

ANTIOXIDANT POTENTIAL OF NATURAL FRUIT FLAVORED YOGURT- A REVIEW

*Tahir Mahmood Qureshi, Muhammad Nadeem, Muhammad Mushtaq Ahmad,
Sarfraz Hussain*, Salim-ur-Rehman** and Amal Shaukat**

ABSTRACT

Fruits are rich sources of natural bioactive components especially antioxidants. Such type of bioactive components may be responsible to delay the development of many diseases. Antioxidants such as carotenoids, vitamin C, E and peptides are present in milk. Yogurt, a fermented milk product, is a good source of antioxidant compounds with therapeutic and high nutritional value and is consumed in most of the countries in the world. This review paper covers the subject research work published during 1978-2016. Many researchers have supplemented yogurt with different fruit juices, pulp, seeds and pomace and investigated their antioxidant activity owing to the presence of bioactive compounds in both fruits and yogurt. These researchers used various methods to measure the antioxidant activity of flavored (containing fruits) yogurts. It was confirmed that the bioactivity of such yogurt increased due to presence of antioxidant compounds incorporated by fruits.

KEYWORDS: Antioxidants; Yogurt; Fruits; bioactive components.

INTRODUCTION

Bioactive compounds such as prebiotics, probiotics, flavonoids, peptides, phytosterols and carbohydrates present in different foods show bioactivity (6). Food systems containing antioxidant peptides may either scavenge free radicals or prevent the formation of those radicals which may lead towards cancer, artiosclerosis, aging, etc through damaging action on biomolecules (25).

Fruits as well as vegetables are rich sources of antioxidants (2, 18, 29). Antioxdiant activity and phenolics have been investigated in fruit pulps of mango, banana, plum, pear, guava, apple, apricot, different types of cherries and berries, blood orange, pitanga and Jambul (7, 43). Antioxidant

*Institute of Food Science and Nutrition, University of Sargodha, Sargodha, **National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan.

compounds such as urate (12), carotenoids, vitamins (vitamin A, C and E) and different peptides (15, 20) have been reported to be present in milk. Yogurt which is a fermented milk product, is produced as a result of fermentation by lactic acid bacteria (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*). It is consumed all over the world due to its excellent sensory, therapeutic and high nutritional properties (34). The high antioxidant potential of yoghurts might be due to the presence of bioactive compounds produced as a result of lactic acid fermentation (4, 49).

Nowadays, more focuss has been given to produce functional foods (35) through incorporation of high value ingredients such as flavonoids, phenolics, anthocyanins, ellagic acid etc. (9, 10, 31, 34) present in different foods. Hence, this review has summarized the antioxidant potential of yogurts containing bioactive compounds from different fruit juices.

Determination of antioxidant activity by using different assays

Many researchers have used different methods to measure the antioxidant potential of foods. By following the free radical/reactive oxygen species method, Ferrari (21,22) reported that the free radicals may damage cells. These free radicals may increase due to pathogenic attack and environmental stress, which ultimately lead to chain reaction (42, 46). Shimada *et al.* (41) and Yamaguchi *et al.* (47) followed the 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) radical scavenging assay to measure the antioxidant activity of foods. Antioxidants which are present in foods might have an interaction with DPPH (acting as free radical) by transferring either electrons or hydrogen atoms to DPPH. In this way, deep violet color of DPPH will be changed into colorless or yellow after neutralization. The decrease in absorbance at 517 nm means more DPPH radical scavenging activity of antioxidants present of the investigated foods. The total antioxidant activity of food materials can also be measured using ABTS radical scavenging assay through radical cation decolorization (37).

Hydroxyl radicals induced in the biomacromolecules can be measured using hydroxyl radical scavenging assay. These hydroxyl radicals may damage tissues and biomolecules leading to diseases (30, 44). The superoxide radicals may be generated through many biological reactions and their scavenging ability can be measured using superoxide radical scavenging assay (8, 28, 38).

Iron plays an important role in transportation of oxygen and ultimately reparation in the human body, redox reaction and activity of enzymes (26). However, it also accelerates the oxidation reactions of biological molecules.

Redox reaction of iron can be measured using Iron (Fe^{2+}) chelating activity assay (14, 17).

Antioxidant activity of yogurt supplemented with juices or pulps from different fruits

Yogurt supplemented with pomegranate juice: Arjmand *et al.* (5) investigated the TPC contents (mg/L gallic acid equivalent (GAE)) of the probiotic yogurts supplemented with Australian pomegranate juice (various concentrations i.e. 9, 13, 17 and 20%). It was found that TPC contents of aforementioned yogurts were higher than control yogurts i.e. without pomegranate juice (Table 1).

Yogurt supplemented with pitanga, berries and black currant: Bueno *et al.* (10) studied the physical properties of probiotic yogurt containing different berry fruit pulps such as strawberry, raspberry and pitanga. Moreover, total ellagic acid (EA) (a powerful antioxidant) contents of the aforementioned yogurts were also investigated. It was found that EA contents of fruit yogurt were higher than control yogurt and ranged $1.533\text{-}6.679 \mu\text{g}\cdot\text{mL}^{-1}$ (21 days, 4°C) (Table 1). A study was conducted in Canada by Gunenc *et al.* (24) in which they investigated that probiotic viability in yogurt was improved on addition of raspberry and strawberry in yogurt. Further, they confirmed that raspberry and strawberry possess good antioxidant activity on the basis of results found through oxygen radical absorbance (ORAC), and DPPH radical scavenging activity, total phenolic content (TPC). Therefore, they concluded that both berries may have prebiotic potential (due to presence of fiber) in yogurt as well as good antioxidant activity (due to presence of polyphenols) and suggested those berries to develop functional foods and nutraceutical applications.

Selvamuthukumaran and Farhath (40) developed seabuckthorn (*Hippophae rhamnoides* L.var. *rhamnoides*) berry fruit (syrup having TSS of 70 °Brix, 15% rate of addition) supplemented yoghurt using standardized cow milk (fat 4.5% and SNF 8.5%). The prepared fruit yogurts were then compared with commercial pineapple and grape fruit yogurts. It was observed that the total phenolics (mg/100 g), vitamin C (mg/100 g), vitamin E (mg/100 g) and total carotenoids (mg/100 g) contents of seabuckthorn were higher compared to pineapple and grape yogurts whereas, the anthocyanins (mg/100 g) were only available in seabuckthorn yogurt. It was concluded that seabuckthorn fruit yogurt may provide better nutrition compared to other fruit yogurts.

Skrede *et al.* (43) monitored the antioxidant activity of commercially prepared fermented milk supplemented with bilberry (10 °Brix juice) and black currant (13 °Brix juice) extracts during storage (1, 2 and 3 weeks). The anti-radical power (ARP, $\mu\text{mol TE/g}$) and oxygen radical absorbance capacity (ORAC, $\mu\text{mol TE/g}$) were increased due to addition of fruits.

Najgebauer-Lejko and Sady (33) procured natural fruit (strawberries, bilberries, blackcurrants, cherries and forest fruits) flavored fermented milks from super- and hypermarkets in Poland and assessed their antioxidant potential by following ferric reducing antioxidant power (FRAP) and DPPH radical scavenging ability (ARP) assays. It was found that the fermented milks having aforementioned fruit juices possessed strong antioxidant potential. They concluded that both type as well as quality (% of juice or bioactive components) of flavouring preparations might be the main factor affecting antioxidant potential of fermented milks.

In Egypt, El Samh *et al.* (19) investigated the antioxidant activity of probiotic yogurt (using *Bifidobacterium lactis* Bb-12) containing strawberry jam (Table 1). It was found that the total phenolics of yogurt containing strawberry jam was higher (28.48 mg tannic acid equivalent (TAE) /100 g) as compared to probiotic plain yogurt (21.40 mg TAE/100 g). Similarly, it was investigated that total flavonoids of yogurt having strawberry jam were higher (15.78 mg quercetin equivalent (QE)/100 g) as compared to probiotic plain yogurt (9.39 mg QE/100 g). Regarding radical scavenging activity (RSA%), a similar trend was observed. The IC_{50} value of yogurt containing strawberry jam was lower than probiotic plain yogurt. The lower IC_{50} value means higher antioxidant activity.

Fermented milk fortified with aqueous extracts of grapes marc:

Aliakbarian *et al.* (1) monitored the total polyphenols (TP) (μg caffeic acid equivalent (CAE)/g) and antiradical power (ARP) (μg 2,2-diphenyl-1-picrylhydrazyl (DPPH)/mg) of fermented milks (stored up to 50 days) fortified with aqueous extracts of grape marc (GM) (Table 1). All the fermented milks fortified with GM was found to have higher TP values than control (without GM) fermented milks. In another study, Frumento *et al.* (23) developed probiotic fermented milk using culture of *Lactobacillus acidophilus*, and fortified with the GM of a cultivar (Croatina). The prepared functional fermented milk was evaluated for its phenolic compounds and antioxidant activity. The fermented milk fortified with Croatina marc showed higher phenolics (mg of gallic acid equivalents (GAE) per g milk) than control fermented milks. Simliar trend was observed for the antioxidant activity (mg

of Trolox equivalents (TE) per g). It was concluded that fermented milks fortified with GM showed higher antioxidant activity than control milks owing to the presence of their considerable concentrations of the phenolics.

Yogurt supplemented with grape seed ethanolic extracts: Chouchouli *et al.* (13) monitored the antioxidant activity of full-fat yogurts fortified with ethanolic extracts of grape (*Vitis vinifera*) seeds from grape varieties i.e. Moschofilero and Agiorgitiko (Table 1). The total phenolics, antioxidant activity, antiradical activity, reducing power, and epicatechin contents of yogurts (1-32 days) was monitored. During storage, the contents of Epicatechin and total phenolics of both Moschofilero and Agiorgitiko grape seed fortified yogurts was decreased during storage. They discussed that the degradation of polyphenols during may be responsible for decreasing trend of total phenolics. A similar trend was also observed for radical scavenging activity for Moschofilero grape seed fortified yogurts (1487.4 to 234.8 mg Trolox equivalents (TE)/100g FW) and Agiorgitiko grape seed fortified yogurts (1567.2 to 440.5 mg TE/100g FW). Similarly, reducing power for Moschofilero grape seed fortified full fat (4%) yogurts (223.5 to 121.2 mg ascorbic acid equivalents (AAE)/100g FW) and Agiorgitiko grape seed fortified full fat (4%) yogurts (311.3 to 146.4 mg AAE/100g FW) were decreased and showed higher values than control yogurts (Table 1). On the basis of their results, they suggested that grape seeds (discarded usually) may be used in value added products.

Yogurt supplemented with dried grape pomace: In Egypt, Mohamed *et al.* (32) investigated the antioxidant activity of probiotic yogurt (3% fat) containing dried grape pomace (DGP) (1 to 5%) during storage (21 days, 4°C). Even though, total phenolics of fresh yogurts containing DGP increased by increasing the DGP concentration but after 21 days of storage, the decreasing trend in the contents of yogurts supplemented with DGP was observed. There might be the degradation of total phenolic contents during storage period. Radical scavenging activity (RSA) of fresh and 21 days DGP supplemented yogurts at respective concentrations (1 to 5%) was also increased (Table 1). They concluded that yogurts supplemented with 3% DGP might have good antioxidant potential and should be regarded as an acceptable product.

Yogurt supplemented with jackfruit puree: Che Othman *et al.* (11) investigated the antioxidant activity of Malaysian probiotic yogurt (locally called dadih) supplemented with Jackfruit (*Artocarpus heterophyllus*) puree. Four types of dadih were made. The Jackfruit probiotic dadih (JPD) samples

showed the highest total phenolic content followed by Jackfruit dadih (ConJD), standard probiotic dadih (ConPD) and control (Table 1). The higher values of probiotic fruit supplemented dadih might be due to the presence of jackfruit and activity of probiotic bacteria.

Yogurt supplemented with dragon fruit: Zainoldin and Baba (48) used dragon fruits (red and white) (concentrations, 10%, 20% and 30%) in the preparation of probiotic yogurts. The DPPH inhibition (%) shown by yogurt supplemented with white dragon as well as red dragon fruits was higher than plain yogurt. The total phenolics (Table 1) in yogurt supplemented with white dragon as well as a red dragon were higher compared to plain yogurt. On the basis of results, it was suggested that yogurt containing dragon fruits may improve its therapeutic value.

Yogurt supplemented with apple polyphenol extract: Sun-Waterhouse *et al.* (45) investigated yogurts fortified with apple polyphenol extract (APE) in New Zealand. The yogurt fortified with polyphenol ingredients were found to have higher total extractable polyphenol (PP) contents (TEPC) (as catechin equivalent, CtE mg/g) than the plain yogurts. They observed that PP contents did not degrade into other molecules during processing. The yogurts fortified with APE also contained phlorizin, epicatechin, *p*-coumaric acid, chlorogenic acid, and phloretin derivative.

Yogurt supplemented with pieces of different fruits: Pereira *et al.* (36) investigated the antioxidant potential of yogurts containing different fruit pieces, procured from the local supermarket in Portugal. They determined the contents of phenolics (mg GAE/g extract), tocopherols (mg/100g extract), and flavonoids (mg CE/g extract) and further evaluation of reducing power (EC₅₀; mg/mL) and DPPH radicals scavenging activity (EC₅₀; mg/mL). Freeze dried extracts of all the yogurts were used for the analysis. The berry fruit yogurt showed the highest concentration of flavonoids and phenolics (Table 1). Similarly, the pineapple fruit yogurt also showed very high concentrations of phenolics. Yogurt having pieces of berries and cherry showed the highest DPPH scavenging activity. Yogurt having blackberries pieces revealed higher phenolic content than cherry Burlat and Griotte yogurt (Table 1). The reducing power and DPPH scavenging activity shown by cherry Burlat (IC₅₀: 8.43 mg/mL and 11.35 mg/mL respectively) and Griotte yogurt (IC₅₀: 10.39 mg/mL and 31.11 mg/mL respectively) were higher than cherry yogurt (IC₅₀: 11.12 mg/mL and 36.07 mg/mL, respectively).

Yogurt containing pieces of blackberry showed higher content of total tocopherols (0.94 mg/100 g FW), followed by cherry Burlat fruit pieces yogurt and cherry fruit pieces yogurt. It was concluded from the study that the antioxidant potential of yogurt may be improved due to addition of fruit pieces in yogurt.

Yogurt supplemented with the juice of *Euterpe oleracea*: Coisson *et al.* (16) investigated yogurt having juice of *Euterpe oleracea* (Acai) for antioxidant potential. One of the important anthocyanin compound i.e. cyanidin-3-O-glycoside was also confirmed in Acai juice in an optimum concentration. It has also been reported that optimum concentration of calcium content (1180 mg kg⁻¹) and substantial levels of cyanidin 3-O-glycoside, vitamins C, A and tocopherols Acai pulp, have also been reported by Rogez (39).

Yogurt supplemented with different grape varieties: Karaaslan *et al.* (27) investigated yogurts containing ethanol extracts of grape callus and different grape varieties such as Cabernet sauvignon (red), Merlot (red), Chardonnay (white) and Shyrah (red) for total phenolic (mg gallic acid equivalents/mL) and anthocyanin (mg malvidin-3-O-glucoside equivalents/mL) and antioxidant activity of (Table 1). The Merlot extract showed the highest phenolic as well as anthocyanin contents compared to other extracts. The fresh (1 day storage) yogurt having all the grape varieties extract showed higher phenolic and anthocyanin contents than control yogurts. It was suggested that yogurts containing grape cultivars may be used in the diet especially yogurt.

Yogurt supplemented with papaya and cactus pear extract: In Egypt, Amal *et al.* (3) prepared yogurt with the addition of different fruit pulps including papaya (*Carica papaya*) and cactus pear (*Opuntia ficusindica*) at varying concentrations (5%, 10% and 15% w/w) and investigated their antioxidant activity upto 10 days. Both type of fruit yogurts having 15% w/w fruit pulp increased overall acceptability. The highest ascorbic acid contents (7.21 mg/100g) were found in the papaya fruit (15% w/w) yogurt which might be due to the highest ascorbic acid in papaya pulp. Similarly, papaya fruit (15% w/w) yogurt also showed the highest phenolic contents (18.2 mg GAE/100g) and antioxidant activity (2.02%). The cactus pear fruit yogurt also showed considerable ascorbic acid contents (4.72 mg/100g), phenolic contents (5.20 mg GAE/100g) and antioxidant activity (1.98%) at 15% addition of fruit pulp. It was concluded that addition of fruits may have an increasing effect on yogurt consumption due to its health impacts.

Table 1. Phenolic content, flavonoid content, AA, TPP, ARP, IC₅₀, IC₆₀, Ellagic acid, Epicatechin, FARP, IP%, TA, RP (IC₅₀) of yogurts supplemented with natural fruits.

Fruit yogurts	Phenolics	Flavonoids	A _A	TP	ARP ^a	IC ₅₀ (L)	IC ₆₀ (L)	Ellagic acid ^b	Epicatechin n ^c	FARP ^d	IP % ^e	TA ^o	RP ^h IC ₂₀	References
Plain yogurt	21.40 ^a	9.39 ^f				1.76	3.16				28.49			El Saeidi et al. (19)
Strawberry jam	64.67 ^a	20.69 ^g				1.07	1.92				46.80			El Saeidi et al. (19)
Strawberry yogurt	28.49 ^a	15.78 ^h				1.10	2.24				40.12			El Saeidi et al. (19)
Plain yogurt (7 days)				65	~0.33									Alshabanian et al. (1)
Yogurt with grape marc (7 days)				98	~0.42									Alshabanian et al. (1)
Plain yogurt	514 ^a													Agmand et al. (5)
Yogurt with pomegranate juice	731 ^a													Agmand et al. (5)
Pomegranate juice	2400 ^a													Agmand et al. (5)
Yogurt with red berry juice (21 days)								1.533-6.679						Buono et al. (10)
Yogurt with grape seed extract (M) (1-32 days)	12.94 - 7.04 ^d								43.6-30.6	223.5-121.2	1487.4-234.8 ^a			Chouchouli et al. (13)
Yogurt with grape seed extract (A) (1-32 days)	14.31-7.52 ^d								61.6-43.7	311.3-146.4	1567.2-440.9 ^a			Chouchouli et al. (13)
Yogurt with dried grapes pomace (21 days)	26-38 ^d													Monamad et al. (32)
Malaysian yogurt with jackfruit	1.71 ^h													Cher Othman et al. (11)
Probiotic yogurt with dragon fruit (white)	36.44-64.43													Zainudin & Baba (46)

Fruit yogurt	Flavonoids	AA ¹	TTP ²	ARP ³	IC ₂₅ (L)	IC ₅₀ (L)	Elagic acid ⁴	Epilob. echin ⁵	FARP ⁶	IP % ⁷	TA ⁸	RP ⁹ IC ₂₅	References
Probiotic yogurt with dragon fruit (Red)	37.15-49.61 ¹									33.71-45.74			Zainuddin and Bada (48)
Yogurt with pineapple essence (12 days)	24.4 ²										0.05 ¹		Sekaran, Kumaran and Farooq (40)
Yogurt with pineapple (12 days)	2.2 ²										0		Sekaran, Kumaran and Farooq (40)
Yogurt with grape (12 days)	2.6 ²										0		Sekaran, Kumaran and Farooq (40)
Fermented milk with grape marc	1.6 ²	0.0004											Sekaran, Kumaran and Farooq (40)
Yogurt with berries	6.91 ²				11.95								Fuente et al. (23)
Yogurt with Cherry						11.35							Pereira et al. (36)
Yogurt with plum						62.01							Pereira et al. (36)
Yogurt with raspberry						57.03							Pereira et al. (36)
Yogurt with blackberry "Antioxidant"	4.15 ²					19.09						7.77	Pereira et al. (36)
Yogurt with blackberry	2.69 ²					43.61							Pereira et al. (36)
Yogurt with Cherry "Antioxidant"	3.69 ²					11.35							Pereira et al. (36)
Yogurt with Cherry "Antioxidant"	3.41 ²					31.11							Pereira et al. (36)
Yogurt + Euphorbia juice (10% w/w)						36.07				16.18			Pereira et al. (36)
													Correia et al. (16)

CONCLUSION AND RECOMMENDATION

The antioxidant potential of fermented milk, i.e. yogurt may be enhanced due to inclusion of various fruits (containing compounds with antioxidant potential) as revealed from the various studies. Hence, yogurt supplemented with different fruit juices or pulp (rich in polyphenols, beta carotene, anthocyanines, vitamin A, C, E, flavonoids) may be recommended to be used as a part of our daily diet.

REFERENCES

1. Aliakbarian, B., M. Casale, M. Paini, A.A. Casazza, S. Lanteri and P. Perego. 2014. Production of a novel fermented milk fortified with natural antioxidants and its analysis by NIR spectroscopy. *LWT-Food Sci. Technol.* 1-8.
2. Aliakbarian, B., A. A. Casazza, E. J. O. Montoya and A. Convert. 2010. Valorisation of olive oil solid wastes: Valuable compounds recovery using high pressure-high temperature. *J. Biotechnol.* 150:332.
3. Amal, A. Matter, Eman, A. M. Mahmoud and N. S. Zidan. 2016. Fruit flavored yoghurt: chemical, functional and rheological properties. *Int. J. Env. Agr. Res.* 2:57-66.
4. Amirdivani, S. and A. S. Baba. 2011. Changes in yogurt fermentation characteristics, and antioxidant potential and in vitro inhibition of angiotensin-1 converting enzyme upon the inclusion of peppermint, dill and basil. *LWT-Food Sci. Technol.* 44:1458-1464.
5. Arjmand, A., K. Shamsi and F. Sherkat. 2013. Effects of extraction methods and heat treatment on total phenolic compounds and antioxidant activity in juice extracted from the Australian grown wonderful pomegranate. *Asi. J. Food Agro. Ind.* 6:42-57.
6. Arvanitoyannis, I. S. and M. Van Houwelingen-Koukaliaroglou. 2005. Functional foods: a survey of health claims, pros and cons, and current legislation. *Crit. Rev. Food Sci. Nutr.* 45:385-404.
7. Batiston, W. P., S. A. Maruyama, S. T. M. Gomes, J. V. Visentainer, N. E. Souza and M. Matsushita. 2013. Total phenolic content and antioxidant capacity of methanolic extracts of ten fruits. *ACTA. Sci. Polo. Technol. Aliment.* 35:581-585.
8. Bi, H., T. Gao, Z. Li, L. Ji, W. Yang, B. Jeff Iteku, E. Liu and Y. Zhou. 2013. Structural elucidation and antioxidant activity of a water-soluble polysaccharide from the fruit bodies of *Bulgaria inquinans* (Fries). *Food Chem.* 138:1470-1475.

9. Brignac, B. and K. J. Aryana. 2012. Influence of various antioxidants on the characteristics of plain yogurt. *Food Nutr. Sci.* 3:1277.
10. Bueno, L., T. M. Silva, N. P. Perina, C. Bogsan and M. N. Oliveira. 2014. Addition of Strawberry, Raspberry and "Pitanga" Pulp Improves the Physical Properties of Symbiotic Yoghurts. *Chem. Eng.* 38.
11. Che Othman, S., A. Noor Aziah and R. Ahmad. 2012. Effects of jackfruit puree supplementation on lactic acid bacteria (*Lactobacillus acidophilus* FTDC 1295) in terms of viability and chemical compositions of dadih. *Int. Food Res. J.* 19:1687-1697.
12. Chen, J., H. Lindmark-Månsson, L. Gorton and B. Åkesson. 2003. Antioxidant capacity of bovine milk as assayed by spectrophotometric and amperometric methods. *Int. Dairy J.* 13:927-935.
13. Chouchouli, V., N. Kalogeropoulos, S.J. Konteles, E. Karvela, D.P. Makris and V.T. Karathanos. 2013. Fortification of yoghurts with grape (*Vitis vinifera*) seed extracts. *LWT-Food Sci. Technol.* 53:522-529.
14. Chun-hui, L., W. Chang-hai, X. Zhi-liang and W. Yi. 2007. Isolation, chemical characterization and antioxidant activities of two polysaccharides from the gel and the skin of *Aloe barbadensis* Miller irrigated with sea water. *Pro. Biochem.* 42:961-970.
15. Cloetens, L., J. Panee and B. Åkesson. 2013. The antioxidant capacity of milk-the application of different methods in vitro and in vivo. *Cellu. Molecul. Biol.* 59:43-57.
16. Coisson, J., F. Travaglia, G. Piana, M. Capasso and M. Arlorio. 2005. *Euterpe oleracea* juice as a functional pigment for yogurt. *Food Res. Int.* 38:893-897.
17. Decker, E.A. and B. Welch. 1990. Role of ferritin as a lipid oxidation catalyst in muscle food. *J. Agr. Food Chem.* 38:674-677.
18. Donovan, J.L., A.S. Meyer and A.L. Waterhouse. 1998. Phenolic composition and antioxidant activity of prunes and prune juice (*Prunus domestica*). *J. Agr. Food Chem.* 46: 1247-1252.
19. El Samh., M. M. A., A. A. D. Sherein and H. H. Essam. 2013. Properties and antioxidant activity of probiotic yogurt flavored with black carrot, pumpkin and strawberry. *Int. J. Dairy Sci.* 5:48-57.
20. Elias, R. J., S. S. Kellerby and E. A. Decker. 2008. Antioxidant activity of proteins and peptides. *Crit. Rev. Food Sci. Nutr.* 48:430-441.
21. Ferrari, C. 2001. Oxidative stress pathophysiology: searching for an effective antioxidant protection. *Int. Med. J.* 8:175-184.
22. Ferrari, C. K. 2007. Functional foods and physical activities in health promotion of aging people. *Maturit.* 58:327-339.
23. Frumento, D., A. P. Do Espirito Santo, B. Aliakbarian, A. A. Casazza, M. Gallo, A. Converti and P. Perego. 2013. Development of milk

- fermented with *Lactobacillus acidophilus* fortified with *Vitis vinifera* Marc Flour. Food Technol. Biotechnol. 51:370-375.
24. Gunenc, A., S. Fang and F. Hosseinian. 2015. Raspberry and strawberry addition improves probiotic viability in yogurt and possess antioxidant activity. J. Food Res. 4:47-58.
 25. Gupta, A., B. Mann, R. Kumar and R. B. Sangwan. 2009. Antioxidant activity of Cheddar cheeses at different stages of ripening. Int. J. Dairy Technol. 62:339-347.
 26. Hsu, B., I. M. Coupar and K. Ng. 2006. Antioxidant activity of hot water extract from the fruit of the Doum palm, *Hyphaene thebaica*. Food Chem. 98:317-328.
 27. Karaaslan, M., M. Ozden, H. Vardin and H. Turkoglu. 2011. Phenolic fortification of yogurt using grape and callus extracts. LWT-Food Sci. Technol. 44:1065-1072.
 28. Korycka-Dahl, M. and T. Richardson. 1978. Photogeneration of superoxide anion in serum of bovine milk and in model systems containing riboflavin and amino acids. J. Dairy. Sci. 61: 400-407.
 29. Latoui, M., B. Aliakbarian, A. A. Casazza, M. Seffen, A. Converti and P. Perego. 2012. Extraction of phenolic compounds from *Vitex agnus-castus* L. Food Bioprod. Proc. 90:748-754.
 30. Liu, J., J. Luo, H. Ye and X. Zeng. 2012. Preparation, antioxidant and antitumor activities in vitro of different derivatives of levan from endophytic bacterium *Paenibacillus polymyxa* EJS-3. Food Chem. Toxicol. 50:767-772.
 31. Martínez, R., P. Torres, M. A. Meneses, J. G. Figueroa, J. A. Pérez-Álvarez and M. Viuda-Martos. 2012. Chemical, technological and in vitro antioxidant properties of mango, guava, pineapple and passion fruit dietary fibre concentrate. Food Chem. 135:1520-1526.
 32. Mohamed, A., A. F. Zayan and M. Nadia, 2014. Physiochemical and sensory evaluation of yoghurt fortified with dietary fiber and phenolic compounds. Life Sci. J. 11.
 33. Najgebauer-Lejko, D. and M. Sady. 2015. Estimation of the antioxidant activity of the commercially available fermented milks. Acta. Sci. Pol. Technol. Aliment. 14:387-396.
 34. Najgebauer-Lejko, D., T. Grega and M. Tabaszewska. 2014. Yoghurts with addition of selected vegetables: acidity, antioxidant properties and sensory quality. Acta. Sci. Pol. Technol. Aliment. 13:35-42.
 35. Pan, D., Y. Luo and M. Tanokura. 2005. Antihypertensive peptides from skimmed milk hydrolysate digested by cell-free extract of *Lactobacillus helveticus* JCM1004. Food Chem. 91:123-129.

36. Pereira, E., L. Barros and I. C. Ferreira. 2013. Relevance of the mention of antioxidant properties in yogurt labels: In vitro evaluation and chromatographic analysis. *Antioxid.* 2:62-76.
37. Re, R., N. Pellegrini, A. Proteggente, A. Pannala, M. Yang and C. Rice-Evans. 1999. Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free. Rad. Biol. Med.* 26: 1231-1237.
38. Robak, J., R. J. Gryglewski. 1988. Flavonoids are scavengers of superoxide anions. *Biochem. Pharmacol.* 37:837-841.
39. Rogez, H., 2000. Açai: Preparo, Composição e Melhoramento da Conservação.
40. Selvamuthukumar, M. and K. Farhath. 2013. Evaluation of shelf stability of antioxidant rich seabuckthorn fruit yoghurt. *Int. Food Res. J.* 21:759-765.
41. Shimada, K., K. Fujikawa, K. Yahara and T. Nakamura. 1992. Antioxidative properties of xanthan on the autoxidation of soybean oil in cyclodextrin emulsion. *J. Agr. Food. Chem.* 40:945-948.
42. Singh, S. and R. Singh. 2008. *In vitro* methods of assay of antioxidants: an overview. *Food Rev. Int.* 24:392-415.
43. Skrede, G., V. B. Larsen, K. Aaby, A. S. Jørgensen and S. E. Birkeland. 2004. Antioxidative properties of commercial fruit preparations and stability of bilberry and black currant extracts in milk products. *J. Food Sci.* 69:351-356.
44. Spencer, J. P., A. Jenner, O. I. Aruoma, P. J. Evans, H. Kaur, D. T. Dexter, P. Jenner, A. J. Lees, D. C. Marsden and B. Halliwell. 1994. Intensive oxidative DNA damage promoted by L-DOPA and its metabolites implications for neurodegenerative disease. 353: 246-250.
45. Sun-Waterhouse, D., J. Zhou and S.S. Wadhwa. 2012. Effects of adding apple polyphenols before and after fermentation on the properties of drinking yoghurt. *Food Biopro. Technol.* 5:2674-2686.
46. Vermerris, W. and R. Nicholson. 2006. Biosynthesis of Phenolic Compounds. *In: Phenolic Compound Biochemistry.* Springer Netherlands.p 63-149.
47. Yamaguchi, T., H. Takamura, T. Matoba and J. Terao. 1998. HPLC method for evaluation of the free radical-scavenging activity of foods by using 1, 1-diphenyl-2-picrylhydrazyl. *Biosci. Biotechnol. Biochem.* 62: 1201-1204.
48. Zainoldin, K. and A. Baba. 2009. The Effect of *Hylocereus polyrhizus* and *Hylocereus undatus* on physicochemical, proteolysis and antioxidant activity in yogurt. *World Acad. Sci. Eng. Technol.* 60:361-366.

49. Zhang, S., L. Liu, Y. Su, H. Li, Q. Sun, X. Liang and J. Lv. 2011. Antioxidative activity of lactic acid bacteria in yogurt. *Afri. J. Microbiol. Res.* 5:5194-5201.

Received: August 23, 2016 Accepted: September 15, 2016

CONTRIBUTION OF AUTHORS:

Tahir Mahmood Qureshi	:	Planned and write-up review paper
Muhammad Nadeem	:	Assisted in write-up
Muhammad Mushtaq Ahmad	:	Assisted in write-up and technical standing of paper
Sarfraz Hussain	:	Assisted in write-up
Salim-ur-Rehman	:	Assisted in technical health of paper
Amal Shaukat	:	Assisted in write-up