World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(REVIEW ARTICLE)

Check for updates

Incorporation of vegetables in yoghurt as a source of dietary fibre: A review

Faiza Iqbal [1], Muhammad Anees Ur Rehman [2,*] and Maham Ashfaq [3]

[1] *Department of Dairy Technology, PMAS arid agriculture university Rawalpindi Sub campus Khushab, Pakistan.*
[2] *Ruth Pfau College of Nutrition Sciences, Lahore Medical & Dental College, Lahore, Pakistan.*
[3] *Sargodha Institute of Health Sciences, Sargodha, Pakistan.*

World Journal of Biology Pharmacy and Health Sciences, 2021, 08(02), 008–013

Publication history: Received on 29 September 2021; revised on 12 November 2021; accepted on 14 November 2021

Article DOI: https://doi.org/10.30574/wjbphs.2021.8.2.0107

Abstract

Yoghurt is a fermented dairy product with conspicuous consumption around the world due to its pronounced health benefits. Yoghurt is defined as the food produced by culturing the milk in controlled conditions that contain lactic acid-producing bacteria (*Lactobacillus bulgaricus*, *Streptococcus thermophilus*. Consumer acceptability of Yoghurt is high due to its health benefits and sensory attributes. It provides 40% calcium and 30-45% phosphorus of daily requirement. All essential amino acids (proline and glycine) are present in Yoghurt. The biological value of milk proteins present in Yoghurt is high. It is considered a rich source of high-quality protein. Health benefits associated with Yoghurt are to improve the gastrointestinal digestion and immune system of humans. Yoghurt is enriched with proteins, carbohydrates, minerals (calcium and phosphorus), and vitamins (vitamin A, thiamine, riboflavin, niacin, folate and cobalamin). Yoghurt protein and its peptides have many physiological impacts as well as nutritional value. The only deficiency in Yoghurt is a lack of dietary fibre. The review emphasizes the addition of dietary fibre in Yoghurt to boost up its health benefits.

Keywords: Yoghurt; Fermented foods; Dairy products; Healthy foods; Peptides. Dietary fibre

1. Introduction

Yoghurt was first introduced to "Turkish" local immigrants in North America in the 1700s. Yoghurt was first recognised in Barcelona in 1919, and it was given the name "Daniel," which means "little Daniel." In prehistoric times, Yoghurt was known by many various names in different places, including as Dahi (India), mast (Iraq), laban (Iraq and Leban), katyk (Armenia), lebenraib (Saudi Arabia), cujada (Spain), mastoni (Georgia, Russia, and Japan), zabadi (Egypt), iogurte (Brazil), and roba (Sudan) [1].

The word Yoghurt has been derived from the Turkish word "jugurt", which expresses any fermented food with a taste like an acidic. Yoghurt is meant to be a complex mixture of art and scientific process. Yoghurt is manufactured from homogenized heat-treated milk and cultures of lactic acid bacteria with *Streptococcus thermophilus* and *Lactobacillus bulgaricus* [2].

Yoghurt is produced by the spontaneous acidification of milk, which occurs when lactose, a milk sugar, is separated into glucose and galactose, and lactic acid is created. Microflora such as Lactobacillus sp., Bulgaricus sp., Streptococcus sp., and Thermophilus sp. start the fermentation process by fermenting lactose into lactic acid [3].

Yoghurt is best defined as a product prepared by culturing milk or other types of milk under controlled circumstances with lactic acid-producing bacteria (*Lactobacillus bulgaricus*, *Streptococcus thermophilus*). Yoghurt's health advantages

* Corresponding author: Muhammad Anees Ur Rehman
Ruth Pfau College of Nutrition Sciences, Lahore Medical & Dental College, Lahore, Pakistan.

and sensory qualities have a significant impact on customer acceptance. Mouthfeel, such as adequate curd formation or smoothness, are frequent acceptance criteria for dairy products [4]. Different lactic starter bacteria are utilized for numerous fermented milk products, and other fermented milk products are available on the market.

Yoghurt is obtained through the fermentation of lactic acid bacteria. The essential preservative agent in these fermented products is lactic acid, which lowers the pH and raises the food's acidity, thereby preventing the growth of most other bacteria [5]. Yoghurt pH varies from 4.4 to 4.6. Yoghurt is too tart with low pH (<4.4) or from poor-quality milk and contaminated starter culture. Some strains of *Lactobacillus bulgaricus* can also cause a bitter taste in Yoghurt [6].

2. Classification of Yoghurt

Yoghurt is mainly classified based on its chemical composition, manufacturing type, flavor type or post-incubation process [7]

2.1. Types based on the chemical composition of the product

Yoghurt may be divided into three categories based on fat content: non-fat Yoghurt, low-fat Yoghurt, and standard or full-fat Yoghurt. Regular or full-fat Yoghurt is made from full-fat milk with a minimum of 3.25 per cent milk fat content. Low-fat and non-fat, on the other hand. Low-fat or part-skim milk and skim milk (without fat milk) are used to make Yoghurt [8].

2.2. Types based on the physical nature of the product

The physical characteristics of the Yoghurt must be solid, semi-solid or liquid. Types of Yoghurts are substantial, i.e., jelly-like texture known as Set Yoghurt, which is incubated, cooled, and then packaged. While the Semi-solid type of Yoghurt is called; Stirred Yoghurt, and Liquid/Fluid nature of Yoghurt are known as Fluid/ Drinking Yoghurt; Semi-solid or Stirred Yoghurts are manufactured by incubating the mixture in tank followed by splitting by mixing before cooling and packaging [9].

2.3. Types based on the flavors of the product

To manufacture new varieties of Yoghurt and its products, flavors addition may improve customer acceptance. The addition of flavors can be done directly before homogenization or after it. Yoghurt's classification is based on their specific tastes such as Plain/ natural Yoghurt [10].

2.3.1. Plain/Natural Yoghurt

One of the simplest and least impure types of Yoghurts produced from Lactic Acid Bacteria fermentation of the pasteurized milk to create its distinctive flavors and texture. Alternatively, it can be described as a natural/plain and unsweetened (sour) fermented dairy product having no added colours or other additives [11].

2.3.2. Flavored Yoghurt

Flavored Yoghurt is made using numerous flavors or fruits such as apple, strawberries, apricot, black berries, lemon, mandarin, blue berries, black currant, peach, and raspberry vegetables. Some manufacturers also added cereals, vanilla, chocolate, ginger, caramel etc. Moreover, the addition of flavors can be done during manufacturing. It produces a wide variety of flavors and tastes and enhances the sweetness level of the product [12].

3. Dietary fibre

The term dietary fibre is hard to define because this term encompasses an extended range of various materials. Dietary fibre has an extensive history, and its definition has many revisions. One broadly description from the AAAC States that Dietary fibre is a miscellany of ripe parts of plants or corresponding sugars that are challenging to digest and absorb in the small intestine of humans with fractional fermentation in the large intestine. Dietary fibre promotes advantageous effects like reduction in blood cholesterol, blood glucose and laxation [13].

Technically, some researchers believe that dietary fibre have properties that are effective against cancer and tumors by:

- Lessen the assembly of carcinogenic substances by reducing the number of pathogenic bacteria in the colon [14].
- To affect the pH-dependent enzymatic reactions by reducing colonic pH [15].

- Exert inhibitory effect on beginning and endorsement stages in colon cancer development in which fatty acids like butyric (short-chain fatty acids) play an essential role (Intake of dietary fibre provides various benefits. It lowers the risk of many diseases such as cardiac vascular diseases, diabetes, obesity, and digestive disorders (Consumption of dietary fibre improves serum lipid concentration, decreases blood pressure, and improves immune functions [16].

3.1. Use of vegetables in Yoghurt

Supplemented vegetable Yoghurt is developed with suitable sensation, chemical and microbial quality. In an experiment, six different vegetables (cucumber, green pepper, fried eggplant, celery and mint leaves, and dried garlic) were used with 10% of these vegetables +1g of dried garlic [17]. At refrigeration temperature within two weeks' time period, it was observed that 10% of fried eggplant with garlic, 10% of cucumber with garlic and mint, and 10% of mixed vegetables improves the sensory evaluation and chemical characteristics of vegetable yoghurt, without any texture improver, it was the safe and nutritional healthy product with low calories. They are rich in dietary fibre, minerals, and many bioactive compounds such as antioxidants, e.g., carotenoids, ascorbic acid, tocopherols, and phenol substances [18].

The addition of carrot juice in Yoghurt is convenient owing to the properties like sterile, antifungal, and inhibition of aflatoxin M1. The outcome of this product is very effective at the concentration of 15% carrot juice in Yoghurt. The final product with this concentration is proving of good quality with long shelf life and stored at 4 c about 21 days without considering any growth of microbes, and there is no color and consistency with 77% reduction of M1 aflatoxin during the storage condition [19].

In strained Yoghurt, the addition of apple fiber was not favored by panelists because their frazzled structure and taste of apple are very predominant with the aroma. The addition of wheat and bamboo fibre had the same effect in strained Yoghurt. During the storage period, the texture parameter was uncertain in all types of enriched Strained Yoghurt, and b values of apple fibre strained Yoghurts were deciding differently in contrast with wheat and bamboo fibrous strained Yoghurt due to apple fibre structure [20].

The enrichment of Yoghurt with vegetables like broccoli and red sweet pepper did not affect the Ph value and tithable acidity but had maximum antioxidant capacity. By comparing this vegetable enriched Yoghurt with Natural Yoghurt, it had the ultimate ability of ferric reducing, but the value of FARP decreased after1-2 weeks of storage in cold conditions. Thus, it is suggested that to obtain higher benefits from this vegetable, Yoghurt and these goods should be used in very little time after the preparation. After the examination of all enriched Yoghurts. the Yoghurt enriched with sweet peppers were healthier regarding its antioxidant and sensory properties [21].

By searching for the effect of adding grape pomace as a source of antioxidants and fiber at the different levels like 1.0% -5.0% on the sensory and physicochemical properties of Yoghurt during the storage period of 21 days at 4C. The pH values of this Yoghurt were reduced by enhancing the titrable acidity during 21 days. The addition of dried grape pomace at 2% concentration did not effect on values of syneresis, but the 4- 5% concentration had reduced the importance of syneresis. After comparison with control Yoghurt, the Yoghurt with 1-2% dried grape pomace had the same consistency, but the dried grape pomace at 3, 4,5 % effect the surface of Yoghurt [22]. The dietary fibre and phenolic content increase with the increase in the concentration of dried grape pomace. Increasing dried grape pomace fortification to 4.0% and 5% decreased appearance, flavor, texture, consistency and overall acceptance ratings significantly compared with control yoghurt [23].

It is recognized that supplementation Yoghurt with beta glucan, an alternative probiotic and dietary fibre, increases the capability of viable cells and metabolic activity of Bifidum by showing as an effect of probiotic and considered as an effective and consider as an alternative for the improvement of cereal-based dairy products [24].

The dairy products with the addition of carrot powder had shown to increase nutritional values, and the health benefitted Yoghurt production of Yoghurt with1-2 % carrot powder demonstrated good organoleptic properties. Due to the antimicrobial properties of carrots, the shelf life of Yoghurt increases. But powder of carrot was unsuccessful in introducing sweetening in Yoghurt, so the researchers added sweeteners to increase the taste. For selecting powder of carrot, there is not essential to utilize powder from different drying methods like freeze-drying and fluidized bed drying [25].

Yoghurt was prepared at different concentrations of carrot juice, which prominently influent quality of Yoghurt, raised activity of exopolysaccharide, β-D galactosidase and as a source of beta carotene [17].

In fat reduced set type Yoghurt, the pumpkin fibre was added at different compressions influenced the rheological, physicochemical and microstructural properties. During Yoghurt making, PF had not negatively affected the development of Ph and bacteria of Yoghurt.PF reduce the intensity and also increase a* and b* values. Yoghurt with PF had condensed and lower porous structure, comprising ropy development adjacent to the protein aggregates. Changes in microstructure affected the rheological behavior, syneresis and apparent viscosity, which have an influential gel strength, larger thickness and minor whey division. At 1% concentration, the use of PF raises storage (G0) and loss (G″) moduli compared to the control. The PF can be used as a preservative and natural food ingredient to improve the quality, nutritional and textural properties of fat-reduced Yoghurt [26].

In the study, Yoghurt was prepared from different vegetable fibres include pumpkin (PY), carrot (CY), green pea (GY) and zucchini (ZY). Yoghurt supplemented with vegetable purees had higher counts of *Streptococcus thermophilus* and Lactobacillus delbrueckii subsp. Bulgaricus. Puree enriched with vegetables influences the titrable acidity, syneresis, pH, colour (L*, a*, b*, DE values), texture (firmness, cohesiveness, consistency and viscosity index) and sensorial properties of the Yoghurts. Carrot puree had Firmness, consistency and viscosity indices, whereas the highest antioxidant capacity in pumpkin Yoghurt. This vegetable enriched Yoghurt had higher nutritional values [27].

In Yoghurt preparation, adding pea and inulin fibres had changed rheological, physicochemical and sensory properties. In contrast with the control sample, a small amount of tan δ with inulin and pea fibres shows a non-significant difference between tan δ values. The inclusion of pea fibres and inulin does not change the structural organisation. Fibre addition enhances structure firmness (increase G', G", |η*|). It was noticed that fibres increase the acidification rate of milk in the Yoghurt proportionate addition of wool did not change the colour of Yoghurt. There were no significant experiential changes in the different samples' L*, a*, b* parameters. Fibre addition enhances the syneresis of all samples, and the best results are experiential for the samples I3 and P6 (15.8% and 16.40% improvement). The sensory analysis exposed the Yoghurt samples with the highest acceptance scores, 18.6 and 19, which were I3 (2% inulin fibres) and respectively P6 (4% pea fibres). Therefore, it is possible to produce yoghurts containing inulin and pea fibre without changing the technological procedure and good quality for the consumers [27].

In Yoghurt preparation, adding pea and inulin fibres had changed rheological, physicochemical and sensory properties. In contrast with the control sample, a small amount of tan δ with inulin and pea fibres shows a non-significant difference between tan δ values. The inclusion of pea fibres and inulin does not change the structural organisation. Fibre addition enhances structure firmness (increase G', G", |η*|). It was noticed that fibres increase the acidification rate of milk in Yoghurt proportionate addition of fibre did not change the colour of Yoghurt. There were no significant experiential changes in the different samples' L*, a*, b* parameters. Fibre addition enhances the syneresis of all samples, and the best results are experiential for the samples I3 and P6 (15.8% and 16.40% improvement). The sensory analysis exposed the Yoghurt samples with the highest acceptance scores, 18.6 and 19, which were I3 (2% inulin fibres) and respectively P6 (4% pea fibres). Therefore, it is possible to produce yoghurts containing inulin and pea fibre without changing the technological procedure and good quality for the consumers [28].

Leahu, A., and Hretcanu, C. E. in 2017 were evaluated the sensory characteristics and consumer acceptance of Yoghurt enriched with carrot juice. Carrot juice was added at different concentrations like 10%,20% and 30% with two starter cultures. It was equipped in a laboratory by adding carrot juice in milk and inoculation of 3%. The sensory and quality parameters of the Yoghurt was analysed, and the data was statistically determined [29].

To check Physico-chemical and nutritional values, Yoghurt was prepared with pumpkin high in beta carotene. The fortification of Yoghurt with pumpkin puree can regulate microbial bacteria and is supplemented with dietary fibrate pumpkin fortified Yoghurt was compared with commercially produced Yoghurt and pumpkin supplemented samples consisted of 8.5 mg ascorbic acid, 8.9mg beta carotene and 4.5% fibre. The preparation of Yoghurt with different vegetables include cucumber, garlic, cucumber – garlic and mint leaf, green pepper and dried mint leaf, fried eggplant and garlic and all mixed vegetables at 10 % concentration to check its physical, nutritional and organoleptic properties [30]. The physic-chemical properties like total solids, pH and acidity of these samples increased significantly compared to Plain Yoghurt. After statistical analysis, Yoghurt with fried eggplant and garlic, and then cucumber mixed with garlic have good quality, and according to sensory evaluation, Yoghurt products were improved by supplementation with 10% eggplant and cucumber. The storage period did not affect the quality of supplemented Yoghurt [31].

4. Conclusion

Yogurt is rich in fat and protein but not having dietary fiber which are present in vegetables so the enrichment of yogurt with dietary fibre increases texture, structure and nutritional values of yogurt. Fruits are used in food products to improve its flavor and texture and considered a good source of bioactive peptides (anti-oxidant, anti-hypertensive and

anti-microbial), vitamins, minerals (Calcium, Magnesium, Phosphorus, Iron and Zinc), organic acids and dietary fiber with low calorie. Good sources of dietary fiber include cell wall of fruits, vegetables and cereals including polysaccharides (cellulose, hemicelluloses and pectin) and lignin. The aim of present study was to discuss the yogurt with the addition of dietary fiber source and its effect on physico-chemical, textural and sensory properties of obtained fermented milk products.

Compliance with ethical standards

Acknowledgments

Authors acknowledge the Ruth Pfau College of Nutrition Sciences, Lahore Medical and Dental College for the current study for providing the lab, material and other technical assistance.

Disclosure of conflict of interest

The authors do not have any conflict of interest to publish this review article. The authors hereby certify that this review is not under consideration of any Journal. None of the part of this review is plagiarized.

References

[1] Davis JG. Yoghurt and other cultured milks. J Soc Dairy Technol. 1956; 9: 69–74.

[2] Mohebbi M, Ghoddusi HB. Rheological and sensory evaluation of yoghurts containing probiotic cultures. J Agric Sci Technol. 2008; 10: 147–55.

[3] Dannenberg F, Kessler H-G. Effect of denaturation of β-lactoglobulin on texture properties of set-style nonfat yoghurt. 2. Firmness and flow properties. Milchwissenschaft. 1988; 43: 700–4.

[4] Shukla G, Sharma G, Goyal N. Probiotic Characterization of Lactobacilli and Yeast Strains Isolated from Whey Beverage and Therapeutic Potential of Lactobacillus Yoghurt in Murine Giardiasis. Am J Biomed Sci. 2010; 2: 248–61.

[5] Aryana KJ. Folic acid fortified fat-free plain set yoghurt. Int J Dairy Technol. 2003; 56: 219–22.

[6] Ribeiro MCE, Chaves KS, Gebara C, Infante FNS, Grosso CRF, Gigante ML. Effect of microencapsulation of Lactobacillus acidophilus LA-5 on physicochemical, sensory and microbiological characteristics of stirred probiotic yoghurt. Food Res Int. 2014; 66: 424–31.

[7] Shahidi F, Zhong Y. Bioactive peptides. J AOAC Int. 2008; 91: 914–31.

[8] Galesloot TE, Hassing F. Manufacture of stirred yoghurt of high viscosity. Voed Tech. 1968; 2: 446–8.

[9] Akdeniz H, Buzgan T, Tekin M, Karsen H, Karahocagil MK. An outbreak of botulism in a family in Eastern Anatolia associated with eating süzme yoghurt buried under soil. Scand J Infect Dis 2007; 39: 108–14.

[10] Akalin AS, Fenderya S, Akbulut N. Viability and activity of bifidobacteria in yoghurt containing fructooligosaccharide during refrigerated storage. Int J Food Sci Technol. 2004; 39: 613–21.

[11] Kamal RM, Alnakip ME, Abd El Aal SF, Bayoumi MA. Bio-controlling capability of probiotic strain Lactobacillus rhamnosus against some common foodborne pathogens in yoghurt. Int Dairy J. 2018; 85: 1–7.

[12] Chollet M, Gille D, Schmid A, Walther B, Piccinali P. Acceptance of sugar reduction in flavored yogurt. J Dairy Sci. 2013; 96: 5501–11.

[13] Dueck C, Cenkowski S, Izydorczyk MS. Effects of drying methods (hot air, microwave, and superheated steam) on physicochemical and nutritional properties of bulgur prepared from high-amylose and waxy hull-less barley. Cereal Chem. 2020; 97: 483–95.

[14] Prasad A. Anti-oxidant effect of zinc in humans. Free Radic Biol Med. 2004; 37: 1182–90.

[15] Li J, Kaneko T, Qin LQ, Wang J, Wang Y. Effects of barley intake on glucose tolerance, lipid metabolism, and bowel function in women. Nutrition. 2003; 19: 926–9.

[16] Guerrero-Romero F, Rodríguez-Morán M. Relationship between serum magnesium levels and C-reactive protein concentration, in non-diabetic, non-hypertensive obese subjects. Int J Obes. 2002; 26: 469–74.

[17] Yilmaz-Akyuz E, Ustun-Aytekin O, Bayram B, Tutar Y. Nutrients, bioactive compounds, and health benefits of functional and medicinal beverages. Nutr Beverages Vol 12 Sci Beverages. 2019; 175–235.

[18] De Paula AT, Jeronymo-Ceneviva AB, Silva LF, Todorov SD, Franco BDGM, Penna ALB. Leuconostoc mesenteroides SJRP55: a potential probiotic strain isolated from Brazilian water buffalo mozzarella cheese. Ann Microbiol. 2015; 65: 899–910.

[19] Aly SA, . EAG, . NAE. Carrot Yoghurt : Sensory, Chemical, Microbiological Properties and Consumer Acceptance. Pakistan J Nutr. 2004; 3: 322–30.

[20] Seksik P, Sokol H, Lepage P, Vasquez N, Manichanh C, Mangin I, et al. Review article: The role of bacteria in onset and perpetuation of inflammatory bowel disease. Aliment Pharmacol Ther. 2006; 24: 11–8.

[21] Najgebauer-Lejko D, Żmudziński D, Ptaszek A, Socha R. Textural properties of yogurts with green tea and Pu-erh tea additive. Int J Food Sci Technol. 2014; 49: 1149–58.

[22] Vinderola CG, Reinheimer JA. Culture media for the enumeration of Bifidobacterium bifidum and Lactobacillus acidophilus in the presence of yoghurt bacteria. Int Dairy J. 1999; 9: 497–505.

[23] (17) (PDF) Development of Fruit Flavored Yoghurt with Mango (Mangifera indica L.) and Papaya (Carica papaya L.) Fruits Juices | Bilatu Agza and Getenesh Teshome - Academia.edu n.d.

[24] (5) (PDF) Development of Fruit Flavored Yoghurt with Mango (Mangifera indica L.) and Papaya (Carica papaya L.) Fruits Juices n.d.

[25] Madora EP, Takalani TK, Mashau ME. Physicochemical, microbiological and sensory properties of low fat yoghurt fortified with carrot powder. Int J Agric Biol Eng. 2016; 9: 118–24.

[26] Kaur H, Mishra HN, Kumar P. Textural properties of mango soy fortified probiotic yoghurt: Optimisation of inoculum level of yoghurt and probiotic culture. Int J Food Sci Technol. 2009; 44: 415–24.

[27] Yildiz E, Ozcan T. Functional and textural properties of vegetable-fibre enriched yoghurt. Int J Dairy Technol. 2019; 72: 199–207.

[28] Ehsani A, Banihabib EK, Hashemi M, Saravani M, Yarahmadi E. Evaluation of Various Properties of Symbiotic Yoghurt of Buffalo Milk. J Food Process Preserv. 2016; 40: 1466–73.

[29] Kurtuldu O, Ozcan T. Effect of β-glucan on the properties of probiotic set yoghurt with Bifidobacterium animalis subsp. lactis strain Bb-12. Int J Dairy Technol. 2018; 71: 157–66.

[30] O'Sullivan MG. Sensory Properties of Dairy Products. A Handb Sens Consum New Prod Dev. 2017; 259–80.

[31] Soltani M, Hekmat S, Ahmadi L. Microbial and sensory evaluation of probiotic yoghurt supplemented with cereal/pseudo-cereal grains and legumes. Int J Dairy Technol. 2018; 71: 141–8.