 0.17^{e}	14.0± 0.18^{cd}	12.0± 0.18^{g}
	14	12.1± 0.20^{g}	12.0± 0.21^{g}	12.0± 0.20^{g}	12.0± 0.19^{g}	11.5± 0.22^{h}	11.0± 0.20^{i}
Flavor (45%)	1	44.1± 0.24^{b}	44.5± 0.23^{a}	43.5± 0.20^{c}	42.1± 0.23^{f}	42.0± $0.24f^{g}$	42.5± 0.22^{e}
	7	43.2± 0.22^{d}	44.0± 0.23^{b}	42.0± $0.21f^{g}$	42.5± 0.23^{e}	41.0± 0.23^{i}	41.5± 0.22^{g}
	14	40.4± 0.23^{j}	41.5± 0.22^{h}	39.0± 0.22^{k}	39.0± 0.22^{k}	38.0± 0.23^{l}	37.5± 0.21^{m}
Overall accepta bility (100%)	1	96.9± 0.83^{b}	97.5± 0.83^{a}	91.7± 0.81^{e}	93.2± 0.83^{d}	94.0± 0.85^{c}	93.0± 0.82^{d}
	7	94.1± 0.21^{c}	94.0± 0.77^{c}	87.3± 0.68^{h}	91.0± 0.83^{f}	90.8± 0.81^{f}	86.0± 1.14^{i}
	14	86.0± 0.84^{i}	87.7± 0.83^{g}	81.5± 0.83^{k}	82.0± 0.82^{j}	82.0± 0.85^{j}	76.5± 0.83^{l}

The means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at $p \le 0.05$

Table (7):

Mean ±SD of phenolic components for of yogurt fortified with mango and pomegranate juices' treatments analyzed by HPLC

Phenol Components	Conc. (µg/ml)							
	Control yogurt	Probiotic yogurt	Mango juice	Yogurt fortified with mango	Probiotic yogurt fortified with mango	Pomegranate juice	Yogurt fortified with pomegranate	Probiotic yogurt fortified with pomegranate
Gallic acid	0.87± 0.01^{a}	0.99± 0.01^{b}	10.8± 0.01^{c}	1.05± 0.01^{d}	1.73± 0.01e^{a}	33.54±0.01^{f}	2.27± 0.01^{g}	2.36± 0.01^{h}
Chlorogenic acid	0.42± 0.01^{a}	1.55± 0.01^{b}	4.36± 0.01^{c}	1.10± 0.01^{d}	1.24± 0.01^{e}	5.75± 0.01^{f}	0.81± 0.01^{g}	0.25± 0.01^{h}
Catechin	ND	ND	3.35± 0.01^{a}	ND	ND	27.43±0.01^{b}	1.94± 0.01^{c}	1.22± 0.01^{d}
Methyl gallate	ND	ND	1.62± 0.01^{a}	ND	ND	5.74± 0.01^{b}	0.36± 0.01^{c}	0.28± 0.01^{c}
Coffeic acid	ND	ND	0.83± 0.01^{a}	ND	ND	0.77± 0.01^{b}	0.09± 0.01^{c}	ND
Syringic acid	0.17± 0.01^{a}	ND	9.85± 0.01^{b}	0.92± 0.01^{c}	0.62± 0.01^{d}	ND	ND	ND
Pyro catechol	ND	ND	ND	ND	ND	3.53± 0.01^{a}	ND	ND
Rutin	ND	ND	ND	ND	ND	0.62± 0.01^{a}	ND	ND
Ellagic acid	ND	ND	4.11± 0.01^{a}	ND	ND	9.40± 0.01^{b}	ND	ND
Coumaric acid	ND	ND	ND	ND	ND	3.80± 0.01^{a}	0.34± 0.01^{b}	0.21± 0.01^{c}
Ferulic acid	ND	ND	1.83± 0.01^{a}	0.16± 0.01^{b}	0.11± 0.01^{c}	2.99± 0.01^{d}	0.06± 0.01^{e}	0.09± 0.01^{f}
Naringenin	0.13± 0.01^{a}	0.40± 0.01^{b}	0.72± 0.01^{c}	ND	ND	3.20± 0.01^{d}	0.05± 0.01^{e}	0.45± 0.01^{f}
Daidzein	0.18± 0.01^{a}	ND	0.35± 0.01^{b}	0.21± 0.01^{c}	ND	ND	ND	ND
Quercetin	ND	ND	3.35± 0.01^{a}	0.67± 0.01^{b}	0.10± 0.01^{c}	1.58± 0.01^{d}	0.96± 0.01^{e}	ND

ND: not detected, the means each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at $p \le 0.05$

Table (8):

Viable counts of lactic acid bacteria (CFU/g) of yogurt fortified with mango and pomegranate juices during storage at 4°C for 1,7 and 14 days.

Treatment	Storage period (d)	Lactobacillus	Streptococcus
		CFU×10^6/g	
Control yogurt	1	8.46±0.02^{cd}	8.50±0.02^{d}
	7	8.34±0.04^{de}	8.38±0.03^{e}
	14	6.73±0.01^{f}	7.61±0.01^{h}
Yogurt fortified with mango juice	1	8.53±0.02^{c}	8.61±0.01^{c}
	7	8.67±0.04^{b}	8.68±0.02^{b}
	14	8.82±0.02^{a}	8.74±0.02^{a}
Yogurt fortified with pomegranate juice	1	8.32±0.02^{e}	8.36±0.01^{f}
	7	8.27±0.03^{e}	8.31±0.02^{g}
	14	6.56±0.03^{f}	7.48±0.01^{i}

The means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at p ≤ 0.05

Table (9):

Viable counts of lactic acid bacteria and *Bifidobacterium* (CFU/g) of yogurt fortified with mango and pomegranate juices during storage at refrigerator temperature (4°C) for 1, 7 and 14 days.

Treatment	Storage period (d)	Lactobacillus	Streptococcus	Bifidobacterium
		CFU×10^6/g		
Probiotic yogurt	1	8.55±0.01^{d}	8.54±0.02^{d}	8.89±0.01^{b}
	7	8.38±0.03^{e}	8.41±0.04^{e}	8.63±0.02^{e}
	14	6.77±0.01^{g}	7.70±0.02^{g}	8.11±0.01^{g}
Probiotic yogurt fortified with mango juice	1	8.58±0.02^{c}	8.67±0.02^{c}	8.87±0.01^{c}
	7	8.69±0.03^{b}	8.75±0.03^{b}	8.90±0.02^{ab}
	14	8.82±0.02^{a}	8.84±0.03^{a}	8.91±0.01^{a}
Probiotic yogurt fortified with pomegranate juice	1	8.37±0.01^{e}	8.41±0.01^{e}	8.77±0.02^{d}
	7	8.29±0.02^{f}	8.30±0.01^{f}	8.54±0.02^{f}
	14	6.48±0.02^{h}	7.50±0.02^{h}	8.03±0.03^{h}

The means in each column with similar superscript letter (s) is non- significantly different while different letters are significantly different at p ≤ 0.05

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دراسة مقارنة لتأثير إضافة عصير المانجو و الرمان على زبادي بالبروبيوتيك

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المستخلص

الهدف من الدراسة الحالية معرفة تأثير إضافة عصائر المانجو والرمان إلى زبادي البروبيوتيك. تم أضافة 10 % من عصير المانجو (*Mangifera indiea* L.) وعصير الرمان (*Punica granatum* L.) إلى الزبادي مع أو بدون بكتيريا البروبيوتيك ، خلال فترة التخزين من 1 و 7 و 14 يومًا عند 4 درجة مئوية. تم تقديرالتركيب الكيميائي لجميع العينات ، الشرش ، اللزوجة ، الفينولات الكلية ، الفلافونويدات الكلية ، النشاط المضاد للأكسدة والتقييم الحسي . أظهرت النتائج أن نسبة الدهون والبروتينات والرماد وكذلك كمية المركبات الفينولية والفلافونويدات والنشاط المضاد للأكسدة لعصير الرمان كان أعلى من عصير المانجو. كما أوضحت النتائج أن الزبادي المدعم بعصير الرمان أحتوى على درجة pH منخفضة (4.29±0.02) وأعلى درجة للحموضة (0.93±0.01). أدت إضافة *Bifidobacterium* إلى الزبادي الكنترول كبكتيريا بروبيوتيك إلى زيادة المواد الصلبة الكلية. كما أدى تدعيم زبادي البروبيوتيك بعصير المانجو إلى ارتفاع نسبة المواد الصلبة الكلية (16.26±0.03) واللزوجة (10±161سنتيبواز) أكثر من عصير الرمان (12±150 و 13.95±0.03) على التوالي. . و بشكل عام ، قلت جميع المعاملات تدريجياً خلال فترات التخزين. وأظهرت النتائج ايضا أن gallic acid و catechin هى المركبات الفينولية السائدة في الزبادي المدعم بعصير الرمان و زبادي البروبيوتيك المدعم بعصير الرمان.

وخلصت الدراسة إلى أن إضافة عصير الرمان إلى زبادي البروبيوتيك كان أفضل من أضافة عصير المانجو لاحتوائه على العديد من المركبات الفينولية والفلافونويدات ونشاط مضادات الأكسدة. على الرغم من أن القبول العام له كان أقل و كان أعلى في كمية الشرش.

الكلمات المفتاحية: عصير المانجو ، عصير الرمان ، المركبات الفينولية ، النشاط المضادات للأكسدة ، البروبيوتيك ، التقييم الحسي ، اللزوجة والشرش.