Annals of Agricultural Sciences 65 (2020) 6–12

Contents lists available at ScienceDirect

Annals of Agricultural Sciences

journal homepage: www.elsevier.com/locate/aoas

Comparative evaluation of some herbs and their suitability for skimmed milk yoghurt and cast Kariesh cheese fortification as functional foods

Dalia F. Hasneen [a], Nahed L. Zaki [a], Mohamed S. Abbas [b], Amira S. Soliman [b], Ihab S. Ashoush [c,*], Atef E. Fayed [c]

[a] Food Technologies Research Institute, Agricultural Research Center, Giza, Egypt
[b] Faculty of African Postgraduate Studies, Cairo University, Giza, Egypt
[c] Food Science Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt

ARTICLE INFO

Article history:
Received 28 February 2020
Received in revised form 18 April 2020
Accepted 4 May 2020
Available online xxxx

Keywords:
Turmeric
Sage
Marjoram
Yoghurt bacterial starter culture
Phenols
Flavonoids

ABSTRACT

The objective was to add certain herbs rich in active physiological ingredients for skimmed-milk yoghurt and cast ultrafiltration (UF)-Kariesh cheese to find out their suitability as fortifiers *en* route to innovate functional products. Yoghurt was made using cow's skimmed milk fortified with the milled herbal aqueous extract (10% *w*/w) at the level of nil (control), 1, 2, or 3% (*w*/w) of turmeric, sage or marjoram. Cheese was made using UF-skimmed milk concentrated, to the desired final cheese total solids (TS) % and fortified as mentioned before. Skim milk powder was used to avoid any dilution in the final TS %, whether of yoghurt milk or pre-cheese. Organoleptically, it was accepted the herbal extract providing that its level did not exceed 1.0% for yoghurt or 2% for cheese. The protein content exhibited no difference in yoghurt and reduction in cheese due to herbs because which the ash content decreased in yoghurt and increased in cheese, in those the fiber presented because of herbs. Turmeric encouraged the growth of bacterial starter culture and acid production *versus* marjoram or sage. The *Streptococcus thermophilus* count was always higher than that of *Lactobacillus delbrueckii* ssp. *bulgaricus*. But their counts in cheese were lower *versus* yoghurt. In conclusion, skimmed-milk yoghurt and cast UF-Kariesh cheese could meet the intended health purposes when fortified with 1% for the former or 2% for the latter using aqueous extract (10%) of sage, marjoram or rather turmeric, those of many impressive health benefits.

1. Introduction

Yoghurt is the most popular fermented dairy product in world and well-being has existed in many civilizations for a long time *per capita* consumption of fermented milk including yoghurt in most countries in the world has increased dramatically over the past three decades mainly due to the upward trend in the awareness of the nutritional value and health aspects associated therewith (Fayed et al., 2011a, 2011b; Tamime, 2004).

The distinctive characteristics of yoghurt are its contents of live lactic culture and a large amount of lactic acid (Tamime and Robinson, 1999). To meet the specifications reported by United States Department of Agriculture (USDA) (2001), the finished yoghurt product must contain live lactic acid bacteria amounts of $>10^6$ organisms/g at the time of manufacture and the cultures must remain active at the end of the stated shelf life.

Skimmed milk (Kariesh) cheese is one of the indigenous white soft cheese types in Egypt. Kariesh, as well as Domiati chesses, are the most popular varieties of soft cheese in Egypt, but the former is the oldest type manufactured since 3000 BCE It composes about 50% of soft white cheeses produced in Egypt (Abou-Donia, 1991; Hegazy et al., 2012).

Given the growing awareness of the health of the consumer, Kariesh cheese becomes very popular because of its remarkable health quality as the only known relatively fat-free cheese consumed by the Egyptians. It is often recommended for persons suffering from obesity, cholesterol and heart disease as reported by Fayed et al. (2014), who additionally concluded that, Kariesh cheese, which made without whey drainage using skimmed milk concentrated by ultrafiltration (UF) process, cultured with the probiotic strains and rennet-incorporated, possessed super marketing and physiological advantages. The whey proteins, especially glycomacropeptide entrapped in this cheese, acted a synergistic effect with the probiotics for preventing colonic cancer.

Ever-growing consumer demand for convenience, combined with a healthy diet and preference for natural ingredients, has led to a growth in functional beverage markets. Scientific and clinical evidence is also mounting to corroborate the consumer perception of health from fermented milk. Probiotics, prebiotics, synbiotics and associated ingredients also add an attractive dimension to cultured dairy products. Another potential growth area for fermented milk includes added-value products such as low calorie, reduced-fat varieties and those fortified

* Corresponding author.
E-mail address: ihab_ashoush@agr.asu.edu.eg (I.S. Ashoush).

https://doi.org/10.1016/j.aoas.2020.05.001

with physiologically active ingredients including fibers, phytosterols, omega-3-fatty acids, whey-based ingredients, antioxidant vitamins, herbs and isoflavones those provide specific health benefits beyond basic nutrition (Fayed, 2015; Khurana and Kanawjia, 2007).

The followings shed light on the health benefits of three herbs interested in this research concerning their suitability for yoghurt and Kariesh cheese fortification.

Turmeric is distinguishing with multi healthy benefits, where it possesses therapeutic effects on the brain and nervous system (Zhou et al., 2011) and offers protective action against vascular dementia by exerting antioxidant activity (Thiyagarajan and Sharma, 2004; Vajragupta et al., 2003) and on blood and cardiovascular system (Nirmala and Puvanakrishnan, 1996). It helps Wounds Heal (Akbik et al., 2014) and influences on gastrointestinal system including stomach (Liju et al., 2014), intestine (Platel and Srinivasan, 1996), liver (Shukla and Arora, 2003) and pancreas (Platel and Srinivasan, 2000). Also, turmeric has an anticarcinogenic effect – induction of apoptosis (Khar et al., 2001), pro/antimutagenic activity (Shukla et al., 2002), antioxidant effect (Masuda et al., 2001) and anti-inflammatory activity (Phan et al., 2001). Turmeric reduces aches and discomfort (Kuptniratsaikul et al., 2014), helps stiff joints (Chandran and Goel, 2012). Turmeric has anti-pathogenic bacterial activity (Mahady et al., 2002; Moghadamtousi et al., 2014), antifungal effect (Jayaprakasha et al., 2001) antiviral effect (Taher et al., 2003), antiprotozoan activity (Koide et al., 2002), antifibrotic effect (Punithavathi et al., 2000) and antivenom effect (Araujo and Leon, 2001; Moghadamtousi et al., 2014).

Sage particularizes with antioxidant activity (Yadav and Mukundan, 2011), leads to memory improvement (Imanshadi and Hosseinzadeh, 2006) and acts as antidiabetic (Christensen et al., 2010), anticarcinogenic (Keshavarz et al., 2011). Sage is also effective in the prevention of cardiovascular disease and cholesterol lowering (Christensen et al., 2010). Sage is reducing obesity (Canale et al., 2013) and act as hot flashes treatment (Bommer et al., 2011), controlling inflammation (Hamidpour et al., 2014) as well as possesses anti-pathogenic bacterial activity (Khalil and Li, 2011) and anti-diarrheal activity (Khan et al., 2011). Sage was applied in Swissalp Panorama and Bellevue cheeses surface coating, which also provides aroma to entire cheese (Hayaloglu and Farkye, 2011).

The medicinal effects of marjoram are gastrointestinal tract stimulant, tonic, carminative, diaphoretic, hypoglycemic, diuretic as well as anti-pathogenic bacterial and helps alleviate common digestive disorders such as flatulence, constipation, diarrhea and stomach cramps (Leeja and Thoppil, 2007) and as an antioxidant (Handl et al., 2008). The antigenotoxicity of marjoram was reported by El-Ashmawy et al. (2005).The different extracts of marjoram possess antioxidant, antimicrobial (Mohammed et al., 2011), antimutagenic (Al-Harbi, 2011) or anticancer activities (Vagi et al., 2005), antihyperglycemic, antilipidemic, antiulcer (Pimple et al., 2012a, 2012b) and anti-inflammatory effects (Heo et al., 2002). It is great at relieving a variety of problems due to inflammation, involving: sinus headaches, migraines, fever, asthma, muscle spasms and body aches. Its utilization for the mitigation of diverse diseases was also in practice, being a sudorific, stomachic, emmenagogic, stimulant, expectorant, antiseptic (Ozcan and Al-Juhaimi, 2011), hepatoprotective and nephroprotective (Rashwan, 2011; Shati, 2011). Marjoram is a great antiseptic, anti-pathogenic bacterial, antifungal, and antiviral agent. Therefore, it fights against a variety of common illnesses: tetanus infection in wounds, food poisoning, staph infection, typhoid, malaria, influenza, common cold, mumps and measles. It is generally used as a spice and it is well-liked home remedies for asthma, rheumatism, nervous headaches, cardiovascular diseases, diuretic and stomach disorders. With sedative and antidepressant advantages, marjoram has somewhat a variety of psychological and neurological benefits. It helps in: relieving insomnia, reducing stress, calming anxiety, minimizing emotional reactions and increasing control of sexual desire. Marjoram can aid uplift the mood and improve psychological well-being. There are a variety of other health benefits as well, such as: reduction of phlegm, warding off fungal infections, regulating the menstrual cycle in women, relieving premenstrual syndrome and lessening bruising (Al-Harbi, 2011).

From these points, the objective of this study was to add such herbs rich source of physiologically active ingredients, namely turmeric, sage as well as marjoram to skimmed-milk yoghurt and cast UF-Kariesh cheese to find out to what extent they could be suitable for use as fortifiers *en* route to innovate functional products.

2. Materials and methods

2.1. Materials

The rhizome of turmeric (*Curcuma longa*), dry plant leaves of sage (*Salvia officinalis*) and marjoram (*Origanum majorana*) were obtained from Horticultural Research Institute-Agricultural Research Center, Egypt. Fresh cow's skimmed milk was obtained from the herd of the armed forces farms in Cairo-Ismailia desert road, (8.8% total solids, 0.2% fat, 3.2% protein and pH 6.7). Skimmed milk powder (SMP) was obtained from Synlait Milk Ltd., Rakaia 7783 - New Zealand (3.8% moisture, 34% protein, 1.5% fat and 8.3% ash).

Dried microbial rennet was obtained from MAYSA GIDA San ve Tic. A.S., Tuzla Kimya Sanayicileri Organize Sanayi Bolgesi Melek Aras Bulvari No: 54 TUZLA, Istanbul, 34956, Turkey. Concentrated lyophilized mixed yoghurt starter culture (YC-183) contains *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*, (1:1), was obtained from Chr. Hansen Lab., Denmark. Sodium chloride (NaCl) was obtained from El-Nasr for Salt Production Co.

2.2. Experimental procedure

2.2.1. Preparation of aqueous herbal extract

Aqueous extract of turmeric powder, dry plant leaves of sage and marjoram were prepared according to the method described by Bloor (2001). Briefly, medicinal herbal materials were pulverized separately in a grinder (10% dry matter). The pulverized material was then dissolved and extracted with 1000 ml hot distilled water in an electric blender for 15 min. The suspension was left at room temperature for 1 h, then filtered twice, first through cheese-cloth and then through filter paper (Whatman No. 1). The clear aqueous extract was immediately used.

2.2.2. Preparation of rennet solution

Preparation of rennet solution was carried out by dissolving 40 g rennet powder in 1 L distilled water.

2.2.3. Preparation of bacterial starter culture

Preparation of yoghurt culture (YC-183) was carried out by dissolving 15 g of the lyophilized culture in 1 L of UHT skimmed milk and incubation at 40 ± 1 °C up to curdling, at which it usually coagulated throughout 3 h.

2.2.4. Skimmed-milk yoghurt making

Fresh cow's skimmed milk (8.5% solids not fat, SNF) was supplemented with skimmed milk powder (SMP) at a level of 3%. Then heat treated to 85 °C for 5 min followed by temperature adjustment to 42 °C. Then milk was divided into 10 equal portions and filled into plastic containers. The first one was the control. The nine portions were fortified with the herbal aqueous extract at the level of 1, 2, or 3% (*w*/w) either of turmeric, sage or marjoram. To avoid any dilution occurred in final TS % of yoghurt milk, the TS % of all herbal extracts were heightened to be equal to that of yoghurt milk using SMP. Then, milk was converted into yoghurt according to the protocol proposed by Tamime and Robinson (1999) with adopting the manufacture conditions enacted by Egyptian Organization for Standardization and Quality (EOSQ) (2010),

where milk was inoculated with 2% of freshly activated YC-183 starter culture, filled into 100 ml containers, covered, and incubated at the same temperature degree (42 °C) until complete coagulation (through about 3 h.). Thereafter, containers were transferred to the refrigerator (5 ± 1 °C), where they were kept to the next day for analyses. Three replicates were done for every treatment.

2.2.5. Cast ultrafiltration (UF)-Kariesh cheese manufacture

The experimental procedure of cast UF-Kariesh cheese making described by Fayed (1986) was applied. Skimmed cow's milk was firstly heat treated at 72 °C for 15 s., cooled immediately to 5 °C and rewarmed to 50 °C at which the UF-process was run as recommended by Maubois et al. (1987) using UF TECH-SEP (group of Rhone Poulenc, France) unit equipped with Carbo Sep Tubular Mineral Membrane having area 34.2 m^2 and a nominal molecular weight cut off 20 Kilo Dalton. The resultant retentate (concentrated to give the milk solids content desired in the final Kariesh cheese) was subjected to another heat treatment (72 °C/15 s.), cooled to the suitable temperature, and then divided into 10 equal portions and filled into plastic containers. The first one was the control. The nine portions were fortified with the herbal aqueous extract (10% *W*/W) at the level of 1, 2, or 3% (*w*/w) either of turmeric, sage or marjoram. To avoid any dilution occurred in final TS % of precheese, the TS % of all herbal extracts were heightened to be equal to that of precheese using SMP. All treatments were and salted to 2% NaCl, inoculated with 3% activated YC starter culture +0.05 ml rennet solution (4%) /Kg and incubated at 40 °C up to curdling within 30 min. Thereafter, containers were transferred to the refrigerator (5 ± 1 °C) where they were kept to the next day for analyses. Three replicates were carried out for each treatment.

2.3. Analytical methods

Determination of dry matter method no. 934.01, fat method no. 945.18, total nitrogen method no. 935.58, crude fiber method no. 920.169 and ash contents method no. 941.12, as well as titratable acidity (TA) % method no. 947.05 was carried out as in Association of Official Analytical Chemists (AOAC) (2007). The pH value was measured by a microprocessor pH meter (model 8417, Hanna Instruments, Singapore) at 20 ± 1 °C as described in British Standards Institution (BSI) (1990). The viscosity was measured at 10 ± 1 °C as explained by Toledo (1980) using a rotary viscometer (RHEOTEST, type RV and Pruefgeraetewerk Medingn, Dresden) equipped with a spindle No. SC4-21 in 250 ml cup. One-day yoghurt samples were exposed for dynamic viscosity measurement at a shear rate of 437 s^{-1}. All samples were adjusted to 10 ± 1 °C before loading in the viscometer device.

The Electron-donating ability of each extract was determined by implying 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging assay, as described by Brand-Williams et al. (1995). The total phenolic content of each extract was colorimetrically determined using the Folin-Ciocalteu method, as described by Singleton and Orthofer (1999). The total flavonoid contents were determined according to the method of Mohdaly et al. (2012).

The viable cell of *Lb. delbrueckii* ssp. *bulgaricus* was counted using De Man, Rogosa and Sharpe (MRS) agar medium as described by Gueimonde et al. (2003). The culture was incubated anaerobically for 2 days at 37 °C. While viable cell of *Str. thermophilus* was enumerated using M17 agar after the incubation at 37 °C for 72 h. as in Dave and Shah (1996). Coliform count was enumerated in cheese samples using violet red bile agar medium as reported by American Public Health Association (APHA) (1992). The plates were incubated at 37 °C for 48 h. Yeasts and molds were determined using malt extract agar at 25–27 °C for 4 days as suggested by Harrigan and McCance (1966). The count was expressed as colony forming units (cfu)/g of product.

Sensorial properties were evaluated by ten panelists familiar with the product after overnight storage of the samples at 5 °C. Sensory characteristics were appearance (5 points), body and texture (5 points), flavor (10 points) with a total score of 20 points, according to Pearce and Heap (1974).

Statistical analysis was performed using one-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test with probability (P) ≤ 0.05 being considered statistically significant (Snedecor and Cochran, 1980). Statistical analysis was conducted with SAS program (Statistical Analysis System (SAS), 1996).

3. Results and discussion

3.1. Antioxidant status of separate herbal aqueous extracts

It could be observed a high content of total phenols for aqueous turmeric extract comparing to sage and marjoram. On the other side, the sage and marjoram extract had a high content of total flavonoids and revealed potent scavenging activity compared to aqueous turmeric extract (Table 1). These results are agreed with those of Mariutti et al. (2008), who reported that marjoram has potent antioxidant effects, which are attributed to its content of phenolic acids and flavonoids. Also, the use of sage as an antioxidant was already successfully tested in foods.

3.2. Characteristics of herbal skimmed-milk yoghurt

3.2.1. Organoleptic attributes

As could be observed from the given data in Table 2, the appearance score was significantly influenced due to adding of herbal extract so that the appearance of a sample containing 3% herbal extract (10% *w*/w) gained the lowest score regardless the herbal kind.

Likewise, the consistency (body and texture) score was gradually weakened as a result of herbal extract adding (Table 2).

On the other hand, the palatability of yoghurt sample was significantly harmed by increasing the level of herbal extract added as exhibited from the flavor scores given in Table 2.

Therefore, the overall acceptance scores, which are, indeed, the summation of appearance, body & texture and flavor scores, reflecting that obvious reduction in the total sensory score were associated with the proportional adding of herbal extract.

The forgoing results led to conclude that it could be organoleptically accepted yoghurt fortified with herbal extract (10% *w*/w), providing that the fortification level did not exceed 1.0% (w/w).

3.2.2. Physiochemical properties

As could be seen in Table 3 the dry matter (DM) content of all herbal yoghurts was surrounding that of the control one. That could be due to the previous adjustment of the DM content of water herbal extract by skimmed milk powder (SMP) to be equal to that of the yoghurt milk prior to or without fortification. It is worthy of mentioning that, all obtained DM contents in this study are, in general, in coincidence with the Egyptian Organization for Standardization and Quality (EOSQ) (2010). Similar observations were reported by Aita et al. (2015); Fayed et al. (2011a and b); Fayed et al. (2016).

Likewise, the protein, fat and ash contents exhibited no difference due to yoghurt fortification with the herbal extract. Although the

Table 1
Antioxidant status of certain aqueous milled herbal extracts (10% *w*/w).

Property	Kind of aqueous herbal extract (10% w/w)		
	Turmeric	Sage	Marjoram
Total phenols (mg/g) as gallic acid	8.29[a]	3.37[c]	2.88[b]
Total flavonoids (mg/g) as quercetin	1.16[c]	2.25[b]	2.48[a]
Radical scavenging activity %	50.590[b]	85.517[a]	85.640[a]

$N = 3$, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).

Table 2
Sensory scores of skimmed-milk yoghurt as affected either by the kind and fortification level with the aqueous milled herbal extract (10% w/w).

Sensory attribute	Plain (control)	Kind of aqueous herbal extract (10% w/w)								
		Turmeric			Sage			Marjoram		
		Fortification level			Fortification level			Fortification level		
		1%	2%	3%	1%	2%	3%	1%	2%	3%
Appearance (Out of 10 points)	10.00^{a}	9.08^{a}	8.83^{a}	7.41^{b}	8.66^{a}	7.05^{ab}	6.58^{b}	8.83^{a}	8.33^{a}	7.25^{b}
Consistency (Out of 10 points)	10.00^{a}	8.83^{a}	8.14^{ab}	7.60^{b}	8.48^{a}	7.89^{a}	7.10^{b}	8.75^{a}	8.33^{a}	7.56^{b}
Flavor (Out of 10 points)	10.00^{a}	9.00^{a}	7.91^{b}	7.02^{b}	8.27^{a}	7.77^{ab}	6.43^{b}	8.60^{a}	8.37^{ab}	7.41^{b}
Overall (Out of 30 points)	30.00 ^{a}	26.91^{b}	24.89^{c}	22.04^{d}	25.42^{b}	23.16^{c}	20.12^{d}	26.19^{b}	25.04^{c}	22.22^{d}

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).

control yoghurt contained no fiber, a gradual increase in the fiber content of yoghurt was associated with the proportional fortification with the herbal extract.

Moreover, the fortification with turmeric extract did not lead to any difference in the TA%, while both marjoram and rather sage extract delayed the acid production in yoghurt. These phenomena were negatively reflected on the pH values of the resultant yoghurt, where the yoghurt containing the extract of the last two herbs possessed higher pH values.

The viscosity of marjoram yoghurt was as high as that of the control, while those of sage and rather of turmeric appeared the lowest viscosity.

3.2.3. Microbiological quality

Data of (Table 4) indicated that the yoghurt skimmed milk fortification with 1.0% turmeric extract led to encourage the bacterial yoghurt of both strains, while both of marjoram and sage extract delay slightly their growth in comparison with the control (plain yoghurt).

From the comparison between the given data of both strains, it could be noticed that the *Str. thermophilus* count is always higher than that of *Lb. delbrueckii* ssp. *bulgaricus*. Rasic and Kurmann (1978) reviewed that *Str. thermophilus* grows faster at the beginning of lactic acid fermentation, outnumbering *Lb. delbrueckii* ssp. *bulgaricus* by 3 or 4 times often the 1st h. The obtained results are in complete agreement with those found by Aita et al. (2015); Fayed et al. (2011a and b); Fayed et al. (2016); Hussein and Aumara (2006); Hussein et al. (2008).

Concerning the microbiological food safety, it could be noticed that neither coliform nor yeasts and molds were detected. That is mainly due to the full sanitation precautions adapted during either herbal extracts or yoghurt samples preparations.

Table 3
Physicochemical properties of skimmed-milk yoghurt fortified by 1% of certain milled aqueous milled herbal extracts (10% w/w).

Property	Plain (control)	Kind of aqueous herbal extract (10% w/w)		
		Turmeric	Sage	Marjoram
Dry matter (%)	12.92^{a}	12.84^{a}	12.75^{a}	12.61^{a}
*Protein %	4.00^{a}	3.84^{a}	3.96^{a}	3.89^{a}
Fat (%)	1.20^{a}	1.10^{a}	1.20^{a}	1.10^{a}
Ash (%)	0.73^{a}	0.67^{a}	0.64^{a}	0.67^{a}
Fiber (%)	0.00^{d}	0.23^{c}	0.43^{a}	0.33^{b}
Titratable acidity (%)	1.12^{a}	1.17^{a}	0.85^{c}	0.91^{b}
pH value	4.71^{b}	4.66^{c}	4.99^{a}	4.82^{b}
Viscosity (centipoise)	280^{a}	210^{c}	240^{b}	290^{a}

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).
* Total nitrogen × 6.38.

3.3. Properties of cast UF-Kariesh cheese fortified with herbal extract

3.3.1. Organoleptic attributes

As could be noticed in the appearance property, its score recorded significant reductions as the herbal extract level added increased than 2%.

Likewise, the score of cheese texture and body was lowered when the herbal extract level exceeded 2% except those of sage containing Kariesh cheese, which was not influenced up to the extract level of 3% (Table 5).

Similar trends were recorded with respect to the taste criterion, where although the flavor of turmeric containing cheese was not significantly affected by the level herbal extract up to 3%, the flavor scores of both of marjoram and sage containing cheese were significantly lowered when the level of their extract was exceeded 2%. Therefore, the total score was indeed, reflecting the overall acceptance of the herbal cheese, as given in Table 5.

Most sensory attributes of the resultant herbal cheese were considered strange and somewhat unpalatable in original Kariesh cheese (the control), but due to the multi health importance of these extracts the research has been completed at the highest possible herbal fortification level providing that sensory score should be not far from that of control arbitration. In this respect, the fortification level of 2% obtained mostly the second Duncan's letters after towards the control.

3.3.2. Physicochemical properties

Data in Table 6 revealed that the DM contents of all cheese treatments were fluctuated from 26.17 to 26.89% indicating that, the previous adjustment of all pre-cheese recipes was reflected in the equality of resultant DM% of the cheese. Moreover, all DM% are in complete agreement with the Egyptian Organization for Standardization and Quality (EOSQ) (2005), which provided that the DM content should be not <25%. Similar observations were reported by Fayed et al. (2014). Regarding the protein content of herbal UF-Kariesh cheese,

Table 4
Count of bacterial yoghurt strains, coliform, yeasts and molds of skimmed-milk yoghurt fortified by 1% of some aqueous milled herbal extracts (10%w/w).

Microorganism	Plain (control)	Kind of aqueous herbal extract (10% w/w)		
		Turmeric	Sage	Marjoram
Str. thermophilus	58×10^{6b}	60×10^{6a}	51×10^{6d}	52×10^{6c}
Lb. delbrueckii ssp. *bulgaricus*	55×10^{5b}	58×10^{5a}	54×10^{5c}	49×10^{5d}
Coliform	ND	ND	ND	ND
Yeasts and molds	ND	ND	ND	ND

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).
cfu/g: colony forming unit/g; ND: Not detected.

Table 5
Sensory scores of UF-Kariesh cheese fortified with different levels of certain aqueous milled herbal extracts (10.0% *w*/w).

Sensory attribute	Plain (control)	Kind of aqueous herbal extract (10% w/w)								
		Turmeric			Sage			Marjoram		
		1%	2%	3%	1%	2%	3%	1%	2%	3%
Appearance (Out of 10 points)	10.00^{a}	9.08^{a}	8.41^{ab}	7.75^{b}	8.66^{a}	8.16^{a}	7.16^{b}	9.16^{a}	8.75^{a}	7.41^{b}
Consistency (Out of 10 points)	10.00^{a}	9.06^{a}	8.22^{ab}	7.31^{b}	8.22^{a}	7.97^{b}	7.22^{b}	9.22^{a}	8.72^{ab}	7.97^{b}
Flavor (Out of 10 points)	10.00^{a}	8.66^{a}	8.25^{a}	8.00^{a}	8.25^{a}	8.00^{a}	7.50^{b}	8.66^{a}	8.33^{ab}	7.66^{b}
Overall (Out of 30 points)	30.00^{a}	26.81^{b}	24.89^{b}	23.06^{c}	25.13^{b}	24.14^{b}	21.89^{d}	27.62^{a}	25.81^{b}	23.06^{c}

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).

which was significantly lower than that of the control. That could be due to the dilution in the nitrogenous substances that occurred due to the addition of herbal extract (2% *w*/w) to precheese.

The fat content didn't appear any significant differences among all UF-Kariesh cheese treatments. Opposite to the protein content, the ash content was significantly increased by herbal extract adding. Furthermore, the presence of herbal extract into cheese led to appear the fiber into cheese composition, showing that the turmeric extract caused the highest value (Table 6).

Titratable acidity % exhibited significant reduction when the marjoram or sage extract was added. On the contrary, although the addition of turmeric extract did not show any differences, significant heights were observed in pH value marjoram or rather sage UF-Kariesh cheese (Table 6).

It is worthy of mentioning that UF-Kariesh cheeses always distinguished with higher TA% and hence lower pH value *versus* yoghurt (Table 3). These phenomena could be attributed to the relatively higher protein content and the added NaCl possessed UF-Kariesh; those have an acidic effect. Similar observations were found and discussed by Fayed (1986).

3.3.3. Microbiological quality

Data present in Table 7 indicated that the UF- Kariesh precheese fortification with 2.0% extract of any herbal kind, especially turmeric, led significantly to encourage the growth of *Str. thermophilus*, while both of marjoram and sage extracts delay significantly the growth of *Lb. delbrueckii* ssp. *bulgaricus* in comparison with the control.

As previously observed in yoghurt, comparing the data given of both strains, it could also be noticed that, the *Str. thermophilus* count is always higher than that of *Lb. delbrueckii* ssp. *bulgaricus*. The obtained results are in complete agreement with those found by Aita et al. (2015); Fayed et al. (2011a and b); Fayed et al. (2016); Hussein and Aumara (2006); Hussein et al. (2008); Rasic and Kurmann (1978).

Moreover, it is worthy of mentioning that, although the precheese was previously inoculated with 3% yoghurt bacterial starter culture, the resultant count of both lactic acid strains was lower than those enumerated in yoghurt itself. That could be ascribed to the relative bacterial growth inhibition due either to the presence of NaCl added to the precheese or/and the liquid precheese was in the concentrated form because the ultrafiltration process. Similar findings were reported and discussed by Fayed (1986).

As previously mentioned in yoghurt products, neither coliform nor yeasts and molds were detected in all Kariesh cheese treatments. That is mainly because of the full sanitation precautions adapted during either herbal extracts or cheese samples preparations.

3.4. Physiological advantages resulting from the herbal fortification of dairy products towards the antioxidant activity

Firstly, the obtained results in Table 8 appeared that, the both of the two plain dairy products, namely skimmed milk yoghurt and cast kariesh cheese, possessed essentially antioxidant activity mainly due to the presence of milk proteins and as a result of the heat treatment, which leads to the thermal liberation of sulfhydryl groups, those increase the protein reducing value as previously mentioned by Fayed (1981). Moreover, all determined parameters of the antioxidant activity of the control yoghurt are in coincidence with those of Illupapalayam et al. (2014), Perna et al. (2014) and Fayed et al. (2015). Likewise, the trending of antioxidant activity parameters of Kariesh cheese are in complete agreement with those of the control of soft cheese (paneer) found by Qureshi et al. (2019).

Concerning the physiological benefits gained due to the herbal fortification of skimmed milk yoghurt or cast kariesh cheese, data present in Table 8 demonstrated that the total phenolic equivalent content of yoghurt was improved only by turmeric extract. In contrast, that of kariesh cheese was enriched either by a sage or rather by turmeric extract. That may declare that the higher levels added to cheese *versus* yoghurt help to show the result of the fortification with sage or turmeric extract.

Regarding the total flavonoids content of yoghurt, the recorded results confirmed that it has significant improvement to the same degree by adding any herbal extract that has been tried without any exception.

Table 6
Physicochemical properties of UF- Kariesh cheese fortified with 2.0% of certain aqueous milled herbal extracts (10.0%w/w).

Property	Plain (control)	Kind of herbal extract (10% w/w)		
		Turmeric	Sage	Marjoram
Dry matter (%)	26.89^{a}	26.33^{b}	26.35^{b}	26.17^{b}
*Protein (%)	17.50^{a}	15.50^{b}	15.15^{c}	16.16^{b}
Fat (%)	2.75	2.59	2.70	2.60
Ash (%)	3.20^{c}	3.44^{c}	3.96^{a}	3.69^{b}
Fiber (%)	0.00^{c}	0.53^{a}	0.10^{b}	0.04^{b}
Titratable acidiy (%)	1.61^{a}	1.77^{a}	1.29^{c}	1.46^{b}
pH value	4.42^{c}	4.43^{c}	4.74^{a}	4.52^{b}

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).
* Total nitrogen × 6.38.

Table 7
Count of bacterial yoghurt strains of UF- Kariesh cheese fortified by 2% of certain aqueous milled herbal extracts (10%*w*/w).

Microorganism	Plain (control)	Kind of aqueous herbal extract (10% w/w)		
		Turmeric	Sage	Marjoram
Str. thermophilus	70×10^{4d}	85×10^{4a}	77×10^{4b}	71×10^{4c}
Lb. delbrueckii ssp. *bulgaricus*	80×10^{3b}	98×10^{3a}	74×10^{3d}	79×10^{3c}
Coliform	ND	ND	ND	ND
Yeasts and molds	ND	ND	ND	ND

N = 3, Means having different superscripts in the same row are significantly different ($p \leq 0.05$).
cfu/g: colony forming unit/g.
ND: not detected

Table 8
Antioxidant activity of herbal skimmed milk yoghurt and cast kariesh cheese.

Property	Plain		Kind of aqueous herbal extract (10% w/w)					
			Turmeric		Sage		Marjoram	
	Yoghurt control	Cheese control	Yoghurt	Cheese	Yoghurt	Cheese	Yoghurt	Cheese
			Fortification level with aqueous herbal extract					
			1%	2%	1%	2%	1%	2%
Total phenols (mg/g) as gallic acid	$3.09^{b,b}$	$12.36^{c,a}$	$4.32^{a,b}$	$14.74^{a,a}$	$3.17^{b,b}$	$13.31^{b,a}$	$3.14^{b,b}$	$12.84^{c,a}$
Total flavonoids (mg/g) as quercetin	$1.12^{b,b}$	$4.48^{c,a}$	$1.39^{a,b}$	$4.83^{c,a}$	$1.41^{a,b}$	$5.03^{b,a}$	$1.48^{a,b}$	$5.75^{a,a}$
Radical scavenging activity %	$20.56^{c,b}$	$63.98^{c,a}$	$26.72^{b,b}$	$75.36^{b,a}$	$29.42^{a,b}$	$88.47^{a,a}$	$29.56^{a,b}$	$88.79^{a,a}$

N = 3, the letters before comma possess of the factor of herbal kind, while those after comma possess the factor of the type of dairy product, respectively. The means with the same letter at any position did not significantly differ ($p \leq 0.05$).

While in the case of kariesh cheese, although turmeric exhibited no impact, the cheese total flavonoids content increased significantly either by a sage or rather by marjoram adding. This means with respect to those both herbs (sage and marjoram) that higher addition levels, as done in kariesh cheese *versus* yoghurt, highlight the effect of fortification (Table 8).

Regarding the radical scavenging activity (RSA) % of either skimmed milk yoghurt or cast kariesh cheese, the results stated that, the RSA of both dairy products were significantly enhanced by turmeric and rather by sage or marjoram.

It is worthy to mention that, cast kariesh cheese was distinguished with antioxidant activity values always higher than those of skimmed milk yoghurt (Table 8). These findings could be mainly due to the higher protein content as well as, the higher level of herbal extract added in the case of cheese *versus* the yoghurt.

Briefly, those mains the herbal fortification of such dairy products is considered as additional antioxidant activities besides those essentially present in the original products. This trending is in agreement with those found by Josipović et al. (2015), who determined antioxidant activity and phenolic compounds in Cottage cheese containing different spices. Therefore, turmeric sage or marjoram can be considered as an additive functional ingredient because of its antioxidant properties.

4. Conclusion

The forgoing results led satisfactory to conclude that, it could successfully make a skimmed-milk yoghurt and UF- Kariesh cheese, those meet the intended health purposes based on the fortification with 1% for the former or 2% for the latter using herbal aqueous extract (10%), consequentialist according to the sensory acceptability, either of sage, marjoram or rather of turmeric, those of many impressive health benefits *en* route to innovate functional dairy foods such as yoghurt and UF-Kariesh cheese. This ensures that the product is supplied through the fortification with turmeric, sage or marjoram as additional natural sources of antioxidant activity to elevate its physiological benefits and *en* route to innovate functional products.

References

Abou-Donia, S.A., 1991. Manufacture of Egyptian soft pickled cheese. In: Robinson, R.K., Tamime, A.Y. (Eds.), Feta and Related Cheeses. Ellis Horwood, London, UK.

Aita, O.A., Husein, Y.A., Fayed, A.E., El-Nawawy, M.A., 2015. Quality attributes of protein fortified yoghurt. J. Food Dairy Sci. 6, 227–241 Mansoura Univ.

Akbik, D., Ghadiri, M., Chrzanowski, W., Rohanizadeh, R., 2014. Review article: curcumin as a wound healing agent. Life Sci. 116, 1–7.

Al-Harbi, N.E., 2011. Effect of marjoram extract treatment on the cytological and biochemical changes induced by cyclophosphamide in mice. J. Med. Plant Res. 5, 5479–5485.

American Public Health Association (APHA), 1992. Standard Methods for the Examination of Water and Wastewater. 18th ed. Washington, D.C., USA.

Araujo, C.A.C., Leon, L.L., 2001. Biological activities of *Curcuma longa* L. Mem. Inst. Oswaldo Cruz 96, 723–728.

Association of Official Analytical Chemists (AOAC), 2007. Official Method of Analysis. 18th ed. Benjamin Franklin Station, Washington, D.C., USA, pp. 302–850.

Bloor, S., 2001. Overview of methods for analysis and identification of flavonoids. Methods Enzymol. 335, 3–14.

Bommer, S., Klein, P., Suter, A., 2011. First time proof of sage's tolerability and efficacy in menopausal women with hot flushes. Adv. Ther. 28, 490–500.

Brand-Williams, W., Cuvelier, M.E., Berset, C., 1995. Review article: use of a free radical method to evaluate antioxidant activity. LWT-Food Sci. Technol. 28, 25–30.

British Standards Institution (BSI), 1990. Testing Aggregates. General Requirements for Apparatus and Calibration. BS 812: Part 100. BSI, London, UK.

Canale, M.P., Villahermos, S.M., Martino, G., Rovella, V., Noce, A., DeLorenzo, A., 2013. Obesity-related metabolic syndrome: mechanisms of sympathetic overactivity. Int. J. Endocrinol. 1–12.

Chandran, B., Goel, A., 2012. A randomized, pilot study to assess the efficacy and safety of curcumin in patients with active rheumatoid arthritis. Phytother. Res. 26, 1719–1725.

Christensen, K.B., Jorgenson, M., Kotowska, D., Peterson, R.K., Kristiansen, K., Christensen, L.P., 2010. Activation of the nuclear receptor PPARγ by metabolites isolated from sage (*Salvia officinalis L.*). J. Ethnopharmacol. 132, 127–133.

Dave, R.I., Shah, N.P., 1996. Evaluaton of media for selective enumeration of *Streptococcus thermophilus*, *Lactobacillus delbrueckii ssp. bulgaricus*, *Lactobacillus acidophilus* and bifidobacteria. J. Dairy Sci. 79, 1529–1536.

Egyptian Organization for Standardization and Quality (EOSQ), 2005. Egyptian standards. D-1 Food/2005. Guide Lines for Quality Criteria for Milk and Milk Products.

Egyptian Organization for Standardization and Quality (EOSQ), 2010. Egyptian standard. D-1 Food/2010. Guide Lines for Quality Criteria for Milk and Milk Products.

El-Ashmawy, I.M., El-Nahas, A.F., Salama, O.M., 2005. Protective effect of volatile oil, alcoholic and aqueous extracts of *Origanum majorana* on lead acetate toxicity in mice. Basic Clin. Pharmacol. Toxicol. 97, 238–243.

Fayed, A.E., 1981. Detection of Milk Powder in some Dairy Products. (MSc. Thesis). Fac. Agric., Ain Shams Univ, Cairo, Egypt, pp. 55–70.

Fayed, A.E., 1986. Protein Fortification of Some Dairy Products. (Ph.D. Thesis). Fac. Agric., Ain Shams Univ, Cairo, Egypt, pp. 139–143.

Fayed, A.E., 2015. Health benefits of physiologically active ingredients and their suitability as yoghurt fortifiers. J. Food Sci. Technol. 52, 2512–2521.

Fayed, A.E., Hussein, G.A., El-Mahdy, L.D., Masoud, M.S., Gab-Allah, R.H., 2011a. Glycoprotein fortification of bioyoghurt. Egypt J. Food Sci. 39, 81–106.

Fayed, A.E., Hussein, G.A., Youssef, M.S., Gab-Allah, R.H., 2011b. Improvement of yoghurt efficiency as functional food by glycoprotein fortification. J. Biol. Chem. Environ. Sci. 6, 241–265.

Fayed, A.E., Farahat, A.M., Metwally, A.E., Massoud, M.S., Emam, A.O., 2014. Health stimulating properties of the most popular soft cheese in Egypt "Kariesh" made using skimmed milk UF-retentate and probiotics. Acta Sci. Pol. Technol. Aliment. 13, 359–373.

Fayed, A.E., Farahat, A.M., Azouz, A., Swelem, S.E., 2015. Bacterial viability and biological aspects of drinking bioyoghurt fortified with some herbs as source of natural antioxidants. Proc. 2nd Int. Conf. of Food Safety and Technol., Health and Food Safety, Present and Future. Egypt. J. Agric. Res. 93, 875–907.

Fayed, A.E., Tawfek, M.A., El-Deeb, A.M., Ibrahim, A.E., 2016. Studies on the production of synbiotic yoghurt. Nat. Sci. J. 14, 150–157.

Gueimonde, M., Alonso, L., Delgado, T., Bada-Gancedo, J.C., Reyes-Gavilan, C., 2003. Quality of plain yoghurt made from refrigerated and CO_2-treated milk. Food Res. Int. 36, 43–48.

Hamidpour, M., Hamidpour, R., Hamidpour, S., Shahlari, M., 2014. Chemistry, pharmacology, and medicinal property of sage (*salvia*) to prevent and cure illnesses such as obesity, diabetes, depression, dementia, lupus, autism, heart disease, and cancer. J. Tradit. Complement. Med. 4, 82–88.

Handl, S., Hellweg, P., Khol-parisini, A., Rossmann, B., Thurner, K., Luf, W., Novak, J., Zentek, J., 2008. Effect of oregano (*O. majorana* × *O. vulgare*) on performance and antioxidative capacity of quails fed a diet rich in omega 3 fatty acids. J. Animal Physiol. Animal Nutr. (Berl) 92, 242–245.

Harrigan, W.F., McCance, M.E., 1966. Laboratory Methods in Microbiology. Academic Press London and New York.

Hayaloglu, A.A., Farkye, N.Y., 2011. Cheese with added herbs, spices and condiments. Encyclopedia of Dairy Sci, 2nd ed. Vol. 1, pp. 783–789.

Hegazy, N.M., Nasr, M.M., Fayed, A.E., Youssef, M.S., 2012. Economics scale for processing of white soft cheese in Egypt. Egypt. J. Agric. Economics 22, 1079–1094.

Heo, H.J., Cho, H.Y., Hong, B., Kim, H.K., Heo, T.R., Kim, E.K., Kim, S.K., Kim, C.J., Shin, D.H., 2002. Ursolic acid of *Origanum majorana* L. reduces Abeta-induced oxidative injury. Mol. Cell 13, 5–11.

Hussein, G.A., Aumara, I.E., 2006. Preparation and properties of probiotic frozen yoghurt made with sweet potato and pumpkin. Arab Univ. J. Agric. Sci. 14, 679–695 Ain Shams Univ..
Hussein, G.A., Youssef, M.S., Masoud, M.S., Fayed, A.E., 2008. Biological attributes of bio-yoghurt *versus* the conventional one fed in spray dried form. Ann. Agric. Sci. 53, 207–220.
Illupapalayam, V.V., Smith, S.C., Gamlath, S., 2014. Consumer acceptability and antioxidant potential of probiotic-yogurt with spices. LWT-Food Sci. Technol. 55, 255–262.
Imanshadi, M., Hosseinzadeh, H., 2006. The pharmacological effects of Salvia species on the central nervous system. Phytother. Res. 20, 427–437.
Jayaprakasha, G.K., Negi, P.S., Anandharamakrishnan, C., Sakariah, K.K., 2001. Chemical composition of turmeric oil – a byproduct from turmeric oleorsin industry and its inhibitory activity against different fungi. Z. Naturforsch. 56, 40–44.
Josipović, R., Knežević, Z.M., Frece, J., Markov, K., Kazazić, S., Mrvčić, J., 2015. Improved properties and microbiological safety of novel cottage cheese containing spices. Food Technol. Biotechnol. 53, 454–462.
Keshavarz, M., Bidmeshkipour, A., Mostafavi, A., Mansouri, K., Mohamadi-Motlagh, H., 2011. Antitumor activity of Salvia officinalis is due to its anti-angiogenic, anti-migratory and anti-proliferative effects. Cell J. 12, 477–482.
Khalil, R., Li, Z., 2011. Antimicrobial activity of essential oil of *Salvia officinalis* L. collected in Syria. Afr. J. Biotechnol. 10, 8397–8402.
Khan, A., Najeeb-ur-Rahman, K.A., Gilani, A., 2011. Antidiarrheal and antispasmodic activities of *Salvia officinalis* are mediated through activation of K + channels. J. Bangladesh Pharmacol. Soc. 6, 111–116.
Khar, A., Ali, A.M., Pardhasaradhi, B.V., Varalakshmi, C.H., Anjum, R., Kumari, A.L., 2001. Induction of stress response renders human tumor cell lines resistant to curcumin mediated apoptosis: role of reactive oxygen intermediates. Cell Stress Chaperones 6, 368–376.
Khurana, H.K., Kanawjia, S.K., 2007. Recent trends in development of fermented milks. Curr. Nutr. Food Sci. 3, 91–108.
Koide, T., Nose, M., Ogihara, Y., Yabu, Y., Ohta, N., 2002. Leishmanicidal effect of curcumin in vitro. Biol. Pharm. Bull. 25, 131–133.
Kuptniratsaikul, V., Dajpratham, P., Taechaarpornkul, W., Buntragulpoontawee, M., Lukkanapichonchut, P., Chootip, C., Saengsuwan, J., Tantayakom, K., Laongpech, S., 2014. Efficacy and safety of *Curcuma domestica* extracts compared with ibuprofen in patients with knee osteoarthritis: a multicenter study. Clin. Interv. Aging 9, 451–458.
Leeja, L., Thoppil, J.E., 2007. Antimicrobial activity of methanol extract of *Origanum majorana* L. (Sweet marjoram). J. Environ. Biol. 28, 145–146.
Liju, V.B., Jeena, K., Kuttan, R., 2014. Gastroprotective activity of essential oils from turmeric and ginger. J. Basic Clin. Physiol. Pharmacol. 26, 95–103.
Mahady, G.B., Pendland, S.L., Yun, G., Lu, Z.Z., 2002. Turmeric (*Curcuma longa*) and curcumin inhibit the growth of *Helicobacter pylori*, of group 1 carcinogen. Anticancer Res. 22, 4179–4181.
Mariutti, L.R.B., Barreto, G.P.M., Bragagnolo, N., Mercadante, A.Z., 2008. Free radical scavenging activity of ethanolic extracts from herbs and spices commercialized in Brazil. Braz. Arch. Biol. Technol. 51, 1225–1232.
Masuda, T., Maekawa, T., Hidaka, K., Bando, H., Takeda, Y., Yamaguchi, H., 2001. Chemical studies on antioxidant mechanisms of curcumin: analysis of oxidative coupling products from curcumin and linoleate. J. Agric. Food Chem. 49, 2539–2547.
Maubois, J.L., Pierre, A., Fauquant, J., Piot, M., 1987. Industrial fractionation of main whey proteins. Int. Dairy Fed. Bull. 212, 154–159.
Moghadamtousi, S.Z., AbdulKadir, H., Hassandarvish, P., Tajik, H., Abubakar, S., Zandi, K., 2014. A review on antibacterial, antiviral, and antifungal activity of curcumin. Biomed. Res. Int. 2014, 186864 12 pages. https://doi.org/10.1155/2014/186864.
Mohammed, N., Yasmen, S.H., Nohir, G., 2011. Antimicrobial activity of water and ethanol Marjoram (*Origanum marjorana* L.) extract. The 6th Arab and 3rd Int. Ann. Sci. Conf.: Development of Higher Specific Education Programs in Egypt and the Arab World in the Light of Knowledge Era Requirements Faculty of Specific Education Mansoura Univ., Egypt; April 13–14, pp. 2350–2366.
Mohdaly, A.A.A., Hassanien, M.F.R., Mahmoud, A., Sarhan, M.A., Smetanska, I., 2012. Phenolics extracted from potato, sugar beet, and sesame processing by-products. Int. J. Food Prop. 16, 1148–1168.
Nirmala, C., Puvanakrishnan, R., 1996. Protective role of curcumin against isoproterenol-induced myocardial infarction in rats. Mol. Cell. Biochem. 159, 85–93.
Ozcan, M.M., Al-Juhaimi, F.Y., 2011. Antioxidant and antifungal activity of some aromatic plant extracts. J. Med. Plant Res. 5, 1361–1366.
Pearce, L.E., Heap, H.A., 1974. Town milk. J. New Zealand Milk Board 22, 18.
Perna, A., Intaglietta, I., Simonetti, A., Gambacorta, E., 2014. Antioxidant activity of yogurt made from milk characterized by different casein haplotypes and fortified with chestnut and sulla honeys. J. Dairy Sci. 97, 6662–6670.
Phan, T., See, P., Lee, S., Chan, S., 2001. Protective effects of curcumin against oxidative damage on skin cells in vitro: its implication for wound healing. J. Trauma 51, 927–931.
Pimple, B.P., Kadam, P.V., Patil, M.J., 2012a. Comparative antihyperglycaemic and antihyperlipidemic effect of Origanum majorana extracts in NIDDM rats. Orient Pharm Exp Med 12, 41–50.
Pimple, B.P., Kadam, P.V., Patil, M.J., 2012b. Protective effect of Luffa acutangula extracts on gastric ulceration in NIDDM rats: role of gastric mucosal glycoproteins and antioxidants. Asian Pac J Trop Med 5, 610–615.
Platel, K., Srinivasan, K., 1996. Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rats. Int. J. Food Sci. Nutr. 47, 55–59.
Platel, K., Srinivasan, K., 2000. Influence of dietary spices or their active principles on pancreatic digestive enzymes in albino rats. Mol. Nutr. Food Res. 44 (1), 42–46.
Punithavathi, D., Venkatesan, N., Babu, M., 2000. Curcumin inhibition of bleomycin-induced pulmonary fibrosis in rats. Br. J. Pharmacol. 131, 169–172.
Qureshi, T.M., Amjad, A., Nadeem, M., Murtaza, M.A., Munir, M., 2019. Antioxidant potential of a soft cheese (paneer) supplemented with the extracts of date (*Phoenix dactylifera* L.) cultivars and its whey. Asian-Australas J. Anim. Sci. 32, 1591–1602.
Rashwan, N.M., 2011. Effect of majoram and choline mixture consumption against liver injury in experimental rats. World J. Dairy Food Sci. 6, 98–104.
Rasic, J.L., Kurmann, J.A., 1978. Yoghurt, Scientific Grounds, Technology, Manufacture and Preparations. Tech. Dairy Pub. House, Copenhagen, Denmark, pp. 17–68.
Shati, A.A., 2011. Effects of *Origanum majorana L.* on cadmium induced hepatotoxicity and nephrotoxicity in albino rats. Saudi. Med. J. 32, 797–805.
Shukla, Y., Arora, A., 2003. Suppression of altered hepatic foci development by curcumin in Wistar rats. Nutr. Cancer 45, 53–59.
Shukla, Y., Arora, A., Taneja, P., 2002. Antimutagenic potential of curcumin on chromosomal aberrations in Wistar rats. Mutat. Res.-Gen. Toxicol. Environ. Mutagen. 515, 197–202.
Singleton, V.L., Orthofer, R., Lamuela-Ravento's, R.M., 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Methods Enzymol. 299, 152–178.
Snedecor, G.W., Cochran, W.G., 1980. Statistical Methods. 7th ed. Iowa State University Press, Ames, Iowa, USA.
Statistical Analysis System (SAS), 1996. SAS User's Guide. Statistics. SAS Inst. Inc. Ed, Cary, NC, USA.
Taher, M.M., Lammering, G., Hershey, C., Valerie, K., 2003. Curcumin inhibits ultraviolet light induced human immunodeficiency virus gene expression. Mol. Cell. Biochem. 254, 289–297.
Tamime, A.Y., 2004. Yoghurt-latest developments and bridging the link with industry. Int. Dairy Symp., "Recent Developments in Dairy Science and Technology", May, Isparta, Turkey (1pp.), pp. 24–28.
Tamime, A.Y., Robinson, R.K., 1999. Yoghurt, Science and Technology. 2nd ed. CRC press wood lead pub. Limited, Cambridge, England.
Thiyagarajan, M., Sharma, S.S., 2004. Neuroprotective effect of curcumin in middle cerebral artery occlusion induced focal cerebral ischemia in rats. Life Sci. 74, 969–985.
Toledo, T.T., 1980. Fundamental of Food Process Engineering. AVI Pub. Co. West Port, Connecticut, USA, pp. 152–169.
United States Department of Agriculture (USDA), 2001. USDA Specification for Yogurt, Nonfat Yogurt and Lowfat Yogurt. United States Department of Agriculture, Agric. Marketing Service, Dairy Programs.
Vagi, E., Rapavi, E., Hadolin, M., Vasarhelyine, P.K., Balazs, A., Biazovics, A., Simandi, B., 2005. Phenolic and triterpenoid antioxidants from *Origanum majorana* L. herb and extracts obtained with different solvents. J. Agric. Food Chem. 53, 17–21.
Vajragupta, O., Boonchoong, P., Watanabe, H., Tohda, M., Kummasud, N., Sumanont, Y., 2003. Manganese complexes of curcumin and its derivatives: evaluation for the radical scavenging ability and neuroprotective activity. Free Radic. Biol. Med. 35, 1632–1644.
Yadav, S., Mukundan, U., 2011. In vitro antioxidant properties of *Salvia coccinea* Buc'hoz ex etl. and *Salvia officinalis* L. Indian J. Fundam. Appl. Life Sci. 1, 232–238.
Zhou, H., Beevers, C.S., Huang, S., 2011. The targets of curcumin. Curr Drug Targets. 12 (3), 332–347. https://doi.org/10.2174/138945011794815356.