DOI: https://doi.org/10.54393/pjhs.v4i01.496

PAKISTAN JOURNAL OF HEALTH SCIENCES

https://thejas.com.pk/index.php/pjhs

Volume 4, Issue 1 (January 2023)

Original Article

Effect of Dietary Fiber Enrichment on Physicochemical Attributes of Buffalo Milk Yoghurt

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ARTICLE INFO

Key Words:

Buffalo Milk, Yoghurt, Fiber, Turnip, Carrot, Fiber Enriched Yoghurt

How to Cite:

Anees Ur Rehman, M. ., Iqbal, F. ., Tahir, H. ., Yousaf Quddoos, M. ., Sami Ullah, T. ., Fatima, A. ., Qadeer, Z. ., Ayesha Batool, S. ., Chaudhary, F. ., & Naureen, S. (2023). Effect of dietary fiber enrichment on Physicochemical attributes of buffalo milk yoghurt : Effect of Dietary Fiber on Attributes of Buffalo Products. Pakistan Journal of Health Sciences, 4(01). https://doi.org/10.54393/pjhs.v4i01.496

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Received Date: 10th January, 2023
Acceptance Date: 24th January, 2023
Published Date: 31st January, 2023

ABSTRACT

Yogurt has a higher consumer acceptance due to claimed health benefits and sensory characteristics. It provides 40% calcium and 30-45% phosphorus of an adult's requirements in a day, as well as the vital amino acids proline and glycine. It is an excellent source of protein, carbohydrates, calcium and phosphorus, vitamin A, thiamine, riboflavin, niacin, folate, and cobalamin, but low in fiber. Yogurt's health benefits might be enhanced by adding a source of dietary fiber to it. **Objective:** To investigate the impact of fiber addition on physicochemical and nutritional attributes of buffalo milk yogurt during storage. **Method:** Overall Six samples were prepared, one for control, four by adding 10% and 20% puree for each carrot and turnip in 200 mL buffalo milk yoghurt along with one composite sample of carrot and turnip. All six samples were analyzed for moisture, pH, acidity, ash, and protein after 07 and 14 days of ripening. **Results:** A significant decrease in pH was observed during storage of yoghurt. Acidity of yoghurt rise significantly with storage. Lowest acidity level was observed in control sample 0.83. **Conclusion:** Addition of Turnip and carrot puree improved therapeutic potential of yoghurt significantly by modifying its dietary fiber contents.

INTRODUCTION

Fermented foods are integral part of diet all over the world. Yogurt is prepared by culturing the milk with lactic acid bacteria like *Lactobacillus bulgaricus,* and *Streptococcus thermophilus* in controlled conditions. Health claims and sensory attributes appeal to increase consumer acceptability and market of yoghurt [1]. It improves the gastrointestinal digestion and immune system. Yogurt is enriched with proteins, carbohydrate, minerals (calcium and phosphorus), and vitamins (vitamin A, thiamine, riboflavin, niacin, folate, and cobalamin) [2]. Milk is fermented to increase its shelf life and to preserve its nutrients. Milk fermentation increases the nutritional value and enhances bioavailability of nutrients. A variety of products are obtained through milk fermentation which are available in the market [3]. Multiple lactic starter bacteria are used for variety of fermented dairy products. Yogurt protein and its peptides have many physiological impacts as well as nutritional value. The physical texture of yogurt

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can be solid, semi solid or fluid [4]. Yogurt containing solid texture is known as set yogurt while yogurt containing fluid or semi-solid texture is described as stirred yogurt. Set and stirred yogurt texture depends on the production methods and on the physical appearance of the curd [5]. Flavor and texture of food products might be improved by introducing fruits into products. These are considered a good source of bioactive peptides (antioxidant, anti-hypertensive and anti-microbial), vitamins, minerals (Calcium, Magnesium, Phosphorus, Iron and Zinc), organic acids and dietary fiber with low calories. Dietary fiber is classified into water soluble and insoluble compounds. In food products, water insoluble fibers are generally used [6]. During processing, fiber interacts with other dietary components. These interactions may result in changes in nutritional bioavailability, texture, or taste of the product. Carrots are utilized in human cuisine and are high in beta carotene, vitamin C, and tocopherols. It fights cancer and other diet-related human disorders by preventing vitamin A deficiency [7]. Carrots are high in iron and vitamins A and C, but low in protein and fat. Turnip is a root vegetable of the brassica family. It is often utilized in many nations for its leaves, roots, and flower buds [8]. Carrot and Turnip contains phytochemicals and organic acids such as phenolic and malic acids exhibiting antioxidant capacity and some aromatic compounds which increase the immunity of body. It also helps to reduce the constipation, heart burn, gas, and bulging issues [9]. Since vegetables like carrots and turnips are high in dietary fiber and yoghurt is low in this aspect, introducing these vegetables to yoghurt boosts its texture, structure, and nutritional value. The aim of present study was to produce yogurt with the addition of carrot and turnip to evaluate the effect of these selected vegetables on physicochemical characteristics of fermented milk products.

METHODS

The study was aimed to evaluate the physicochemical properties of dietary fiber enriched (carrot and turnip) buffalo milk yogurt at the interval of 0,7 and 14 days of storage at 4°C.

Procurement of milk and other raw materials

Healthy and good quality carrots and turnips were purchased from local market of Sargodha. Buffalo milk was purchased from Hafiz dairy farm of Sargodha.

Preparation of carrot and turnip puree

Fresh carrots and turnips were washed, peeled, and mashed. The homogenized vegetables were pasteurized at 90℃ for 15 mins. The vegetable puree was cooled and refrigerated at 4℃ for further uses.

Manufacturing of yoghurt

Standardized buffalo milk was pasteurized and cooled to 45℃. After this, all milk samples were inoculated with 3% starter culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. The carrot and turnip purees were added into five samples except control according. The fermentation process was carried out at 40°C, until a pH of 4.6 was obtained. Subsequently, all the samples were stored at 4°C for the analysis.

Treatments	Fiber (%)	Milk (mL)
T0	Nil	200
T1(CP)	10	200
T2(TP)	10	200
T3(CP)	20	200
T4(TP)	20	200
T5(CP+TP)	10 :10	200

Table 1: Turnip and carrot puree concentration
CP = Carrot puree, TP= Turnip puree, T0= Control

Proximate analysis of vegetable purees

Vegetable purees of carrot and turnip were analyzed for moisture, ash, total soluble solids, pH and titratable acidity according to AOAC method (1991)[10].

Functional analysis fiber enriched buffalo yoghurt

Moisture, pH, acidity, and ash of fiber enriched buffalo milk yoghurt was carried out at 0, 7 and 14 days of storage at 4°C following the AOAC method (1991)[10].

Statistical analysis

The data on various parameters were analyzed by using SPSS-20 (software) mean, standard deviation, ranges, correlation, and percentages.

RESULTS

The purpose of this research was to find the effect of dietary fiber on physico-chemical attributes of buffalo milk yogurt. Manufacturing of yogurt was done by using starter culture and addition of carrot and turnip puree. Purees and starter culture was added after the process of pasteurization at inoculation temperature and subjected to inoculation at 45℃. After 6 hours of incubation yogurt were stored in refrigerator temperature at4℃. Physico-chemical and sensory attributes of yogurt was analyzed at 0, 7th and 14th day of storage. Carrot and turnip puree was analyzed for moisture, pH, total solids, titratable acidity and ash contents. The results indicates that carrot puree contains higher moisture contents (86%) as compared to turnip puree (52%). Carrot puree exhibited higher titratable acidity (0.243) and lower pH (4.55) relative to turnip titratable acidity (0.01) and pH (6.09). Higher Ash contents were observed in carrot puree (1.1%) as compared to turnip (0.9%). Fresh buffalo milk from healthy animal was standardized to 3.5% fat for yoghurt preparation. Pasteurized milk was used for the purpose. pH, SNF and protein of buffalo milk was recorded 6.6, 9 and 3.5% respectively. The milk analysis indicates 86.5% moisture,

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3.5% fat, 9% SNF and 0.17% acidity in milk sample. The yogurt was stored at 4℃ for 14 days and analyzed at 0,7,14 days of storage for physico-chemical composition. After, yogurt manufacturing, following analyses were performed. The primary determining metric in yoghurt quality is pH. Starter cultures release lactic acid, which is the primary reason for the decline in pH. The pH of yoghurt is reduced throughout the production process owing to the conversion of lactose into lactic acid [11]. The results showed that effect of days during storage and treatment was significant while the effect of interactions treatment and days were found to be non-significant on pH value of yogurt. The results indicate that pH was decreased with the addition of carrot and turnip puree as presented in table 2. The data regarding the pH showed that maximum pH was observed in control treatment with mean value 4.60. The minimum pH was seen in T4 treatment (20% turnip puree) with mean value of 4.38. The effect of storage period on pH of yogurt indicated that pH was decreased with increase in storage. pH of the control yogurt was 4.60 which deceases from 4.49 to 4.39 during 7 and 14 days of storage. The results were highly significant with the aspects of decreasing pH during storage. pH values were decreased by increasing the concentration of fiber from carrot and turnip puree in yogurt (Table 2).

Samples	0 day	7th day	14th day	Mean
T0	4.60±0.11	4.44±0.10	4.35±0.11	4.55
T1	4.45±0.10	4.25±0.11	4.23±0.11	4.45
T2	4.44±0.10	4.23±0.10	4.21±0.11	4.44
T3	4.35±0.10	4.30±0.10	4.18±0.11	4.40
T4	4.34±0.12	4.19±0.10	4.17±0.12	4.38
T5	4.39±0.10	4.24±0.11	4.23±0.11	4.42
Mean	4.49	4.44	4.39	

Table 2: Effect of treatment and storage days on pH content of yogurt

Moisture content had a significant effect on quality of yogurt enriched by carrot and turnip puree. The effect of the treatment was significant, and storage had non-significant effect on moisture content of yogurt. Results showed that the combine effect of treatment and storage have non-significant impact on moisture content of yogurt. The result of mean indicates that moisture content decrease with the addition of carrot and turnip puree. The maximum moisture content was observed in control sample having mean value 83%. The minimum moisture content was observed in T4 (20% turnip puree) sample having mean value of 79.33%. The effect of storage period on the moisture contents of yogurt demonstrated that the moisture content was decreased with the increase of time. The moisture content was decreased from 83% to 79.81% during a storage period of 14 days. The results obtained from statistical analysis for acidity of yogurt with the enrichment of carrot and turnip showed that treatment had significant effect and storage days also effect significantly on acidity of yogurt. However, the effect of treatment and storage had non-significant impact for acidity of yogurt. The results from mean value of the acidity of the yogurt are given in the table 3. The effect of carrot and turnip added in yogurt showed that highest acidity was observed in T3 treatment (20% carrot puree) with mean value 1.20%. The lowest acidity was observed in control yogurt with mean value 0.88% Moreover, results indicate that acidity was increased, and results are significant as shown in the table 3. The effect of storage period on acidity of yogurt indicated that the acidity was increased from 1.02% to 1.03% during storage period of 14 days. Acidity slightly increases from 0 day to 14 days. While mean values indicate that acidity increased in yogurt from 0.83% to1.17 %. The minimum change was observed in acidity of control yogurt with mean value of 0.88%. But there is no significant increase in acidity of yogurt (Table 3).

Yogurt Samples	0 day	7th day	14th day	Mean
T0	0.83±0.1	0.88±0.1	0.94±0.1	0.88
T1	1±0.1	1.05±0.08	1.11±0.1	1.05
T2	0.99±0.1	1.04±0.1	1.10±0.1	1.04
T3	1.15±0.07	1.20±0.1	1.25±0.1	1.20
T4	1.10±0.1	1.15±0.1	1.21±0.09	1.15
T5	1.05±0.1	1.11±0.1	1.17±0.1	1.11
Mean	1.02	1.07	1.13	

Table 3: Effect of treatment and storage days on acidity content of yogurt

The statistical analysis for Ash indicates that the yogurt enriched with carrot and turnip purees had significant effect on treatment. The mean value for the ash content in yogurt with carrot and turnip puree was given in the table 4.

Yogurt Samples	0 day	7th day	14th day	Mean
T0	0.78±0.05	0.78±0.04	0.79±0.04	0.78
T1	2.35±0.04	2.35±0.03	2.36±0.04	2.35
T2	3.78±0.04	3.79±0.04	3.78±0.04	3.78
T3	2.15±0.04	2.16±0.04	2.15±0.04	2.15
T4	3.58±0.30	3.59±0.05	3.58±0.04	3.58
T5	2.86±0.03	2.85±0.04	2.86±0.04	2.86
Mean	2.61	2.6	2.61	

Table 4: Effect of treatment and storage days on Ash contents of yogurt

The effect of these addition showed that the maximum ash content was detected in T2 treatment (20% carrot puree) with mean value of 3.78%. The minimum ash content was detected in T0 treatment with the mean value of 0.78%. The detail of result showed that the ash content was significantly increase by the addition of carrot and turnip puree. During a storage period there was non-significant change in mean values of ash content of yogurt. The overall mean value at 0 and 14 days of storage was 2.61%. However,

DOI: https://doi.org/10.54393/pjhs.v4i01.496

in treatment maximum mean value was observed in T2 treatment with mean value of 3.78% (Figure 1).

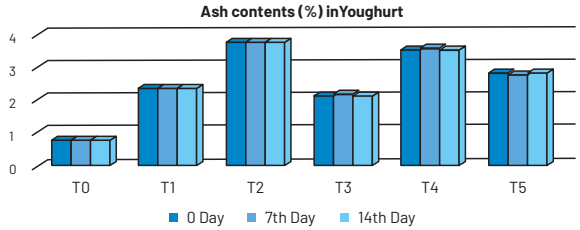

Figure 1: Effect of Different Treatments and storage on Ash Content of Yogurt

DISCUSSION

The most essential aspect in determining the quality of yoghurt is its pH. The starting culture stimulates lactic acid synthesis. The conversion of lactic acid by lactose, already present in milk, is the primary reason of pH reductions in yoghurt. The current research's findings for pH fall with storage are consistent with Yildiz's and Ozcan work who studied the effect of pH in skim milk yogurt. He noted the decrease in pH was during storages [8]. Leclercq-Perlat *et al.*, worked on the effect of the pH of aloe Vera fortified yogurt at refrigeration storage. The same decline in pH was recorded during storage [12]. In food stuff, water is present in free or bound forms. Water is bound in milk protein and therefore not easily accessible for chemical or biological processes, while it is held loosely in fat by attraction forces [13]. Within a yoghurt curd, free moisture transports a solute. During yoghurt storage, free water is available to exchange or release additional bound water for reactions [14]. The moisture content of buffalo milk yoghurt decreased somewhat but not significantly during storage in all treatments. Moisture variations have an impact on the shelf life and textural qualities of yoghurt. The moisture content results are consistent with the findings of Sharma *et al.*, who observed a reduction in moisture content along with storge of yoghurt [15]. The acidity of yoghurt indicates the formation of lactic acid by lactic acid bacteria. Lactic acid production is affected by microbial load in the form of starter culture as well as the product's manufacturing conditions like pH, acidity, processing technology, heat treatment time, temperature combinations and storage time and temperature. The development of acid taste in yoghurt is caused by the production of lactic acid. Acidity is vital in the formation of the structure of yoghurt; as acidity grows, acid taste and yoghurt structure decline [16]. Lactic acid formation in yoghurt represents the acidity value; as acidity increases, the quality of yoghurt in Syneresis deteriorates and the texture of the yoghurt alters. Current study indicates the decrease in pH and increase in acidity along with storage period. They evaluated the influence of acidity in flavored yoghurt during storage. Jayamanne and Adams observed the similar results [17]. Quelal-Vásconez *et al.*, reported that acidity increased due to growth of lactic acid bacteria during storage as they observed similar results in yogurt prepared from different vegetables include carrot, pumpkin and green pea [18]. As it is established that a deficiency of fiber in the diet may induce a variety of nutrition-related disorders, the European Food Safety Authority (EFSA) has been obliged to prescribe a daily fiber intake of 25 g on average [19]. According to several research, the rheological characteristics of yoghurt are changed differently depending on the kind of fiber source. Fibers' roles in boosting water holding capacity, stabilizing high fat yoghurt, enhancing viscosity characteristics, and gel forming ability enable to produce fiber-enriched yoghurt with enhanced texture and decreased syneresis. When compared to the control full-fat yoghurt, the addition of inulin to skimmed yoghurt led to the production of yoghurt with comparable textural features [20].

CONCLUSION

Manufacturers are keen on employing natural substances in the production of dairy products. Taking this into consideration, one of the purposes of this research was to establish the kind and number of fibers that may be suggested for the industrial manufacturing of yoghurt to enhance the final product's quality. It was concluded that addition of fiber improved the nutritional profile, ash contents and overall acceptability of buffalo milk yoghurt.

Conflicts of Interest

The authors declare no conflict of interest

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article

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