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Formulation and Evaluation of Date Syrup Flavored Soy Milk Yogurt, a Novel Plant Based Alternative of Dairy Products †

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Abstract: The healthier and natural alternatives to traditional dairy based products are in demand nowadays, that's why the use of soy milk as a dairy substitute has gained popularity due to its numerous health benefits and suitability for lactose-intolerant individuals. Soymilk is produced from soybean, a leguminous plant that is widely cultivated for its edible beans. Soy milk is produced by soaking, grinding, and boiling soybeans and then straining the liquid. In this research yogurt, a fermented form of milk was produced from nutrient-dense soy milk with several health benefits such as reducing the risk of heart diseases, improving bone health, favorable for the digestive system, and helping in weight management. Additionally, stevia a natural zero-calorie sweetener derived from the leaves of the Stevia rebaudiana plant and date syrup, also known as date honey or date molasses, made from dates, the fruit of the date palm tree (Phoenix dactylifera) rich in vitamins and minerals, aims to enhance the sweetness and nutritional profile of the soy-based yogurt were added. The four treatments were conducted, T_1 control without stevia and date syrup only (100%) yogurt and other treatments T_2 (95%) and (5%), T_3 (90%) and (10%), T_4 (85%) and (15%) soy yogurt and date syrup with 1.5% stevia were prepared. All the treatments were subjected to different proximate analyses to determine protein, fat, fiber, minerals and moisture. The various tests were performed to check the total phenolic content (TPC) and total flavonoid content (TFC) along with the determination of antibacterial and antioxidant properties of the flavored yogurt. Also, the physicochemical properties, including pH, viscosity, and sensory attributes, were assessed to evaluate the textural and sensory characteristics of the soy yogurt with varying sweetener levels. The findings of this research demonstrated that the incorporation of stevia and date syrup in soy milk-based yogurt effectively provided a balanced and natural sweetness while maintaining a low-calorie profile. The resulting product exhibited a smooth texture and appealing taste, with antimicrobial and antibacterial properties with high TPC and TFC content, making it an attractive option for health-conscious consumers seeking a dairy-free and nutritious yogurt alternative.

Keywords: dairy alternatives; date syrup; soy milk; soy yogurt; stevia

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1. Introduction

Soybean *(Glycine max* L. Merrill*)* annual legume crop belongs to the family *Fabaceae* that is originated from China and now cultivated Worldwide (Sanjukta & Rai, 2016). It is very nutritious, not only comprises high quality protein but contain almost all essential amino acids with greatly digestibility of about (92–100%)(Lee et al., 2018). It has multiple health benefits by limiting the risk of cardiac endemic, hyperlipidemia, renal diseases, lower plasma cholesterol and antiatherosclerotic (Sanjukta & Rai, 2016). Soybean is processed to make soymilk which can serve as the substitute of cow, buffalo and goat milk (Jiang et al., 2013). Soymilk due to its excellent nutritional value, low cost, and ease of use, could be an improved substitute for dairy milk. As a result, there is a demand for human-

grade substitute milk (Varghese & Pare, 2019). Yogurt has become a hugely popular dairy product for a long time and preparation of yogurt from the plant based milk is in great demand (Chandan et al., 2017). Probiotic yoghurts are more effective than regular yoghurt at improving a variety of health outcome (Kvist et al., 2020). Stevia is a plant whose leaf extracts are used as a sweetener alternative of sugar which cause various diseases (Mukhtar et al., 2016). Plant-derived products such as date syrup (DS) have demonstrated antibacterial activity and can inhibit bacteria through numerous different mechanisms, which may be attributed to bioactive compounds including plant-derived phenolic molecules (Taleb et al., 2016). DS is prepared by keeping date fruit pieces in water overnight, then boiling the mixture for 2 h followed by filtration (Abou-Zeid et al., 2018)

This research focuses on the development and evaluation of a novel soybean milk-based yogurt, catering to the growing demand for plant-based milk alternatives. The yogurt is uniquely flavored with the rich and nuanced taste of date syrup, offering a departure from conventional yogurt flavors. The novelty of this product lies in its use of soymilk and date syrup, providing a suitable alternative to dairy milk while replacing artificial flavors with a natural sweetening agent. The research aims to contribute to the discourse on innovative, environmentally friendly, and nutritionally sound food products by examining the sensory attributes, nutrient composition, and consumer acceptance of this distinct creation.

2. Materials and Methodology

2.1. Procurement of Raw Materials

All raw materials were collected from the local market for the yogurt manufacturing. All the required raw material including soybean, stevia, soymilk and date syrup were purchased from the local market of Faisalabad.

2.2. Preparation of Product

The process began by soaking soybeans overnight, followed by straining them to remove the soaking water. The beans were then manually dehusked, and a mixture of water (at a 1:4 ratio with soybeans) was used to grind them down. The resulting mixture was strained through muslin cloth to obtain soy milk. The soy milk was then gently boiled on low heat with continuous stirring for 10–15 min. Date syrup and stevia were added to the mixture, and it was heated over low flame. Afterward, a starter mixture was introduced, and the mixture was left to ferment at room temperature overnight. Total four treatments T_1 control without stevia and date syrup only (100%) yogurt and other treatments T_2 (95%) and (5%), T_3 (90%) and (10%), T_4 (85%) and (15%) soy yogurt and date syrup with 1.5% stevia were prepared.

2.3. Physiochemical Analysis of Product

2.3.1. Moisture Content

Soy yogurt's moisture content was determined using the method given in (AOAC International, 2016). 5 g samples of different proportions of flavored soy yogurt were weighed individually in a pre-weighed clean and dry china dishes before being placed in hot air oven at 105 °C for 24 h.

2.3.2. Ash Contents

The ash level of flavored soy yogurts samples was measured using the method outlined in (AOAC International, 2016). Firstly, weighed the empty crucibles and their weights were noted. Then, 1 g soy yogurt sample from each treatment was weighed in a pre-weighed porcelain crucible, placed on the stove, and heated to 600 °C in a muffle furnace overnight. Before being reweighed, the crucible is taken out of the muffle furnace and cooled in desiccators.

2.3.3. Crude Fat Contents

The crude fat content of evaluated using the solvent extraction technique described in (AOAC International, 2016). 2 g moisture free samples from each treatments were taken in a thimble prior to filling the flask connected to the soxhlet apparatus with 50 mL of n-hexane. Three to four drops of hexane were added to the sample per second for two to three hours as the fat was extracted. The thimble was removed after 6–7 syphons and heated to 1005 °C in an oven for 1 h before being weighed.

2.3.4. Crude Protein Content

Kjeldahl's technique was used to determine the crude protein content of soy yogurt enriched with date syrup by the method described in (AOAC International, 2016). Soy yogurt samples were digested with a solution containing $CuSO_4$, $FeSO_4$, and K_2SO_4, along with concentrated H_2SO_4 for 3–4 h. The resulting material was transferred to a 250 mL volumetric jar filled with distilled water. A diluted sample was mixed with 40% NaOH and distilled, recovering ammonia with methyl red indicator in 4% boric acid. The solution was titrated with 0.1 N hydrochloric acid. A blank tube without the sample was also run alongside.

2.3.5. Crude Fiber Analysis

By dissolving fat-free flavored soy yogurt in 1.25% H_2SO_4 and then 1.25% NaOH solution, the crude fiber content of the yogurt was ascertained, as stated in (AOAC International, 2016). A 1 g sample of flavored soy yogurt was digested with 1.25% H_2SO_4 for 30 min. After rinsing, 150 mL of 1.25% sodium hydroxide was added, followed by another 30-min digestion. The sample was dried, weighed (W1), ashed at 550 °C for 2 h, cooled, and weighed again (W2) to calculate the extracted fiber relative to the original sample.

2.3.6. Total Soluble Solids

Refractive index can be used to measure the concentration of percent dissolved solids of a substance. Brix is the new name for brix scale, that reflects the proportion of sugar along with other dissolved substances in the solution quantitatively. The method described by (Cavalcanti et al., 2013) was used to determine total soluble solids.

2.3.7. Acidity

The acidity of yogurt is affected by various parameters including the bacterial number and also storage time. These factors are directly related to acidity. By increasing these factors acidity is found to be increased. The acidity was measured by using method of (Karaca, 2013)

2.3.8. Hydrogen Ion Concentration

The measurement of hydrogen ion concentration in soy yoghurt samples were done by the help of pH meter. In present study the pH of all four soy yoghurts T_1, T_2, T_3 and control soy yoghurt was analyzed and mean values for pH were determined.

2.4. Phytochemical Analysis of Product

The total phenolic content (TPC) and total flavonoids content (TFC) of flavored soy yogurt was calculated using the Folin Ciocalteu technique provided by (Unuigbe et al., 2015).

2.4.1. Determination of Total Phenolic Content

For TPC, we mixed 0.05 mL of flavored soy yogurt sample, 0.75 mL of 20% sodium carbonate, and 250 µL of Folin-Ciocalteu reagent in each tube. After adjusting the volume

to 5 mL with distilled water, we measured the absorbance at 765 nm using a UV-visible spectrophotometer after 120 min. The result is expressed as mg GAE/100 g dry weight. Each sample was tested three times.

2.4.2. Determination of Total Flavonoid Content

0.25 g of flavor-infused soy yogurt samples were mixed with 20 cc of methanol for 2 h at room temperature. Then, 6 M HCl (5 mL) was added, and the solution was refluxed at 90 °C for 2 h. After cooling, the hydrolyzed sample was filtered, and total flavonoids were measured using an aluminum chloride test. Quercetin served as the standard. A 1 mL soy yogurt extract was mixed with 4 mL distilled water, 0.3 mL of 5% sodium nitrite, and 0.3 mL of 10% aluminum chloride. After adding 2 mL of 1 M sodium hydroxide and adjusting the volume to 10 mL with distilled water, absorbance was measured at 430 nm using a UV-VIS Spectrophotometer. Total flavonoids are expressed as mg QE/100 g dry weight (QE). Each sample was tested three times.

2.4.3. Antioxidant Analysis

Antioxidant analysis was performed by the DPPH scavenging process using three milliliters of sample extract were combined with one milliliter of DPPH to create the solution, which was then left in the dark for 30 min. With a spectrophotometer, check the amount of absorption at 517 nm next. Every test was run in triplicate. Ascorbic acid and BHT standard solutions were also examined

2.5. Sensory Analysis

(Aksoylu et al., 2015) approach was used to generate results utilizing an appropriate sensory methodology. The soy yogurt was evaluated by placing them in a temperature and light controlled setting. The sensory characteristics of yogurt were determined using a panel of 10 judges of university of Agriculture Faisalabad who were familiar with the major sensory aspects of the food items. According to a hedonic scale, all of the samples were assessed on a nine-point score. To score a product's overall acceptability, 1 is for complete dislike, 2 is for extreme dislike, 3 is moderately disliked, 4 is for slightly dislike, 5 is neutral and 6, 7,8, and 9 are for a moderate to extreme liking of the product

3. Results and Discussions

Moisture, ash, protein, fiber, and fat were computed in it to show the nutritional makeup of the food. The maximum moisture content (89.54%) was observed in T_0 (100% soy milk) followed by T_1 (85% soy milk with 15% date syrup) whereas the minimum moisture content was found in T_4 (75% soy milk with 25% date syrup). The results revealed that the treatments had highly significant ($p < 0.05$) effect on the moisture content of yogurt. Similar study was conducted by (Farinde et al., 2008) who reported that the yoghurt prepared with soy milk by the inoculation of commercial starter cultures represent the moisture content of 0.63%. The maximum protein value (3.70%) was recorded in T_0 (100% soy milk) whereas the minimum value of protein (3.62%) was recorded in T_3 (75% soy milk with 25% date syrup) followed by T_2 (80% soy milk with 20% date syrup) 3.65%. This represents that soy milk is a rich source of protein. The crude protein pattern indicated that as the amount of soy milk in the treatment decreased, the crude protein decreased till T_3 (75% soy milk with 25% date syrup). But at T_0 (100% soy milk) the protein content was significantly higher than the other treatment levels. The results revealed that the treatments had non significant ($p < 0.05$) effect on the crude protein of flavored soy yogurt. (Osundahunsi et al., 2007) investigated that the protein content of soy yoghurt 3.75 g/100 g. Similar study was conducted by (Farinde et al., 2008) who reported that the yoghurt prepared with soy milk by the inoculation of commercial starter cultures represent the protein content of 3.25%. (Farinde et al., 2009) compared the soymilk yoghurt, cow milk

yogurt and commercial yoghurt in which investigated that the soy milk yoghurt contains highest amount of crude protein which is 6.6%

The maximum crude fat content (1.8%) was observed in T_0 (100% soymilk) followed by T_1(85% soymilk, 15% date syrup) 1.6% whereas the minimum crude fat content (1%) was recorded in T_3 (75% soymilk, 25% date syrup). (Osundahunsi et al., 2007) reported that the fat content of soy yoghurt was 4.58 g/100 g. Similar study was conducted by (Farinde et al., 2008) who investigated that the yoghurt prepared with soy milk by the inoculation of commercial starter cultures represent the fat content of 1.21% to 3.60%. The highest value (0.45%) of the fiber content was observed in T_3 (75% soymilk, 25% date syrup) while the lowest value (0.35%) was observed in T_0 (100% soy milk). Similar study was conducted by Farinde*et al*. (2008), who reported that the yoghurt prepared with soy milk by the inoculation of commercial starter cultures had similar fiber content. The highest value 1.11% of the ash content was recorded in T_3 (75% soymilk, 25% date syrup) followed by T_2 (80% soymilk, 20% date syrup) 1.03% whereas the lowest value (0.83%) was found in T_0 (100% soy milk)). (Osundahunsi et al., 2007) investigated that the ash content of soy yoghurt is 0.520/100 g. Similar study was conducted by (Farinde et al., 2008) who reported that the yoghurt prepared with soy milk by the inoculation of commercial starter cultures represent the ash content of 0.63%. It is evident from statistical data that different treatments have a highly significant effect on the total soluble solids date flavored soy yogurt. For the treatments, with the increasing concentration of date syrup, the total soluble solids of the date flavored soy yogurt were increased. T_0 showed minimum total soluble solids (9.83 Brix) which gradually increased and finally the maximum value was obtained at T_3 (15.63 Brix). The findings of the current study were per the narrations of (Navicha et al., 2017) who prepared yogurt with the addition of pawpaw puree. He found that by increasing the concentration of puree, the total soluble solids in flavored yogurt were also increased from 11.83 Brix to 13.5 Brix because fruit contains high sugar content. For the treatments, with increasing concentration of date syrup, the acidity of the date flavored soy yogurt was elevated. T_0 showed the least acidity (0.75%) which was increased for T_1 (1.18%), T_2 (1.25%) and finally, the highest value was obtained at T_3 (1.30%). The pH of all yoghurt samples T_1, T_2 and T_3 and control were analyzed and the mean values were 4.15, 4.00, 3.67 and 4.93 respectively. pH of all the yoghurt sample were different from each other because of addition of date but the pH of T_0 yoghurt prepared with 100% soy milk and stevia addition was high (4.93) as compared to other samples. The lowest pH was seen in the sample T_3 (3.67) and the highest in T_0 (4.93) so results indicates that the pH of all yoghurts drops considerably by the addition of date syrup. The table no 1 shows the all mean values obtained from the treatments of proximate analysis.

It is evident from the results that date syrup had significant effect on the TPC content of the soy yogurt. The maximum value (21.71 μg GAE/g) was observed in T_3 (75% soymilk, 25% date syrup) followed by T_2 (19.47 μg GAE/g). The lowest value was observed in T_0 (100% soy milk) (11.46 μg GAE/g). Similarly, The TPC content of soy yogurt enhanced significantly with the addition of the red fruit in soy yogurt (Tang'nga et al., 2019). It is evident from the results that date syrup had significant effect on the TFC content of the soy yogurt. The highest value (1.73 μg QE/g) was observed in T_3 followed by T_2 having 1.68 μg QE/g, whereas the lowest value was observed in T_0 (100% soy milk) 1.6μg QE/g. The same results were obtained when the soy yogurt was enriched with red fruit (Tang'nga et al., 2019). DPPH percentage found in the T_0 (46.66%) but it increased gradually as date syrup percentage increased in the soy yogurt. The maximum DPPH was found in the T_3 (70.21%) due to the higher ratio of the date syrup upto 25%. The results of this research work are comparable with the (Tang'nga et al., 2019) worked on the soy yogurt for their phenolic compounds. The table no 1 shows all the mean values of phytochemical analysis.

Table 1. Mean values of phytochemical analysis.

Variable	Treatments	Mean Value
Total phenolic content	**T_0**	11.46 ± 0.04 ^{d}
	T_1	16.55 ± 0.02 ^{c}
	T_2	19.47 ± 0.04 ^{b}
	T_3	21.71 ± 0.03 ^{a}
Total flavonoid content	**T_0**	1.6 ± 0.02 ^{c}
	T_1	1.65 ± 0.03 ^{bc}
	T_2	1.68 ± 0.03 ^{ab}
	T_3	1.73 ± 0.03 ^{a}
Effect of DPPH	**T_0**	46.44 ± 0.03 ^{d}
	T_1	66.01 ± 0.05 ^{c}
	T_2	68.31 ± 0.05 ^{b}
	T_3	70.21 ± 0.04 ^{a}

T_0= (100% soymilk), T_1 = (85% soymilk, 15% date syrup), T_2 = (80% soymilk, 20% date syrup), T_3 = (75% soymilk, 25% date syrup).

In sensory analysis the color of the T_3 (75% soymilk, 25% date syrup) was most liked by the panel followed by the T_2 (8.65) and T_1 (8.58). The T_0 was in lower most in term of its color due to 0% date syrup. The flavor is important parameter in the successful product development and it is a combination of taste and aroma of the food. The analysis of variance for the flavor showed that the date syrup in soy yogurt did effect significantly on the flavor of the soy yogurt.. The analysis of variance for the texture of flavored and non-flavored yogurt cleared significant relation among them. T_2 (80% soymilk, 20% date syrup) gained the highest score for texture. The minimum texture was observed in the T_0 (100% soy milk with no date addition). The analysis of variance for the texture of flavored and non-flavored yogurt cleared significant relation among them. T_2 (80% soymilk, 20% date syrup) gained the highest score for texture. The minimum texture was observed in the T_0 (100% soy milk with no date addition). The overall acceptability resulted in the judges mostly liked the T_2 and T_3 this might be due to the high level of date syrup.

4. Conclusions

The research has focused in the development of a novel plant-based yogurt product that stands as a compelling alternative to its dairy-based yogurt. This innovative yogurt boasts a remarkable array of attributes, including a high protein content, an abundance of phenolic compounds, and flavonoids, all of which contribute to its nutritional richness. The infusion of natural date syrup, which not only serves as a flavor enhancer but also elevates the product's phenolic and flavonoid content. It is important to emphasize that our yogurt achieves its delightful sweetness without any added artificial sugars, aligning perfectly with the modern consumer's preference for natural and wholesome ingredients. The harmonious fusion of protein, phenolic compounds, and flavonoids in our yogurt reflects our commitment to crafting a wholesome product that caters to the discerning tastes and health-conscious choices of today's consumers. In closing, our research underscores the potential of plant-based yogurt as a nutrient-rich and naturally flavored alternative to traditional dairy products.

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