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Application of *Gundelia tournefortii* L. in yoghurt

Azam Ebrahimi, Ali Mohamadi Sani*

Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran

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ABSTRACT

Yoghurt is a fermented milk product consumed in the entire world. It is easily digested, has high nutritional value and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus. 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. *Gundelia tournefortii L.*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 L*. is used for treatment of liver diseases, diabetes, chest pain, heart stroke, gastric pain, vitiligo, diarrhea and bronchitis. It is also reported to have hypoglycemic, Laxative, sedative, anti-inflammatory, anti-parasite, antiseptic and emetic effects. Compounds found in *G. tournefortii* 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. Dairy together with fruit and vegetable ingredients may get transformed into 'functional foods' that is gaining grounds in recent years.
KEY WORD: *Gundelia tournefortii*, Yoghurt, Pharmacological effects, Traditional medicine.

INTRODUCTION

Yoghurt is a fermented milk product consumed in the entire world [2].This is partly because of an increased awareness of the consumer regarding possible health benefits of yoghurt. It is easily digested, has high nutritional value and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus [1]. 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 [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 [4]. 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 [4]. 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 M_1[5]. 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[2].According to Iranian Standard (No. 4046) vegetable yoghurt is a product which is made by adding variety of fresh or dried vegetables such asmint, oregano, spinach, basil, tarragon, celery, carrots, cucumber, boiled beets, shallots etc. to yoghurt[7].

G. tournefortii L. 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 hypoglycemic, 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 [8]. In this review article, we discuss on the advantages of using *G. tournefortii* on the quality of dairy products especially yogurt.

Botanical specifications, geographic distribution and Ecology

Acanthus with scientific name: *G. tournefortii* is in Chicory family. Acanthus is permanent vegetable covered with wool hair down and lots of blade its stem is thick, simple or branching with short branch and in the

* **Corresponding Author:** Ali Mohamadi Sani, Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran

form of corymb [9]. *G. tournefortii* L. is a medicinal plant, native to the Asian temperate zones of Western Asia, namely Cyperus, Egypt, Iran, Israel, Turkey, Azarbaijan and Turkmenistan[10]. Recently two new well-defined localities of Gundelia, i.e. *G.tournefortii* and *G. rosea* have been suggested in Armenia, with different distribution areas, different flower shapes and different pollinators. A look at the Iranian collections results in this supposition that all collections from the Flora Iranica could, in reality, belong to *G.rosea*. In the Flora of Turkey only *G.tournefortii* recognized for its flower color as "white, yellow, green, maroon or red" and the hairiness as smooth or arachnoid. Both species grow widely in Turkey. However, *G.rosea* is more observed in regions near Iran and Armenia. Gundelia is common name of *G. tournefortii* and *tumbleweed,* akub (kuub or aqub) and kanger, respectively, are English, Arabic and Kurdish equivalents for this plant[8]. *G. tournefortii* locally known as 'Kangar' in Iran is found as a wild herb growing during late winter and early spring in the hills in the western and southern parts of Iran as an occasional food in different forms and also as a folk remedy[10]. G. tournefortii grows well in different localities. The plant, is not able to grow in shade, but prefers sandy and loamy or acid, neutral and alkaline, drained and moist soils [8].

Non-clinical popular application

It is recorded that the flowers, leaves, seeds and stems of *G. tournefortii* are used as food sources. In the Middle East, the young and still undeveloped flower buds are sold in the local markets just like artichoke hearts; it is a highly sought item. Fresh seeds of *G. tournefortii* are used in pickles and also are effective diuretics[16]. The heads of the plant are usually consumed either as fresh plant or after being cooked like artichoke [11]. *G. tournefortii* L. Stem, which is a rich source of minerals and vitamins C, B and A, is edible and has therapeutic uses in traditional medicine. Because the high oil content of Gundelia seed (22.8%), it is a potent source for extraction of edible oil. The physicochemical properties of Gundelia seed oil indicates to high edibility quality of the oil. The fatty acid composition of this oil was similar to soybean and sunflower oils. The Main phytosterols in Gundelia seed oil are sitosterol and stigmasterol [2]. The volatile oils from the aerial parts of *G. tournefortii* were identified by GC-MS analysis with terpinyl acetate and methyl eugenol as the major oil components [13]. *G. tournefortii* L. is a perennial spiny herb which is collected and dried for winter fodder for small ruminant animals in most parts of Turkey and surrounding countries. In desert part of Israel, mature *G. tournefortii* is sometimes used as fodder for camels. There are more studies on the nutritional and health effects of the *G. tournefortii* from different countries. It is investigated that to determine the effect of maturity stage on the nutritive value of *G. tournefortii* in terms of chemical composition and *in situ* and *in vitro* dry matter degradability, calculated metabolizable energy and organic dry matter digestibility3. In Turkey the plant is collected and dried in summer being stacked for winter fodder on the Anatolian plateau. A chewing gum (called kenger sakizi) is made from the latex and the seeds are used as coffee (Kenger kahvesi). *G. tournefortii* and their taxa were considered as nutritious food in the world and Turkey and the results highlight the importance of these plants for local people and support efforts for their industrial usage, conservation, renewable resources and the food nutrition and additive[14]**.** Also, total protein assay showed that *Gundelia* can be a good source of protein [10]. The young leaves are used in soup. In western and central Anatolia of Turkey *G. tournefortii* is used as roasted, salad and pickled. For example, its fruits are treated with vinegar or lemon with salt and used as a garnish. Thick stems, flower buds, leaves and roots may be consumed as food while toasted seeds are consumed as kenger coffee. In the Palestinian traditional culture and ethnobotany, its roots are used as vegetables and consumed as fried in olive oil especially in an omlette. *G. tournefortii* young stems and leaves are fried by olive oil, then accompanied with meat chops, boiled and after it gets well done and a boiled yogurt suspension is introduced, the mixture will be left to boil. The stalk of *G. tournefortii* is used in different parts of Iran as an occasional food in different forms and also as a folk remedy. According to the Persian traditional medicine, the stalk of the plant is heoatoprotective and blood purifier. In Kurdistan, Iran, *G. tournefortii* straw is used in preparing dug cakes. In northeast of Lebanon, *G. tournefortii* is considered a nutritious food. It is not eaten during summer and autumn and the main edible part is the stalk and consumed especially if freshly gathered, usually eaten cooked. The results of a study indicated that *G. tournefortii* could accumulate phytoremediation of the soils polluted with metals. In addition, *G. tournefortii* had high potential for accumulating arsenic, perhaps very effective for removing contamination from soils [8].

Phytochemical compounds

Karabulut *et al*., (2006) reported that the nutritive value of tumbleweed hay (*Gundelia tournefortii L.*), is better than that of wheat straw and comparable to that of alfalfa hay. Concentration of tumbleweed hay was lower. Tumbleweed hay was rich in phosphorus and iron in contrast to alfalfa hay and wheat straw. Within the confines of this study, tumbleweed hay seems to have potential as a forage crop for smallholder farmers during periods of forage scarcity [18]. Kamalak et al. (2005) reported that *in situ* dry matter *(*DM)degradability and estimated parameters were negatively correlated with fiber fractions (NDF and ADF) but positively correlated with crude protein (CP) content of tumbleweeds (*G. tournefortii*). In a study where tumbleweed (*G. tournefortii*) hays were harvested at three maturity stages, *in situ* DM disappearance decreased with increasing maturity [15].

Therapeutic uses in traditional medicine and pharmacopoeia of various countries

Fresh seeds of *G. tournifortii* are used in pickles and also are effective diuretics and inhibitor of α-amylase activity [16]. In folkloric medicine, *G. tournifortii* is used in Jordan among Bedouins for the treatment of chest pain and heart stroke. In Turkey, this plant is used in folk medicine to remove water from patients having splenomegaly [11]. It is claimed that this plant may act as a liver protector and a blood purifier as well. It was reported that *Gundelia tournefortii* L. has similar properties to *Cynara scolymus* L. and may reduce fat and specially cholesterol content of the blood [8]. Dry seed of *G. tournefortii* L. has an effective influence for the treatment of vitiligo [2]. In traditional medicine this vegetable is mentioned for vitiligo, diabetes, epilepsy and stomach and intestine disease. Nooraei has written in his book that this plant increase libido and contain plants hormones that they reinforce sexual libido. Another research in Iran proves the protection effect of this vegetable on liver cells [9]. As an occasional food, this plant or extract has been used for prevention and treatment of liver diseases. In addition, it could relieve pain and inflammation. Ethnobotanical survey of herbal remedies traditionally used in Kohgiluyeh va Boyer-Ahmad, Iran showed that root of *G. tournefortii* has antiparasitic effect for digestive system orally. Traditionally, *G. tournefortii* is believed, in Lebanon, to have hypoglycemic and laxative properties. In Turkey, it is proposed to enhance gingiva's and used as an appetizer. Its stem is used for treatment in case of gastric pain, diarrhea, bronchitis, inflammations and kidney. In addition, stem spiny part and stem of fresh plant are used as mumps. In addition this plant is used in folk medicine to remove water from patients with splenomegaly. In Duk's handbook of medicinal plants of the Bible, some of activities such as antiseptic, bactericide and emetic have been mentioned for *G. tournefortii*; it could also act as an inhibitor of multidrug resistance and a vulnerary agent[8].

Pharmacological effects

Antibacterial activity: According to some of studies [8] methanol extracts of whole plant material of G.*tournefortti* acted as antibacterial against multi drug resistant Escherichia coli and Pseudomonas aeruginosa. These studies showed that when combined with penicillin G and erythromycin gundelia, full growth of standard strain of *P.aeruginosa* was possible while the growth of a resistant strain isolated from hospitalized patients was inhibited [11]. Methanolic extract of G.*tournefortii* in combination with seven different antibiotics was investigated to monitor the synergic activities against *P. aeruginosa*, including a resistant strain. Their results showed that the effects of some compounds on the resistant and the standard strains varied significantly probably because of structural changes. Nearly all the plant parts combined with penicillin G and erythromycin helped full growth of the standard strain, while the combination with *G.tournefortii* and *Lepidium satium L.*inhibited its growth. In another study, the inhibitory effects of methanol extracts of some Jordanian plants, such as *G.tournefortii* and their combinations with different antibiotics on the resistance of *Staphlococcus aureus* have been surveyed. Assessment of antibiotic resistant inhibitors of some plant materials showed that cephaloxin compounds accompanied with the plant materials against the resistant strain improved the antimicrobial activity. The antibacterial activity of genamycin and chloramphenicol, when mixed G.*tournefortii* methanol extract, was significantly improved against strains of *Staphylococcus aureus* [8]. In a study of nineteen plants in Jordan, known for their antimicrobial property in folk medicine, it was indicated that extract of *G.tournefortii* L. generally enhanced activity of clarithromycin against the resistant strain of *E.coli* (Darwish and Aburjai,2010).Study of phytocompounds and antibacterial effects of four medicinal plants essence in Lorestan, Iran showed that essence of G.*tournefortii* leaves had bacteriostatic effect on *Staphlococcus epidermis*. Essence of leaves has effect in concentration of 30μ mL^{-1}, indicating bacteriostatic effect on Gram-positive cocci (Talei *et al*., 2007). In addition, a study on twenty native Iranian plants against 10 clinical isolates of *H.pylori* found that sixteen had good anti *H.pylori* activity. Majority of the plant extracts used in this study such as G.*tournefortii* had considerable in vitro activity against clinical isolates of *H.pylori* [17].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 [8].

Anti-platelet activity:

The anti-platelet activity of G. *tournifortii* was studied in vitro using adenosine-50-diphosphate (ADP) and arachidonic acid (AA) as agonists. The chloroform extract of G. *tournifortii* was found to have a mild inhibitory effect on platelet aggregation induced by ADP and AA. None of the pure isolated compounds or the volatile oil showed an inhibitory effect on platelet aggregation using ADP and AA as agonists[15].

Hepato-protective activity:

A study from Jamshidzadeh8 reported that the *G. tournefortii* extract could protect the liver against CCl4-induced damages with doses of 200 and 300 mg/kg, but concentrations higher than 300 mg/kg were less effective and the result of the study support the traditional believes on hepato-protective effects of *G. tournefortii* however, high concentrations were hepatotoxic. In the study of Chehregani *et al*., *Gundelia tournefortii* was determined as among the heavy metals acumulator plants in the Angouran region of Iran [14].

Hypolipemic activity

Azeez and Kheder (2012) reported that Beneficial effect were seen when mice treated with *G. tournefortii* at dose of 300 mg/kg.b.w. that lead to significant decrease in levels of glucose, triglyceride, and cholesterol. These results indicate the usefulness of *G. tournefortii* extract as hypoglycemia and hypolipidemia in dexamethasone treated mice[19].In study of Asgary *et al.*(2008,2009) effect of *G. tournefortii* on some cardiovascular risk factors in animal model was investigated. Results of this study showed that *G. tournefortii* decreased the cholesterol, LDL-cholesterol, triglyceride, VLDL-Cholesterol, apolipoprotein B, oxidized LDL and factor VII. It also increased the level of HDL-cholesterol and apolipoprotein when compared to diet with high cholesterol [8].

Mechanisms of action

Therapeutic effects of medicinal plants are known to be closely related to their antioxidant capacities. Methanol extracts of G. *tournefortii*, especially the seed extracts, have considerable antioxidant capacity compared with a tocopherol. The seed extracts, having higher phenolic content, were also more effective GST inhibitors, with an IC50 of 97.5g/mL[16]. It is recorded that the water extracts of *G. tournefortii* roots were containing phenols, glycosides, tannins, flavonoids, carbohydrates, proteins, alkaloids and nitrate, and saponins. It is used to enhance gingivas and as an appetizer, also fresh seeds of it are used in pickles and also are effective diuretics, and inhibition of α-amylase activity [19]. In a study was designed to examine the *in vitro* antioxidant activities of methanol extracts of *Tymbra spicata, Gundelia tournefortii, Urtica dioica L., Malva sylvestris* and *Mentha pulegium* and to determine their total contents of phenolics and flavonoids. These results show that methanolic extracts of these plants could be considered as a natural alternative source for food, pharmacology and medicine sectors [20]. Mahboobeh Tabibian *et al.*(2012) reported that *Gundelia tournefortii* extract increases the number, motility of sperm and testosterone level because of antioxidant components for example Quercetin presumably. Quercetin is the most numerous natural flavonoid in vegetable and plant, but it is a group of flavonoid without glycoside. Flavonoids without glycoside more powerful antioxidants related to their glycoside flavonoid. Other study shows the powerful antioxidant effect of Quercetin. So *Gundelia tournefortii* has high capacity of antioxidant. Quercetin in *Gundelia tournefortii* could decrease production of nitric acid which inhibit production of steroid. So extract of *Gundelia tournefortii* could increase steroid production in cells of testis and so increase testosterone concentration. Result of this study show that probable properties of antioxidant of leaf and stem of *Gundelia tournefortii* on sperm parameter has protective effect against free radical and help improve sperm parameter situation especially number and movement of sperms and could increase testis weight and testosterone hormone. Results show that this vegetable has antioxidant component that lead to many therapy effects. Another research in Iran proves the protection effect of this vegetable on liver cells. *Gundelia tournefortii* increases lipid level of plasma. *Gundelia tournefortii* contain phenol compound such as Quercetin, this substance has strong antioxidant effects. Antioxidant components protect sperm cells from free radicals and improve quality of sperm. Antioxidant therapy protects against oxidative stress and improves fertility parameters. According to antioxidant effect of *Gundelia tournefortii* and the fact that it wasn't any research about the effect of *Gundelia tournefortii* on sperm parameters and sexual hormones, this research study effect of this vegetable on sperm parameters and level of testosterone hormone [9]. Total phenolic contents and the antioxidant activities of *G. tournefortii* have been investigated. However, not much attention has been paid to this extract as a source of corrosion inhibitor. *G. tournefortii* extract acts as a good inhibitor of corrosion of mild steel in both 2.0 M HCl and 1.0 M H2SO4 solutions. Inhibition efficiency value increases with the inhibitor concentration [21].

Yogurt with vegetables

Konstantinos *et al*. (2012) in Production of Novel Bioactive Yogurt Enriched with Olive Fruit Polyphenols reported that initially there is a lag time where the starter culture is not affected from the polyphenols while at a second stage after 2-3 hours the pH value of samples A, B containing the plain and encapsulated polyphenols respectively decreases faster than the pH value of sample C without polyphenols. This offers better protection against microbiological contamination and spoilage for the A and B samples. Furthermore, after the yogurt samples set in the fridge (0-4ºC), the polyphenol enriched yogurt samples A and B had a better self-life while the control was spoiled by moulds in less than 24 days of storage. These findings support the hypothesis 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 [4].

Yan Wen et al., (2011) reported that Treatment of skimmed bovine milk with HRP(horseradish peroxidase) only, or in combination with FA showed an impact on the rheological properties of the milk by enhancing its apparent viscosity, storage modulus and viscous modulus, especially when FA (ferulic acid) was added. However, the treatment did not have any influence on the main chemical composition or fermentation of the prepared yoghurt. Compared to the control yoghurt, the yoghurt prepared from the treated milk had higher apparent viscosity, storage and viscous moduli, and greater hysteresis loop area or better structural reversibility,

showing that this approach might be a possible alternative to modify rheological properties of defatted set yoghurt [23].

Salwa et al. (2004) said 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. The inhibition of the growth of mold and yeast in carrot yoghurt may be attributed to the action of isocoumarine which naturally present in traces in carrot. High reduction of AFM_1 may be due to the action of riboflavin naturally present in carrot juice. On the other hand, high carrot juice suppressed the growth of mold, yeast and coliforms while *Lactobacillus bulgaricus* and *Streptococcus thermophillus* were not significantly ($P>0.05$) affected. In addition carrot is safe for public health and used as vitaminized food supplement. Chemical analysis revealed an increase in acidity, decrease soluble nitrogen /total nitrogen ratio and curd tension with increasing carrot juice [5].

Rasdhari *et al.*(2008) demonstrated that incorporation of Hibiscus sabdariffa extract in yoghurt improved the total antioxidant property, organoleptic qualities and decreased the exudation of whey proteins (Syneresis). Thus, Hibiscus sabdariffa Calyces has beneficial influence on the quality of L.casei incorporated probiotic yoghurt [24].

Iwalikun and Shittu (2007) found higher β-galactosidase activity, and viable lactic acid bacteria of probotic importance in the sabdariffa yogurts compared to the non-sabdariffa counterparts [25].

Bachir Raho Ghalem and Benattouche Zouaoui (2013) reported that there were significant differences in physical, chemical microbiological and sensory properties of *R. officinalis* essential oil added to yogurts compared to the control. On the microbiological level of the two types of yoghurt, one notes complete absence of the total and fecal coliforms, *Staphylococcus aureus*, *Salmonellas* yeast and mould in the two categories of yoghurt. The enriched yoghurt presented a satisfactory hygienic quality, by the absence of any pathogenic germs. This complete abolition of the germs is at the origin of monoterpenes such as α-pinene, β-pinene, myrcene 1,8-cineole and borneol major components of *R. officinalis* which possess strong antibacterial and antimicrobial activities (Deba *et al*., 2008; Okoh *et al*., 2010; Sokmen *et al.*, 2003) on micro-organisms osmophiles responsible for the deterioration of the marketable quality of the food products. Shan et al. (2011) reported that the natural extracts, such as *R. officinalis* oil as mentioned by Moreno et al. (2006), contained high levels of phenolic compounds that contributed to the maintenance of lower pH in cheese (a dairy product like yoghurt). On the basis of the findings, it can be concluded that addition of *R. officinalis* essential oil enhanced the qualities of yogurt [6].

From the results of Okoye, and Animalu (2009), it was observed that the stirred yoghurts stabilized with different proportions of sweet potato starch were generally safe microbiologically but the sample stabilized with 30% sweet potato starch had better viscosity, dry matter and total soluble solids contents than the other samples[26].

Piyawan Supavititpatana *et al.* (2010) reported that the corn milk yogurt was found to have lower fat content, higher protein content with harder and higher consistency than cow milk yogurt [27].

Yogurt containing Gundelia (*Gundelia tournefortii* L.)

Tumbleweed hay (*Gundelia tournefortii L.*), is a forage with a medium to high protein concentration. As such, it has the potential as a forage crop for small farmers during critical periods of year when feed is scarce. By replacing lower quality forages with tumbleweed hay in ruminant diets, dairy producers could decrease concentrate input, decrease feed costs and increase the amount and utilization of forage in small ruminant dairy diets [18]. *Azam Ebrahimi etal.* (2015) demonstrated that the addition of *Gundelia tournefortii* puree to the yogurt improved the quality of yogurt.

According to some studies (Aburjai *etal.*2001; Darwish and Aburjai2010) methanolic extract of the whole plant material of *G.tournefortii* acted as antibacterial agent against multidrug resistant *E. coli* and *P. aeroginosa*. The antibacterial activity of gentamycin and chloramphenicol, when mixed with *G.tournefortii* methanolic extract, was significantly improved against strains of *S. 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 *S. epidermis*. Essence of leaves had bacteriostatic effect on Gram-positive cocci in concentration of 30µg/ml (Talei *etal*.2007). However, the results of recent studies demonstrated that only the root extracts of *G.tournefortii* rather than the whole plant, are responsible for antimicrobial properties (Obeidat, 2011). *Gundelia tournefortii* was shown by Babic et al., 1994 and Nyati, 2000 to have antibacterial activity against pathogenic microorganisms which may get access into yoghurt either before or even after processing rendering the product unsafe for human consumption. This property is due to the presence of phenols and polyphenols components which naturally present in *Gundelia tournefortii* which are effective in preventing various pathological conditions. According to some reports, plant phenols contribute to important activities including antiviral, antitumoral, antibiotic and antioxidant activities. The scores increased with increase in the percentage of *Gandelia tourfonetti* pulp added to yogurt in almost all sensory attributes. Generally, *Gundelia tournefortii* pulp addition, increased apparent viscosity and consistency values of the final product [22].

CONCLUSION

In fact, blending functional ingredients into dairy based foods helps increased sale of dairy foods. Hence, there is a need to merge non-dairy ingredients with dairy based ingredients and products to attain the previous mentioned objectives with attendant savings in cost, enhanced appearance, taste, texture and even functionality. In animal and human experiments, *G.tournefortii* had several pharmacological effects. Considering its very valuable pharmacological features in traditional medicine and frequent use, *G.tournefortii* could be applied in treating infectious diseases, digestive disorders, cancer and high blood pressure.

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