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Evaluation of Rheological, Physicochemical, and Sensory properties of *Gundelia tournefortii* yogurt

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ABSTRACT
The influence of Gundelia tournefortii puree percentages 0, 1, 3, 5, 10, 15 and 20% were added to the stirred yogurts on the Physicochemical properties include Acidity, pH, syneresis, sensory quality of yoghurt samples were determined during 1, 7, 14, and 21 days of storage. Rheological behavior include flow properties of the final product in order to follow n (flow behavior index) and K (consistency index), and the apparent viscosity (μ_e in mpa.s) by a means of Brookfield model rheometer and range of 0.136-0.323 1/s in a total time of 18 minutes of yoghurt samples were determined during21 days of storage. There were significantly differences between plain yogurt and Gundelia tournefortii yogurt in the pH and titratable acidity amounts 1 day of storage. The results showed that acid during storage was increased to fourteen days, but 21 days of storage decreased although Again Gundelia tournefortii yogurt samples were more acid than plain yogurt. lowest values for syneresis were belonged to Gundelia tournefortii yogurt with 15 % and 20% and 21 days storage. Plain yogurt and Gundelia tournefortii yogurt samples during21 days no coliform bacteria, E. coli, mold and yeast were not. All samples were treated sudoplastic. Sensory evaluation results showed that there were no significant differences about shelf life among the yoghurt samples but there were significant differences About concentration. The yoghurt containing Ggundelia tournefortii 20% had the highest overall acceptability scores as compare to other Gundelia tournefortii yogurt samples and also plain yogurt. The results of current study demonstrated that the addition of Gundelia tournefortii puree to the yogurt significantly improved the quality of yogurt.
Key word: *Gundelia tournefortii* yogurts, Rheological behavior, Storage time & concentration.

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INTRODUCTION

Food rheology is the study of the deformation and flow of food materials [1]. Yoghurt is a dairy food with complex rheology that depends on temperature, solids concentration and the physical state of fats and proteins present in the milk. An understanding of the rheological properties of yoghurt is important to texture, stability, and process design [2]. Between all milk fermented products, yoghurt is more well-known than others and has more acceptability in the world [32]. It is easily digested, has high nutritional value and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus [3]. The natural and usual yoghurt is produced by adding the certain lactic acid bacteria that increase the lactic acid content of yogurt [5]. Stirred yogurt is made by fermenting milk and stirring the set curd to break the rigid gel structure to obtain a viscous liquid [33]. The product is accepted by consumer for its flavor and aroma, (mainly acetaldehyde) and pleasant texture [3]. Several yogurt-based products are marketed with the addition of either fruit or vegetables rich in bioactive food ingredients or edible fibers claimed to have beneficial effects on human health product [7]. The rationale behind these enrichments is that the ease of consumption of yogurt may improve body health status by maintaining a favorable intestinal microbial profile, possibly lowering cholesterol and blood pressure, and at the same time provide an optimal intake of bioactive components, often with beneficial antioxidant and free radical scavenging capacities. This policy matches the high expectations of consumers and in turn encourages the consumption of fermented dairy products [7]. Lario et al. found that the addition of fiber from oranges caused a slight decrease in the pH of milk; This decrease did not affect the fermentation process of the yogurt; however, the rheological properties of the yogurt were modified by addition of fiber from orange and depended on the dose of this fiber: 1% fiber addition reduced yogurt syneresis and improved textural properties, increasing gel firmness [37]. Salwa et al., 2004 stated that the use of carrot with yoghurt was advantageous due to its antibacterial and antifungal properties as well as its inhibitory effect on aflatoxin M1[19]. Bachir Raho Ghalem, and Benattouche Zouaoui, 2013 reported that addition of *R. officinalis* essential oil enhanced the qualities of yogurt [6]. The kind of flavorings and their concentration is usually regulated according to the international standard say by each country [5]. According to Iranian Standard (No. 4046) vegetables yoghurt is a product which is made by adding Variety of fresh or dried vegetables such as mint, oregano, spinach, basil, tarragon, celery, carrots, cucumber, boiled beets, shallots, etc. to yoghurt [8].

Gundelia (Gundelia tournefortii) is a member of the *Asteraceae (Compositae)* family which grows in the semi-desert areas of Iran, Jordan, Palestine, Syria, Iraq, Syria, Anatolia and other countries. Traditionally, *G. tournefortii* is used for treatment of liver diseases, diabetes, chest pain, heart stroke, gastric pain, vitiligo, diarrhea and bronchitis. It is also reported to have hypoglycaemic, Laxative, sedative, anti-inflammatory, anti-parasite, antiseptic and emetic effects. Compounds found in *gundelia* proved to have several pharmacological effects, e.g. antibacterial, anti-inflammatory, hepatoprotective, antioxidant, antiplatelet and hypolipemic activities. The observed pharmacological properties indicated a close association of these effects with infectious diseases, digestive disorders, high blood pressure and cancer. In traditional medicine, this plant has been prescribed in many disorders [9]. Therefore, *Gundelia tournefortii* can be used in yoghurts production for improving their quality properties. The objectives of this study were to evaluate the physicochemical, microbiological, rheological properties and sensory quality of yoghurts with different percentage of *Gundelia tournefortii* puree during storage period and compare them with plain yogurt.

MATERIALS AND METHODS

Materials

Fresh cow's milk, Skim milk powder, salt (Nacl), yoghurt culture including *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus*, and microbial media were obtained from the dairy factory of Golriz, Iran. *Gundelia tournefortii* were obtained from the local market of Isfahan, Iran. Experimental yoghurts with viscometer Brookfield Digital Rheometer model DV-III+ (Brookfield, Middleboro, USA), were developed in the foods lab, Sugar Factory of chahar Mahal , Iran.

Bacterial Starter Cultures: Yoghurt starter culture (YC-X11 DIP 50u) contains *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *Bulgaricus* mark Chr. Hansens, Denmark was obtained from factory of Golriz , Iran and activated at 42°C using 12% sterilized reconstituted skim milk. After incubation at 42°C for 4-5 h, the obtained working culture was freshly used.

Gundelia tournefortii puree production

Rosalia ferracane et al. demonstrated that some common cooking treatments can be used to enhance the nutritional value of vegetables, increasing bioaccessibility of health-promoting constituents [10]. *Gundelia tournefortii* were first cleaned, thorns and frills were taken, washed, and heat treated at 100 °C for 15 min, then, its pulp was obtained from the crushed G*undelia tournefortii*, and filled into the sterile jars. This pulp was stored at freeze temperature until after thaw and at ambient temperature added to yogurt. Trails were carried out to standardize the *Gundelia tournefortii* yoghurt.

Yoghurt production

Stirred G*undelia tournefortii* yoghurt with different concentrations manufactured according to the procedure of Manjula et al., [11] with some modifications as follows: Cow's milk (milk fat 3%, total solids 12.3% and acidity 0.17%) was used for yoghurt production and 2% Skimmed milk powder was added to increase solids milk. The milk was heated to 60°C and homogenized. The milk was pasteurized at 85°C for 30 min, and then rapidly cooled to 45°C. *Streptococcus thermophilus* and *Lactobacillus delbrueckii bulgaricus* as starter culture were added at the rate of 2% (w/v) into the milk. The inoculated milk was incubated at 42°C until pH was reached to 4.5. The yoghurt samples were cooled to 25 °C by resting in a temperature controlled room (15 °C) and then stored at 3–5 °C for a period of 12 hours. The yoghurt was stirred to smoothen and to obtain semisolid consistency. 1, 3, 5, 10, 15 and 20 % of *gundelia tournefortii* pulp with 0.7% of salt (Nacl) were added to the smoothened yoghurt. The samples were Mixed with electric stirrer, packed into suitable packing material, then stored under refrigeration i.e., bellow 5°C. Along with *gundelia tournefortii* yoghurt one control yoghurt was also prepared without addition of *gundelia tournefortii* pulp. The experimental yoghurt and control yoghurt were stored in the refrigerator for 21 days. The yoghurt samples were analyzed in triplicate at during at 1, 7, 14, and 21 days storage.

Analytical Methods

Physicochemical Analysis

Syneresis

One hundred grams of each sample was placed on a filter paper resting on a funnel. After 2 hours at 7°C, the weight of whey collected was used as syneresis [5]. The samples analysis was performed in triplicate at during 1, 7,14 ,and 21 days storage.

Determination of titratable acidity

Titratable acidity was determined in milk and yogurt samples at room temperature. The titratable acidity of the yoghurt samples was done according to the procedure of Zekai TARAKÇI., [12] with some modifications as follows: The titratable acidity after mixing yogurt samples (10 g) with 10 mL of distilled water was determined as lactic acid percentage (LA%) by titrating with 0.1 N NaOH, using 0.5%phenolphthalein as an indicator. The samples analysis was performed in triplicate at during 1, 7, 14, and 21 days storage.

Determination of pH

pH of the milk and yogurt samples was determined with a Methrohm pH meter 691(Switzerland) at room temperature [13] . The samples analysis was performed in triplicate at during 1, 7, 14, and 21 days storage.

Sensory evaluation

Sensory analysis of the yoghurt samples was done according to the procedure of Zekai TARAKÇI., [12] with some modifications as follows: The order of presentation of samples was randomized and different 3-digit number codes were used for the sample sets in daylight, who were asked to evaluate each sample in turn covering a list of judged parameter attributes using a 7 point Hedonic Scale with 1 being the worst (1, very poor; 7, very good). The score given by panellists for each sample was noted separately. The qualities judged were: exterior appearance (by looking to yogurt sample in daylight directly), consistency by spoon (by gentle mixing yogurt with a spoon), odor and taste intensity. To determine odor and taste intensity, a spoon of yogurt is taken and spreaded out by tongue. The overall acceptability was calculated as sum of the scores of the parameters judged. The yogurts were evaluated in triplicate at during 1, 7, 14, and 21 days of storing by seven panelists familiar with yogurt: 4 were female and 3 were male and ages ranged from 22 to 40 y. Water was provided for mouth washing between samples.

Microbiological analysis

Yoghurt samples were diluted according to the procedure of Okoye and Animalu [15] with some modifications as follows: The samples (5 g) were weighed aseptically diluted with 45 mL of buffered peptone water. Thus, the first dilution of 10^{-1} was obtained; the other dilutions were prepared from this first 10^{-1} dilution to dilutions of 10^{-3}[14] . Potato dextrose agar was used for *fungal* (*yeast* and *mold*) count at 28°C for 4 days [15]. Procedure Coliform count of the yoghurt samples was determined procedure as follows:. One gram of each sample of yoghurt was serially diluted to 10^{-3}. 0.1 millilitre of each dilution was plated on [15] violet red bile agar plates and incubated at 37°C for 24h [14]. The colony forming unit per millilitre sample (cfu/ml) was counted in each case with the aid of electronic colony counter [15]. All media were provided by Merck [14]. The above procedure was repeated for E.coli count except that luryl sulphat agar was used at 37°C in place of violet red bile agar. The samples microbiological analysis was performed in triplicate at during 1, 7, 14 ,and 21 days storage.

Rheological Measurements

Rheological properties of the yogurt samples after 24 h of storage at 4°C were Determined according to the procedure of Mircea-Adrian OROIAN, Gheorghe GUTT., [16] with some modifications as follows: apparent viscosity (η) measurements with different shear rates ranging from 0.136 to 0.323 s^{-1} were carried out on the *gundelia tournefortii* yogurt samples at ambient temperature (25°C), with a Brookfield Digital Rheometer model DV-III+ (Brookfield, Middleboro, USA). The spindle was used in accordance with the sample nature to get all readings within the scale. The samples (according to the Brookfield requests) were kept in a thermostatically controlled water bath for about 10 min before measurements in order to attain desirable temperature of 25°C. All measurements were carried out on 50 g of each sample that was previously prepared by gently stirring in identical conditions in during every day of experiment. The samples were stirred for 40 seconds before measurement. First measurements were taken 2 min after the spindle was immersed in each sample, so as to allow thermal equilibrium in the sample, and to eliminate the effect of immediate time dependence. All data were then taken after 50 s in each sample. Each measurement was carried out triplicate on the sample in during 1, 7, 14 and 21 days storage. The total analysis time was 18 min and collected 210 points in total. For each sample the shear stress (τ) was recorded for shear rates (γ) ranging from0.136 to 0.323 s^{-1}.

The shear rate versus shear stress data were interpreted using the Hersch-Bulkley expression [22];

Viscosity: $\eta = \tau_0/\gamma^{\bullet} + K\gamma^{\bullet n-1}$

Shear stress: $\tau = \tau_0 + K\gamma^{\bullet n}$

Where:

η = Viscosity(pa.s), (mpa.s)

κ= *consistency index*(pa.s^n), (mpa.s^n)
n= *behavior index* (dim *ensionless*)
τ= Shear stress(pa), (mpa)
$\gamma^\bullet$ = Shear rate(s^{-1})
τ_0=yield *strength*

Statistical analysis

All experiments were carried out in triplicate, and the analysis carried out for each treatment batch was at least for three samples [18]. Data were analyzed for treatment effects, storage time effects, and treatment by storage time interactions [34]. All data obtained were expressed as mean values ± standard deviation [18]. Means and standard deviations (SD) of data were calculated with SPSS (version 20.0, IBM SPSS.). Statistical software SPSS was used to perform [10] two-way analysis of variance (ANOVA) [35], and least significant difference test (LSD) at a 95% confidence level (p < 0.05) to identify differences among groups [10]. Curves design was carried out using the software Microsoft Excel 2007.

RESULTS AND DISCUSSION

Physicochemical Composition

The data given in Table 3, fig.1, and fig.2 indicated that time storage and concentration had significant effect on the resulting acidity, pH, and synersis of the prepared yoghurt samples ($p<0.05$). The pH values decreased while the titratable acidity increased gradually but have enhanced the pH and have decreased the titratable acidity, after14th day in all yogurt samples, during 21 days of storage. The decrease in acidity of *gundelia tournefortii* yogurt with increase of concentration might be due to the acidity of *gundelia tournefortii* . Morvarid Yousef et al., [6] reported that the increase in acidity of fruit yogurt might be due to the acidity of apple, banana and strawberry fruits. This might be due to the higher TS content (low moisture) in fruit yogurt which affects the activity of *lactic acid bacteria*, while Yan Wen *et al.,* (2011) reported that Compared to the acid production in the control yoghurt, treatment of skimmed milk with *horseradish peroxidase (HRP)* or the combination of HRP and Ferulic acid (FA) did not show any impact on the acid production in the yoghurt samples. These results mean that the treatment of skimmed milk had no impact on the fermentation or main chemical composition of the yoghurt samples, *i.e*. the different rheological properties of the prepared yoghurt samples are not the result of their different composition or acidity. Salwa *et al*., [39] reported that the acidity increased and the pH decreased during the storage period especially for samples with 15 and 20% carrot juice may be due to the excessive sugar fermentation and the presence of *lactic acid producing organisms*, or may be due to the presence of phenols and polyphenols components which naturally present in carrot. Nafiseh Vahedi *et al.*, [33] reported that pH value increased after14th day in strawberry and 21th day in apple yoghurt and stated that as sugar sources finish, microorganisms begin to consume proteins and producing some products by microorganisms, will result in pH increase.

Okoye et al .,[15] reported that the pH and the titrable acidity of the yoghurt samples was significantly different from each other ($p<0.05$). The differences could be due to variation in the growth of *lactic acid bacteria* during fermentation [15]. Amna Mahmood et al. [12] reported that the variation in pH value might be due to the environmental temperature, humidity and exposure to the sun [12]. In both of control and *gundelia tournefortii* yogurt the highest of pH related to the first day of production with limit (4.31-4.50) and the lowest of pH related to the 21th day with limit (4.24-4.38) while the lowest of titratable acidity belong to the first day of production with limit (85.33-98) and the highest of titratable acidity related to the 14th day with limit (93-116). Morvarid Yousef et al. [14] reported that this phenomena was due to the growth of lactic acid bacteria and produced the lactic acid, which was due to the especial synergism between Lac. Spp and Strep. spp. *L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus* are responsible for the post acidification of yogurt during cold storage.The lactic acid produced as a consequence of the metabolic activity of *lactic acid bacteria* causes the increase of milk acidity and the reduction of the pH [22]. Parmjit and Chetan Shinde [39] stated that decrease in pH might be attributed to the utilization of residual carbohydrates by viable microorganisms and production of lactic acid, small amounts of co_2 and formic acid from lactose. Vahedi et al., (2008) reported that decrease in pH is due to the microorganisms activity, whereas Kailasapathy [39] stated that post-acidification, during storage is due to B-galactosidase which is still active at 0-5$\hat{C}$. In this case, pH may be decrease to less than 4.2.Some researchers suggested that the drop in pH during storage period is due to residual enzymes produced by starters during fermentation.

Reasons that pH is at limit (4.30-4.40) may be due to:

The pH values were approximately at limit (4.30-4.40) during the storage period especially for samples with10, 15 and 20% G*undelia tournefortii* pulp. This phenomena may be due to the presence of phenolic compounds present in *Gundelia tournefortii*. Konstantinos B. Petrotos *et al., (2012)* reported that sample A which was spiked with 1000 ppm of encapsulated Olive Fruit polyphenols exhibited a fast drop of pH value in the incubator and reached the critical pH value of 4.6 faster than the sample B without polyphenols, thus implying a benefit in energy costs and in production time for the polyphenol enriched yogurt. At the same time, in the long term, during storage of the product in chilled conditions (0-4 ^{o}C) the polyphenols seem to exert a protective effect against post-acidification of the yogurt and stabilize the pH value approximately at 4.4 while the same value for non polyphenol-enriched yogurt (Sample B) approaches a value of 4.2 at 25 day, which is not organoleptically acceptable by the consumer. This means that the presence of the polyphenols can extend the shelf life of the product by more than 10 days. *R. officinalis* oil as mentioned by Moreno et al. [6], contained high levels of phenolic compounds that contributed to the maintenance of lower pH in cheese (a dairy product like yoghurt).

Syneresis

The syneresis is a measure of the quantity of whey separated from the yogurt and is one of the most important factors influencing consumers' acceptance [22]. Higher level of syneresis shows that yogurt is of low quality. The syneresis of the prepared yoghurt samples were affected significantly (P<0.05) by both G*undelia tournefortii* concentration and storage time. In both of control and G*undelia tournefortii* yogurt the highest of syneresis related to the first day of production with limit (8-19.1) and the lowest of syneresis related to the 21th day with limit (3.5-6.4).

Reasons for decreasing syneresis in both control and *Gundelia tournefortii* yogurt might be:

Yogurt was homogenized before fermentation; the intensity of syneresis is higher in the case of yogurts with low levels of fat [22]. Piyawan Supavititpatana (2010) reported that the higher syneresis of the cow milk yogurt possibly resulted from the less gel strength. the commercial yogurt was homogenized before fermentation. Homogenization produces small-sized fat globules. As a result, more protein is absorbed on the surface of the fat globules, leading to increased ability to immobilize water but the gel of the cow milk yogurt had lower consistency. the consistency of the yogurt is related to the strength of the protein-protein interactions of the gel structure.

Pulp content in yogurt formulation, the preparation of yogurt under controlled condition; the excessive whey separation may be a consequence of overcoming the fermentation or storage temperature, of inadequate cooling or of improper handling while in containers during storage and distribution. The syneresis can be usually limited or eliminated by increasing the milk solids content. Anyway, certain food additives used for yogurt stabilization can affect the sensory properties of the final product [22]. Morvarid Yousef et al., (2013) reported that with increase to pulp content in yogurt formulation was expected water absorption will be increased and therefore syneresis decreased. *Nafiseh Vahedi et al., (2008*) reported that in apple yoghurt by increasing fruit amount, synersis decreased in both conditions (before and after fermentation). Synersis was lower in samples which fruit cubes were added to them after fermentation. Because of high acidity of strawberry, by increasing fruit amount, acidity increased too and starter's activity had affected and synersis increased. 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. Amna Mahmood et al.,(2008) reported that a decrease in the value of syneresis was recorded over the storage, because the yogurts were prepared under controlled conditions and stored in screw capped bottles. Salwa et al (2004) reported that the syneresis increased with the increase of the concentration of added carrot juice and with the increase of storage period.

According to Tamime, low pH values can promote syneresis of yogurt, due to excessive repulsion charges [23]. The levels of syneresis decreased as the final fermentation pH decreased [12].

Rheological properties of yoghurt

Food rheology is the study of the deformation and flow of food materials [1]. The rheological properties of stirred yogurt have been well studied; their flow properties are characteristic of a non-Newtonian and weakly viscoelastic fluid [25]. Lee and Lucey (2006) found that the rheological properties of stirred yogurts were greatly influenced by the physical properties of the original intact (set) yogurt gels. Rotational viscometers, such as the Brookfield viscometer, are often used to characterize the flow behavior of stirred yogurts. It should be noted that the power law model does not have a yield stress term while all stirred yogurts have yield stress unless they have been sheared first and no recovery time allowed to rebuild some structures [1]. The viscosity is an important parameter that can be successfully used for comparing the quality of the yogurt samples prepared in different conditions [22].

The rheological tests showed that the products studied demonstrated non-Newtonian behavior (shear thinning), which could be described with Herschell-Bulkley rheological model [24]. The decrease of the apparent viscosity of all studied samples with the increase of the shear rate indicates the pseudo-plastic behavior, with time dependent structural viscosity [22]. All values of flow index (n) were less than1. Thiago Rocha dos Santos MATHIAS et al. [23] observed All values of flow index (n) were less than 1, confirming the pseudoplastic characteristic. According to Horne and Lucey [23] this can occur due to physical destruction of weak bonds between the molecules of the product and due to decreased energy of interaction between them [23]. Aprodu *et al*., [22] reported that the apparent viscosity reaches a plateau of constant values, meaning that the destruction and the reformation rate of the protein aggregates are comparable. Hojjat Karazhiyan *et al*. [26] reported that For all samples, an increase in concentration or temperature led to an increase in pseudoplasticity.

The data given in Tables 5, and 6 indicated that concentration, and storage time had significant effect on the resulting apparent viscosity, and consistency index (k) ($p<0.05$), but had no significant effect on the resulting flow behavior index (n) of the prepared yoghurt samples ($p>0.05$). With increase the content of G*undelia tournefortii* pulp in to yoghurt the consistency index (k) and apparent viscosity increased, except when Pulp G*undelia tournefortii* 20% were added.

Type of G*undelia tournefortii* fiber, increasing *gundelia tournefortii* pulp rate in yogurts; Dello Staffolo et al., [25] observed that the type of fiber significantly affected the rheological properties of the yogurts. Apple fiber fortification decreased yogurt compression values, probably due to the formation of fiber aggregates that interfered with yogurt structure. Wheat and bamboo fiber fortification increased yogurt compression force and texture sensory scores; Consumer's preferred firmer yogurts, probably, resulting from the insoluble nature of these fibers. Zekai Tarkci [12] stated that increasing marmalade rate in yogurts increased the mean viscosity values and this was also found to be concentration-dependent ($P<0.05$).

The rheological characteristics of yogurt are governed by milk composition, temperature and time of milk heat pre treatment, type and quantity of starter culture employed to inoculate the milk, fermentation temperature and storage conditions of the final product. Several authors have studied the correlation among yogurt rheology and structure, evaluating the effect of milk heat treatment, type of starter culture, incubation temperature, storage time, etc. [25].

Yan Wen etal., (2011),reported that Skimmed milk treated with *horseradish peroxidase (HRP)* and Ferulic acid (FA) had the highest apparent viscosity and the control milk had the lowest one, which indicates that HRP treatment could enhance the apparent viscosity of the treated skimmed milk, especially when cross-linking agent FA was added. These results indicated that modification of these rheological properties of the treated skimmed milk might be related to the modification of the main milk components, milk proteins. Apparent viscosity of the prepared yoghurt samples from the skimmed milk treated with *HRP* and FA had the highest value, but that prepared from the control milk had the lowest one. HRP treatment of skimmed milk had no significant influence on the resulting flow behavior indices (*n*) of the yoghurt samples ($p>0.05$), but might have enhanced the consistency coefficient(*K*), especially when FA was added ($p<0.05$). Different rheological properties among the prepared yoghurt samples arose from the modification of milk proteins catalyzed by *HRP* (especially when FA was added), which shows that this approach has potential application to improve product quality in yoghurt processing.

To obtain high consistency and viscosity yoghurts, the industry usually follows one or a combination of the following approaches: (1) milk supplementation with nonfat dairy solids; (2) milk homogenization; and (3) heat treatments o denature serum proteins to allow a better interaction of these with caseins. Denatured serum proteins enhance firmness of yoghurt. Indeed this is the reason milk is heat treated before starter addition [38]. Ana Lúcia Barretto Penna et al. [27] reported that with increase in the content of total solids (9.3–22.7 %) the consistency index and apparent viscosity increased and flow behavior index decreased. Increasing the temperature of heat treatment (81.6–98.4 °C), an increase in consistency index (*K*) and decrease in flow behavior index (*n*) were observed. Higher sample temperatures (1.6–18.4°C) promoted a decrease in consistency index, and increased the flow behavior index. Rheological properties of yogurt were highly dependent on the content of total solids of milk. Thus, the choice of type and quantity of dry matter fortification of milk should be considered in improving rheological properties of yogurt. Collet, L.S.F.C.A and Tadini, C.C. [28] stated that yogurt with higher caseinate content (2%) presented higher equilibrium shear stress that is a higher equilibrium apparent viscosity [28].

At during storage period: The apparent viscosity and the consistency index of the yogurt increased during the first 7 days of storage. No significant difference was observed for longer storage periods. The flow behavior index of yogurt decreased weakly, but results were not significant, despite a good variation coefficient obtained in the flow curve measurements. The our reasons are in line with Samuel Lubbers et al. [29] that stated that the increase in the consistency index and the apparent viscosity could be due, on the one hand, to an acidification of the product, which reinforces the protein network. They observed, the pH of yogurt decreased in 28 days at 10^0C. According to Rawson and Marshall [36], *S. thermophilus* are the most germs incriminated in the production of exocellular texturizing agents called exopolysaccharides that might interact with the protein content of milk and increase the viscosity and rheologial quality of products. During the post-acidification period, the activity of *S. thermophilus* is not completely stopped, but it is less important compared to that of *L. bulcaricus* which not only produces lactic acid, but probably a small amount of texturizing agents. On the other hand, the residual microbial activity in yogurt would generate exopolysaccharides (EPS) in the medium, which take part in the protein network and could reinforce the textural properties of yogurt. Hess et al, Marshall and Rawson, and Laws and Marshall observed that modifications might be due to EPS production and pH decreases however; the authors agreed that the highest EPS production generally occurred in the beginning of the lactic fermentation. Moreover, Shah et al. and Birollo et al. studied the viability of lactic microflora and pH during storage and found not only that pH decreased but also that the survival activity of *lactic bacteria* can decrease dramatically around the 25th day of storage depending on the bacteria strain. However, no data are available on those parameters for a longer period of fermentation. The main effect observed on a plain yogurt is an increase of viscosity due to the bacterial activity, which decreases the pH during aging. Indeed, the strength of the protein network increases along with by the increase of lactic acid amount and exopolysaccharides production, from live bacteria in yogurt [29].

Microbiological analysis

Table 4 showed in both plain and *gundelia tournefortii* yoghurt didn't have any *mold* and *yeast*; *Coliforms* and *E.coli* at during 21 days of storage. This may be due to reasons of below:

The inhibitory effect of *gundelia tournefortii* upon; *Coliform*, *E.coli* organisms and the growth of *mold* and *yeast*. This reasons were in agreement with salwa et al. (2004) that reported that *mold and yeast* , *Coliforms* count markedly decreased with increase carrot juices concentration and completely disappeared in yoghurt with 15 and 20% carrot juice respectively. In Dukes hand book of medicinal Bible, some of activities such as antiseptic, bactericide and emetic have been mentioned for *G.tournefortii*, It is also reported to have hypoglycaemic, Laxative, sedative, anti-inflammatory, and anti-parasite, effects. It could act as an inhibitor of multidrug resistance and a vulnerary agent. According to some studies methanol extracts of the whole plant material of *G.tournefortii* acted as antibacterial against multidrug resistant *Escherichia coli* and *Pseudomonas aeruginosa*. The antibacterial activity of *gentamycin* and *chloramphenicol,* when mixed *G.tournefortii* methanol extract, was significantly improved against strains of *staphylococcus aureus* (Darwish et al., 2002). Study of phytocompounds and antibacterial effects of four medicinal plants essence in Lorestan, Iran showed that essence of *G.tournefortii* leaves has bacteriostatic effect on *staphylococcus epidermis*. Essence of leaves has effect in concentration of 30 μml^{-1} indicating bacteriostatic effect on *Gram-positive cocci*. However, the results of recent studies demonstrated that only root extracts of *G.tournefortii* rather than the whole plant parts, are responsible for antimicrobial properties. Therefore, *gundelia tournefortii* in agreement with about carrot is considered as antibacterial agent against pathogenic microorganisms which may get access into yoghurt either before or even after processing rendering the product unsafe for human consumption [29].

• The presence of phenols and polyphenols components which naturally present in *gundelia tournefortii*; plant phenols and polyphenols are effective in preventing various pathological conditions. According to some reports, plant phenols contribute to important activities including antiviral, anti-tumoral, antibiotic and antioxidant activities [9]. Konstantinos B. Petrotos *et al.,* (2012) reported that the presence of plain or encapsulated polyphenols in yogurt provides protection for the product, initially due to a faster pH drop and later by decelerating mould development in the product. This means that the presence of the polyphenols can extend the shelf life of the product by more than 10 days. The our study results on both plain and *gundelia tournefortii* yoghurt were in agreement with Bachir Raho Ghalem and Benattouche Zouaoui., [6] on both plain and yoghurt enriched with *Rosmarinus officinalis* oil who reported that the presence of major components of *R. officinalis* which possess strong antibacterial and antimicrobial activities on micro-organisms osmophiles responsible for the deterioration of the marketable quality of the food products.

The effect of acidity and high sanitation conditions during manufacture and storage in all yoghurt samples; *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 [32]. Nafiseh Vahedi *et al*.[33]) stated that Competition with LAB cause difficult situation for coliforms' activity so these microorganisms were inactive. Azza M. Farahat and O.I. El-Batawy., [3] reported that Coliform bacteria were not detected in either fresh control or experimental samples and during the refrigerated storage. This may be due to the efficient heat treatment of the different yoghurt milks (85ºC for 10min) and high sanitation conditions during manufacture and storage of yoghurt. In addition, it had been also referred to the effect of acidity in different yoghurts, which plays an important role in reduction of the growth rate of *coliform bacteria.* The high *yeasts* and *moulds* count could be attributed to contamination from air incorporation during stirring the different yoghurt treatments. In addition, the post contamination may be occurred in yoghurt samples from different fruit homogenates and during filling the products [3]. Çon [30] found much higher *yeast* and *mold* count in their yogurt samples. The high *yeast* and *mold* count could be attributed to contamination from air, the fruit marmalade, molasses and the 1 day old culture used for yogurt manufacture.

Sensory evaluations

Sensory properties of foods offer quality control criteria [19].Yogurt should firm, free from any whey separation and creamy layer. Generally the appearance of yogurt should convey smooth, homogeneous, moderately firm gel or custard like body and texture and uniform off white color [20]. Many factors contribute to the organoleptic evaluation in milk products. Pohjanheimo and Sandell noted that subjects who considered natural content, ethical concerns and health as important food choice motives perceived sourer, thicker and more genuine yoghurt flavour as more pleasant, compared to subjects who considered convenience, price, mood and familiarity more important, evaluated sweeter and smoother yoghurt as more pleasant. Addition of other uncommon additives also affects the acceptability of milk products [31]. The addition of *Gandelia tourfonetti* in different proportions significantly affected ($P<0.05$) the scores for aroma, taste, appearance, body and texture, and overall acceptability yogurt samples, while the storage time showed no significant difference ($P>0.05$) with addition of *Gandelia tourfonetti* for sensory parameters evaluated. The scores increased with increase in the percentage of *Gandelia tourfonetti* pulp added to yogurt in almost all sensory attributes.

Yogurt texture is important for product quality control, process development, and consumer acceptability [5]. This characterization can be done using either instrumental or sensory measurements [20]. The our reasons about texture properties In both of control and *gundelia tournefortii* yogurt is agreement of Azza M. Farahat and O.I. El-Batawy [3] that stated that the use of fruit homogenate for making stirred yoghurt caused an improvement in body and texture properties of the final product. This improvement could be due to the higher content of fibers associated with fruit homogenates added and this may lead to increase the viscosity and consequently improve the body and texture.

In both of control and *gundelia tournefortii* yogurt the highest scores of almost all sensory attributes related to yoghurt with 15 and 20% *Gandelia tourfonetti* pulp during the storage period. The results obtained are in accordance to the results of Salwa *et al*., [19]. The addition of 20% *Gandelia tourfonetti* pulp to yoghurt showed to be the best concentration as it got the highest evaluation marks during the storage period. It implies no unpleasant aftertaste, a pleasant level of acidity and pleasing balance of flavor during the storage period [19]. The appearance, taste, texture, flavor and overall acceptability of the experimental sample scored more mean sensory scores than the control [11]. Zekai TARAKÇI., [31] reported that the overall acceptable scores of the yogurts containing 15% and 20% marmalade were found to be generally higher than that the other types of flavored yogurts**.** *Azza M. Farahat and O.I. El-Batawy* about fruit yoghurt [3] reported that some fruit additives increased acceptability of stirred yoghurt. This was due to coordination between pineapple and papaya fruit flavor and dairy products [3]. These results are not in accordance to the results obtained in the study of M.Rasdhari *et al*., [20] where *Sabdariffa* added yogurt showed a higher score in almost all sensory attributes [20]. All yoghurt samples received significantly higher texture percentage. Essential oil mass fraction did not significantly change the texture percentage of the samples. The *wild strains* give yoghurts with strongly different properties of industrial one due to the microorganisms' mutation [2].

At during storage period: At the beginning of storage, all yogurts were superior, mainly because of their more intense flavor and better consistency. However, after 7 days, the acidity of the yogurts increased, and the sensory scores of all samples began to decrease [14].When pH decreased, aroma and acidic taste increased as a result of decreased flavoring characteristics [12].

The overall acceptability scores of samples increased during storage for up to 7 days and then decreased. This could be attributed to the development of acidity [14]. Zekai TARAKÇI, Erdoğan [31] stated that Overall, with prolonged storage the body and texture scores decreased. In contrast, Keating and White found that prolonged storage led to an increase in the body and texture score. The *aerobic mesophilic bacteria* count was significantly affected by the type of flavor additives used in yogurt. *Aziza M. Farahat and* O.I. El-Batawy [3]reported that decrease scores of all the samples may be due to the acidity development or the production of microbial metabolism which slightly harmed the rheological and sensory properties of the product.

Table 1. Composition of milk and *Gundelia tournefortii* pulp used for yogurt making

Food	pH	Acidity (%)
Milk	6.67	0.17
Gundelia tournefortii pulp	5.4	0.41

Table2. Physicochemical composition of different types of fresh yogurt

Dose of *Gundelia tournefortii (%)*	pH	Acidity (%)	Syneresis (ml/2hour)
0	4.43	0.86	14.9
1	4.41	0.85	16.7
3	4.28	1.04	15.7
5	4.39	0.86	13.3
10	4.45	0.86	8.7
15	4.42	0.86	8.2
20	4.48	0.86	7.4

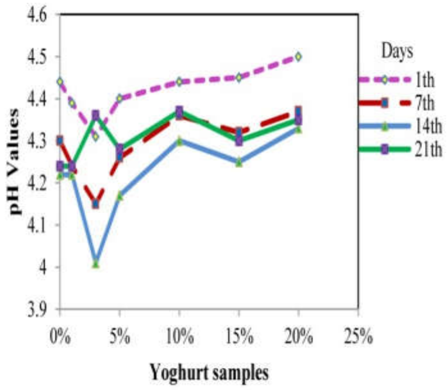

Fig. 2: pH value during storage

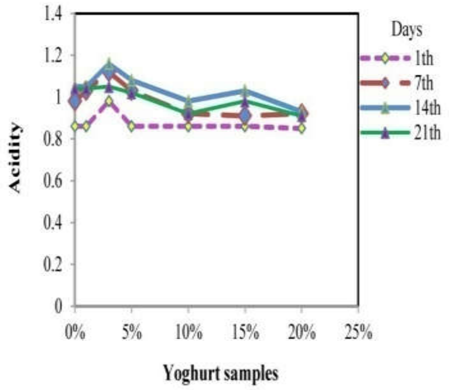

Fig. 1: Acidity value during stora

Table3. Physicochemical composition of control and *gundelia tournefortii* yogurt in storage period

Dose of *Gundelia tournefortii* (%)		Storage time (days)	pH	Acidity (%)	Syneresis (ml/2hour)
0		1th	4.44±0.0056	0.86±0.056	16.9±3.3
		7th	4.30±0.0056	0.98±0.056	8.4±2.6
		14 th	4.22±0.0056	1.05±0.056	6.3±0.6
		21 th	4.24±0.0056	1.04±0.056	5±0.9
		Y x̄	4.30±0.089a	0.98±0.079 a	9.1±5.1a
1		1th	4.39±0.0056	0.86±0	19.1±2.7
		7th	4.24±0	1.03±0.057	11.9±3.7
		14 th	4.22±0	1.05±0.056	7.6±0.3
		21 th	4.24±0	1.04±0.058	4.7±0.5
		Y x̄	4.27±0.074	0.99±0.084a	10.8±6 a
3		1th	4.31±0	0.98±0	17.7±1.2
		7th	4.150	1.12±0	10.3±1.6
		14 th	4.01±0.0057	1.16±0	6.1±0.7
		21 th	4.36±0.4630	1.05±0	4.1±0.2
		Y x̄	4.21±0.2449 a	1.07±0.071 a	9.6±5.5 a
5		1th	4.40±0.0056	0.86±0.057	15.7±0.6
		7th	4.26±0.0057	1.03±0.056	8.7±0.3
		14 th	4.17±0	1.08±0	7.5±0.4
		21 th	4.28±0	1.02±0.056	6.4±1
		Y x̄	4.28±0.088 a	1±0.086a	9.6±3.8 a
		1th	4.44±0.0056	0.86±0.056	9.4±0.5
		7th	4.36±0.0056	0.92±0.056	8.2±0.8

10		14 th	4.30±0	0.98±0.056	6.4±0.4
		21 th	4.37±0.0057	0.92±0	3.8±0.4
		Y x̄	4.37±0.0544^{a}	0.92±0.044^{a}	6.9±2.2^{a}
15		1th	4.45±0	0.86±0.057	9.9±0.3
		7th	4.32±0.0057	0.91±0	8.8±0.4
		14 th	4.25±0.0058	1.03±0.056	5.7±0.2
		21 th	4.30±0	0.98±0.058	3.5±0.3
		Y x̄	4.33±0.0751^{a}	0.94±0.070^{a}	7.1±2.6^{a}
20		1th	4.50±0.0057	0.85±0.057	8±0.1
		7th	4.37±0.0057	0.92±0	7.7±0.9
		14 th	4.33±0.0056	0.93±0	4.4±0.5
		21 th	4.35±0.0057	0.91±0.057	3.5±0.5
		Y x̄	4.39±0.0688^{a}	0.90±0.031^{a}	5.9±2.1^{a}
ST x̄		1th Total	4.42±0.057^{A}	0.87±0.042^{A}	13.8±4.5^{A}
		7th Total	4.28±0.074^{A}	0.99±0.073^{A}	9.1±2.1^{A}
		Total 14 th	4.21±0.1000^{A}	1.04±0.068^{A}	6.3±1.1^{A}
		21 th Total	4.30±0.1559^{A}	0.99±0.057^{A}	4.4±1.1^{A}

* ^{abcd} Letters indicate significant differences among yogurts (Y x̄), P<0.05, ^{ABC} Letters indicate significant differences among storage times (ST x̄), P<0.05.

Table4. Microbiological evaluation of control and G*undelia tournefortii* yogurt in storage period

		Yeast and mold count Storage period (days)					Coliforms count Storage period (days)					E.coli count Storage period (days)			
Dose of *Gundelia tournefortii* (%)		1th	7th	14 th	21 th		1th	7th	14 th	21 th		1th	7th	14 th	21 th
0		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
1		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
3		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
5		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
10		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
15		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs
20		abs	abs	abs	abs		abs	abs	abs	abs		abs	abs	abs	abs

Table 5 Apparent viscosity (mPa·s) of control and Gundelia tournefortii yogurt in storage period.

	Apparent viscosity (mPa·s) Storage period (days)				
Dose of *Gundelia tournefortii (%)*	1th	7th	14 th	21 th	Y x̄
0	11815.10±5424.2	21038.13±23265	13044.67±4630.6	10180.90±3825.6	14019.70±12863^{a}
1	28266±12646.77	26054.93±11.740	20857.63±7500	20295.93±8079.5	23868.62±10660^{a}
3	24944.57±11535	28078.3±12300.08	16815.07±7537.8	18235.53±6414.5	22018.36±10732^{a}
5	1748.88±8423	33593.13±1356	19918.2±7892.9	18729.27±747.24	22432.34±11528^{a}
10	20278.93±7165.4	30765.53±12928	19425.23±7113.7	21755.43±8094.3	23056.28±100.96^{a}
15	14235±6090.394	18093.27±24465	21397.40±10360	19037.20±742.62	18190.78±14191^{a}
20	20054.57±9068.3	17100.07±6595.6	22920.60±8156	18100.70±7065.4	19543.98±8003.9
ST x̄	19583.28±1006.3^{A}	24960.47±16955^{A}	19196.97±8243.5^{A}	18047.85±7759.1^{A}	

* ^{abcd} Letters indicate significant differences among yogurts (Y x̄), P<0.05, ^{ABC} Letters indicate significant differences among storage times (ST x̄), P<0.05.

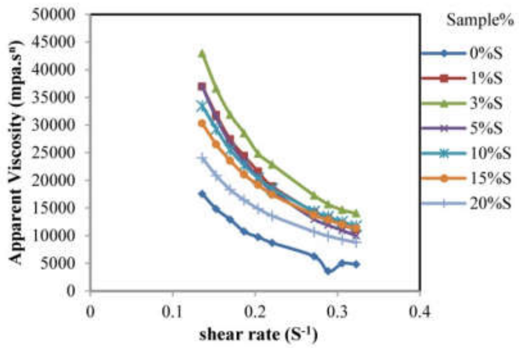

Fig 3: Apparent viscosity of the yoghurt samples (control) and *gundelia tournefortii* yogurts as a function of shear rate

Table6. Rheological parameters (n , k, and R^2) of control and *Gundelia tournefortii* yogurt in storage period.

Dose of *Gundelia tournefortii (%)*	Storage period (days)	K(mPa・s^n)	n(-)	R^2
0	1th	8.12±8.74	0.66±0.28	0.985
	7th	16.78±7.87	0.36±0.12	0.991
	14 th	13.35±4.59	0.33±0.10	0.991
	21 th	7.62±4.36	0.36±0.12	0.991
	$Y\bar{x}$	11.47±6.94	0.43±0.19[a]	
1	1th	26.96±5.84	0.46±0.10	0.985
	7th	10.36±9.13	0.52±0.51	0.994
	14 th	18.57±3.08	0.36±0.91	0.991
	21 th	6.02±6.73	0.62±1.22	0.985
	$Y\bar{x}$	15.48±11.61 [a]	0.49±0.69	
3	1th	27.98±10.88	0.50±0.05	0.982
	7th	16.86±16.89	0.43±0.50	0.989
	14 th	9.27±3.99	0.60±0.28	0.982
	21 th	13.93±17.71	0.32±0.05	0.984
	$Y\bar{x}$	17.01±15.26[a]	0.46±0.22	
5	1th	30.15±3.49	0.41±0	0.995
	7th	11.73±13.33	0.79±0.41	0.986
	14 th	5.59±7.23	0.64±0.12	0.985
	21 th	13.27±2.82	0.36±0.05	0.998
	$Y\bar{x}$	15.19±11.67 [a]	0.55±0.14	
10	1th	8.54±10.78	0.57±0.13	0.990
	7th	36.66±16.26	0.42±0.68	0.993
	14 th	14.93±11.13	0.49±0.31	0.989
	21 th	13.51±10.98	0.70±0.51	0.992
	$Y\bar{x}$	18.41±16.62 [a]	0.55±0.41	
15	1th	11.68±11.93	0.67±0.65	0.992
	7th	12.76±4.38	0.37±0.02	0.994
	14 th	22.46±7.42	0.42±0.16	0.996
	21 th	15.59±1.46	0.44±0.03	0.992
	$Y\bar{x}$	15.62±7.68 [a]	0.47±0.31 [a]	
20	1th	3.30±3.01	0.70±0.60	0.989
	7th	6.06±6.91	0.99±0.79	0.991
	14 th	8.22±4.99	0.59±0.23	0.990
	21 th	8.59±9.94	0.65±0.28	0.992
	$Y\bar{x}$	6.5 5±6.52 [a]	0.73±0.47 [a]	
$ST\bar{x}$	1th Total	16.67±13.75[A]	0.57±0.26	
	7th Total	15.89±13.53 [A]	0.55±0.47	
	14 th Total	13.20±8. 21	0.49±0. 30	
	21 th Total	11.22±8.97 [A]	0.49±0.33	

* [abcd] Letters indicate significant differences among yogurts (Y x̄), P<0.05, [ABC] Letters indicate significant differences among storage times (ST x̄), P<0.05. **Flow behavior indices (n). ***consistency coefficient (k). ****regression coefficient (R^2).

Table7. Sensory properties of control and G*undelia tournefortii* yogurt in storage period

Dose of *Gundelia tournefortii (%)*	Storage period (days)	Appearance	Texture	Taste	Smell
0	1th	5.10±0.53	5.10±0.53	5.24±0.7	4.81±0.40
	7th	5.19±0.40	5.7±0.57	5.48±0.51	5.52±0.51
	14 th	5.19±0.68	5.19±0.68	5±0.54	4.90±0.53
	21 th	4.86±0.35	4.90±0.3	5.05±0.59	4.95±0.21
	Y x̄	5.08±0.52 a	5.21±0.60 a	5.19±0.61 a	5.05±0. 51 a
1	1th	4.90±0.62	4.90±0.43	4.95±0.59	4.86±0.47
	7th	4.90±0.43	4.95±0.49	5±0.77	5.33±0.48
	14 th	5.33±0.48	4.86±0.35	4.86±0.35	5.14±0. 57
	21 th	4.86±0.65	4.81±0.6	4.81±0.40	4.81±0.40
	Y x̄	5±0. 58 a	4.88±0.47 a	4.90±0.55 a	5.04±0. 52
3	1th	5.19±0.40	5.38±0.49	5±0.54	5.05±0.59
	7th	5.33±0.48	5.33±0.48	5.43±0.50	5.52±0.51
	14 th	4.95±0.21	4.90.±0.3	5.29±0.46	5.52±0.51
	21 th	5.19±0.60	4.86±0.47	4.81±0.4	4.81±0.4
	Y x̄	5.17±0.46 a	5.12±0.50 a	5.13±0.53 a	5.23±0.58 a
5	1th	5.33±0.48	5.52±0.51	5.24±0.43	5.29±0.46
	7th	5.38±0.49	5.33±0.48	5.43±0.50	5.62±0.49
	14 th	5.24±0.43	5.19±0.40	5.43±0.50	5.48±0.51
	21 th	5.38±0.49	5.24±0.53	4.95±0.21	5±0.31
	Y x̄	5.33±0.47 a	5.32±0.49 a	5.26±0.46 a	5.35±0.50 a
10	1th	5.48±0.51	5.76±0.7	5.29±0.46	5.33±0.48
	7th	5.52±0.68	5.48±0.68	5.62±0.49	5.76±0.7
	14 th	5.29±0. 56	5.24±0.53	5.43±0.5	5.57±0.50
	21 th	5.67±0.48	5.38±0.49	5±0	5.57±0.50
	Y x̄	5.49±0.57 a	5.46±0.63 a	5.33±0.47 a	5.56±0.56 a
15	1th	5.57±0.50	6.43±0. 5	6±0.83	5.52±0.60
	7th	6.48±51	5.52±0.6	6.14±0.47	6.48±0.51
	14 th	5.52±0.68	5.48±0.68	6.10±0.76	6.38±0.49
	21 th	6.29±0.56	6.14±0.57	6.05±0.59	6.10±0.62
	Y x̄	5. 96±0.70 a	5.89±0.71 a	6.07±0. 67 a	6.12±0.66 a
20	1th	6.62±0.49	6.71±0.46	6.05±0.59	6.05±0. 53
	7th	6.10±0.62	6.05±0.59	6.14±0.65	6.14±0.49
	14 th	6.10±0.53	6.05±0.49	6.14±0.65	6.14±0.48
	21 th	6.48±0.51	6.38±0.66	6.10±0.62	6.10±0. 65
	Y x̄	6.32±0.58 a	6.30±0.61 a	6.11±0.62 a	6.38±0.59 a
ST x̄	1th Total	5.46±0.46	5.69±0.80	5.39±0.72	5.28±0.64
	7th Total	5.56±0.56	5.48±0.63	5.61±0.67	5.84±0.77
	14 th Total	5.37±0.37	5.27±0.62	5.46±0.71	5. 67±0.71
	21 th Total	5.53±0.53	5.39±0.78	5.25±0.69	5.34±0.74

* abcd Letters indicate significant differences among yogurts (Y x̄), $P<0.05$, ABC Letters indicate significant differences among storage times(ST x̄), $P<0.05$.

Table 8. Overall acceptable scores properties of control and *Gundelia tournefortii* yogurt in storage period

Dose of *Gundelia tournefortii (%)*	1th	7th	14 th	21 th	Y x̄
0	20.24±1.51	21.86±1.38	20.29±1.55	19.76±0.53	20.54±1.5 a
1	19.62±1.35	20.19±1.47	20.19±0.92	19.29±1.48	19.82±1. 36 a
3	20.62±1.49	21.62±1.11	20.67±0.85	19.67±1.15	20. 64±1. 35 a
5	21.38±0.48	21.76±0.49	21.33±0.43	20.57±0.49	21.26±1.15 a
10	21.86±1.07	22.38±1.17	21.52±1.19	21.62±0.87	21.85±1.33 a
15	23.52±1.50	24.62±1.11	23.48±1.47	24.57±1.24	24.05±1.43 a
20	25.48±1.28	24.90±1.09	24.95±1.16	25.10±1.72	25.11±1.33 a
ST x̄	21. 82±2.33	22.48±2.03	21.78±2.04	21.51±2.51	

* abcd Letters indicate significant differences among yogurts (Y x̄), $P<0.05$, ABC Letters indicate significant differences among storage times(ST x̄), $P<0.05$.

CONCLUSION

In the present investigation, there were significant differences in physicochemical and sensory characterization of *gundelia tournefortii* yogurt compare to control. Generally, *gundelia tournefortii* addition decreased pH (slightly), sineresis values; increased titratable acidity (slightly), in during storage time. yogurt samples during 21 days no *coliform bacteria*, *E. coli*, *mold* and *yeast* were not. All samples were treated pseudoplastic. Generally, *gundelia tournefortii* pulp addition increased of apparent viscosity and consistency values of the final product, except the yoghurt containing *gundelia tournefortii* 20%. Sensory evaluation results showed that the yoghurt containing *gundelia tournefortii* 20% had the highest overall acceptability scores as compare to other *gundelia tournefortii* yogurt samples and also plain yogurt. The results of current study demonstrated that the addition of *gundelia tournefortii* puree to the yogurt improved the quality of yogurt.

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