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Sensory and Physico-chemical Quality of Fresh Dragon Fruit (*Hylocereus polyrhizus*) Yoghurt

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Abstract

The present investigation entitled "Process standardization for preparation of yoghurt by using dragon fruit (*Hylocereus polyrhizus*) pulp" was undertaken during 2023-24 with a view to standardize the process for preparation of dragon fruit yoghurt with improved therapeutic value using dragon fruit pulp and sugar. Initially, preliminary trials were conducted to finalize the levels of dragon fruit pulp and sugar in the yoghurt. Yoghurt samples were prepared with 4, 6, 8, 10 and 12 percent dragon fruit pulp and 6, 8 and 10 per cent sugar. It was observed that, all the sensory attributes Viz., colour and appearance, flavor, body and texture and overall acceptability of fresh yoghurt samples under different treatment combinations were significant. The colour and appearance, flavour, consistency and overall acceptability score ranged from 7.66 (T_0) to 8.56 (T_3), 7.63 (T_0) to 8.46 (T_3), 7.76 (T_6) to 8.40 (T_3) and 7.71 (T_0) to 8.48 (T_3), respectively. The treatment combination T4 (6 per cent dragon fruit pulp and 8 per cent sugar) found sensorily superior over the rest of treatment combinations. The average chemical composition of fresh yoghurt samples prepared under different treatment combinations ranged from78.37 to 85.81% moisture, 3.07 to 3.48% fat, 2.99 to 3.47% protein, 12.19 to 21.54% total solids, 0.68 to 0.77% titrable acidity, 4.22 to 4.51% reducing sugar, 4.22 to 13.15% total sugar, 0.60to 0.68% ash and 3.98 to 4.38 pH. The effect of levels of dragon fruit pulp and sugar was significant.

Key words : Sensory, Physico-chemical Quality, Dragon Fruit and Yoghurt.

Yoghurt is a fermented product made from fresh milk and or reconstituted milk by using bacteria, such as *lactobacillus bulgaricus* and *streptococcus thermophiles* with or without any additional food ingredients and permitted food additives (Mukhekar *et al.* 2018).

Yoghurt is a nutritious food that contains nutrients like calcium, magnesium, and potassium that protect against cardiac conditions and defects of the nervous system. It is ideal for boosting immunity, building stronger bones, and promoting natural flora, which aids in digestion. Yoghurt can be said to as a health food with beneficial features when it is enriched with active ingredients like fruits, herbs, probiotics, and prebiotics, among others (Jayalalitha *et al.* 2019).

Yoghurt's appeal has significantly increased globally with the introduction of health foods. It is among the most distinctive and versatile dairy products. Yoghurt's distinctive flavour stems from the symbiotic fermentation process *Lactobacillus bulgaricus* and *Streptococcus thermophiles* use in its production. In addition, it is a fermented milk product that is distinct from other fermented milk products due to its semisolid qualities and custard-like consistency. Due to its health benefits, yoghurt is appreciated everywhere in the world. Live lactic acid bacteria in yoghurt provide several health benefits, including reducing the risk of cancer, protecting against gastrointestinal distress, improving lactose digestion by maldigesters, boosting the immune system, and assisting the body in assimilating calcium and protein. (Marona *et al*., 2004).

The pitaya (*Hylocereus polyhizus*), a native of Southeast Asia and South America, is an edible cactus that is grown in tropical climates. They are becoming more and more well-known all over the world as foods, snacks, and dietary supplements. Their high concentration of bioactive phytochemical compounds particularly betalains has recently piqued scientific interest. Red pitaya supplements reduce liver and cardiovascular damage brought on by a diet heavy in fat and carbohydrates, according to in-vivo research. Furthermore, the advantageous properties of pitaya have been documented in rodents and linked to its components, including flavonoids and betalains. The authors ascribed these beneficial effects to the plant's antioxidant components and, as a result, to their capacity to reduce oxidative stress-induced damage. Thus, we study pitaya's hypolipidemic action in an animal model of hypercholesterolemia in order to prevent and control chronic diseases. In contrast to its fruit, the skin of dragon fruit is an unexplored resource. The weight of a leather dragon fruit is between 30 and 35 percent that of a fruit that is primarily wasted and not used extensively. The skin of the dragon fruit has roughly 46.7% fibre, which is highly beneficial to health. (Rijal *et al.* 2019).

Materials and Methods:

Starter Culture : The freeze dried pure cultures of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were procured from the National Collection of Dairy Cultures (NCDC), Division of Dairy Microbiology, National Dairy Research Institute, Karnal (India).

Dragon fruit pulp : The Dragon fruit was purchased from local market of Rahuri city. Dragon fruit pulp was prepared in laboratory of Department of Animal husbandry and Dairy Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.).

Sugar : Food grade sugar was obtained from the local market.

Preparation of Dragon fruit yoghurt:

The Yoghurt was prepared by using the procedure prescribed by Sharma and Singh (1981) with some minor modifications. Fresh good quality cow milk (3.5% fat) was taken and added skim milk powder @ 4% subjected to filtration/clarification. The mix was pre-heated to 60°C and homogenized single stage at 2000-2500 psi, the milk was heated to 85°C for 30 min and then cooled to 43 ± 10C, sugar was added. It was then inoculated @ 2% with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (1:1 ratio) which were mixed well and incubated at 43 ± 1°C for 5 hours in plastic cups/containers. When the curd has set firmly, it is transferred in refrigerator and stored at 5 ± 2°C.

Physical property analysis :

Fat : As per the method described in IS: 1244, Part I, 1977. Protein: As per the procedure described in IS: 1479 (part-II) (1961). Total solids: As per the method given in IS: 1479 Part-II(1961).Titratable acidity (% L. A.) As per the method given in IS: 1479, Part – I(1960).pH:As per the method given in IS: 1479, Part –II(1961).Total soluble solids: The total soluble solids in the juice was determined with the help of Erma hand refractometer (Range 0-320 Brix) pH:pH of the dragon fruit pulp was measured by Elico digital pH meter. Reducing sugar and total sugar: Reducing sugar and total sugar was determined by the method of Lane and Eynon (1923), as adopted by Ranganna (1986).

Statistical Analysis : The data generated during the course of this investigation was tabulated and analyzed using Completely Randomized Design (CRD) for pre-experimental trials and to compare control with other treatments. However, effect of dragon fruit pulp

and sugar levels and their interaction effect was analyzed by Factorial Completely Randomized Design (FCRD) with three replications (Snedecor and Corchan, 1994).

Treatment details are T_0 - Control without addition of dragon fruit pulp and sugar in Yoghurt, T_1 - Yoghurt + 4% dragon fruit pulp + 8% sugar (P_1,S_1), T_2 - Yoghurt + 4% dragon fruit pulp + 10% sugar (P_1,S_2), T_3 - Yoghurt + 6% dragon fruit pulp + 8% sugar (P_2,S_1), T_4 - Yoghurt + 6% dragon fruit pulp + 10% sugar (P_2, S_2), T_5 - Yoghurt + 8% dragon fruit pulp + 8% sugar (P_3, S_1) and T_6 - Yoghurt + 8% dragon fruit pulp + 10% sugar (P_3, S_2).

Result and Discussion

Sensory Evaluation : Yoghurt samples were subjected to the sensory evaluation. The samples of yoghurt were provided to the panel of five semi trained judges for sensory evaluation. The scoring was recorded by using 9 point Hedonic Scale (Appendix-I) as per IS: 6273 (Part –II) 1971.

Colour and appearance : The natural colour of the dragon fruit pulp had an impact on the colour score of the yoghurt. Table 1 presents data on appearance parameters and colour. Out of all the treatments, treatment T_3 received the highest score (8.56), while T0 shows lowest score (7.66). Treatments T_1, T_2, T_5, T_6 and T_0 shown notable variations from one another, while treatments T_3 and T_4 were at par. Changes in sugar and dragon fruit concentration were shown to cause a colour shift from pale white to reddish-pink.

This pattern matched the conclusions made by Patil *et al.* (2018) in jamun juice yoghurt that the treatment T_3 (9 per cent jamun juice and 0.025 per cent aspartame) received maximum score (8.23), while treatment T_6 (12 per cent jamun juice and 0.03 per cent aspartame) received minimum score (7.73) for colour and appearance of fresh yoghurt. According to Khote (2021), the dragon fruit lassi's colour and appearance scores were 8.25, 8.53, 8.80, and 7.53 for treatments T_1, T_2, T_3 and T_4, respectively.

Flavour : Table no 1 reveals that the flavour scores were significantly ($P < 0.05$) affected by both ingredients. Treatments T_1, T_5, and T_6 were found to be comparable. Treatment T_3 achieved the highest flavour score of 8.46. The presence of ethyl acetate, known for its sweet, fruity aroma, might have contributed to the enhanced flavour. Conversely, treatments T_5, and T_6 which included 8% dragon fruit, were less favoured by judges, who noted a slightly unpleasant flavour due to the higher pulp level.

These results are consistent with those of Sameem *et al*. (2018), who found that treatment T_2 had the highest mean flavour and taste score (8.164) for dragon fruit pulp Shrikhand, followed by treatment T_0 (7.562) and treatment T_1 (7.294). The results agree with the findings of Patil *et al.* (2018) they observed that, smell and taste of jamun yoghurt was significantly more than control sample. Treatment T_4 had highest flavour score among the rest of treatment combinations.

Table 1. Sensory quality of Yoghurt samples (score out of 9)

Treatments	Colour and appearance	Flavour	Consistency	Overall acceptability
T_0	7.66^{e}	7.63^{e}	7.85^{d}	7.71^{d}
T_1	8.02^{cd}	8.01^{d}	8.10^{cd}	8.04^{cd}
T_2	8.17^{bc}	8.20^{bc}	8.25^{bc}	8.21^{c}
T_3	8.56^{a}	8.46^{a}	8.40a	8.48^{a}
T_4	8.34^{ab}	8.33^{ab}	8.30^{ab}	8.32^{ab}
T_5	7.99^{cd}	8.10^{cd}	7.79^{cd}	8.05^{cd}
T_6	7.88^{de}	7.95^{d}	7.76^{d}	7.92^{d}
S.E.	0.08	0.05	0.07	0.04
CD at 5%	0.26	0.15	0.21	0.12

Mean of four replications

Consistency : The results obtained during evaluation in terms of consistency in the Table no.1 shows that the levels of dragon fruit and sugar had a significant effect ($P<0.05$) on the consistency of yoghurt. The highest consistency score was observed for treatment T_3 (8.40), while the lowest score was noted for treatment T_6 (7.76). This indicates that consistency improved with higher levels of dragon fruit and sugar, but decreased with an excessive amount of dragon fruit pulp and sugar. The consistency scores for the dragon fruit pulp were rated as "liked moderately" to "liked very much" by a panel of semi-trained judges.

Similar findings were reported by Sameem *et al*. (2018), who noted that treatment T_2 had the highest mean consistency score (7.9) in dragon fruit pulp Shrikhand, followed by T_0 (7.6) and T_1 (7.3). In T_3, the lowest possible score of 6.6 was attained. Hettiarachchi *et al*. (2015) observed the increase in consistency score from T_1 to T_3 and recorded highest consistency score for the T_3 (8.25) and reported decrease in score with increased level of dragon fruit pulp in yoghurt from T_4 to T_6.

Overall Acceptability : Across the board, the yoghurt received mean values ranging from 7.71 to 7.92 for overall acceptance (Table 1). The formulation including 6% dragon fruit pulp and 8% sugar received the highest score, whereas the control sample, which contained no dragon fruit pulp, received the lowest score. Compared to all other treatments, treatment T_3 demonstrated the best colour, flavour, and consistency and was considerably ($P<0.05$) superior. The data indicates that all levels of dragon fruit were accepted, with treatments T_3 and T_4 were at par with each other. All samples fell into the "liked moderately to liked very much" category on the 9-point hedonic scale.

Hettiarachchi *et al.* (2015) observed a similar outcome. The optimum recipe for developing yoghurt with dragon fruit incorporation was determined to be treatment C, which contains 6% of dragon fruit juice, based on the greatest mean rank value across all sensory characteristics. According to Sameem et al. (2018), dragon fruit pulp had the highest mean score for overall acceptance. For treatment T_2, Shrikhand (8.164) was achieved, then T0 (7.562) and T_1 (7.294). In T_3, the lowest possible score of 6.896 was attained.

Chemical qualities of fresh yoghurt samples : All the samples of yoghurt, along with a control, underwent physico-chemical analysis for parameters such as moisture, fat, protein, ash, total sugar, total solids, titrable acidity and pH. The corresponding observations and statistical analysis are presented in Table 2.

Moisture : The data in Table 2 shows that the moisture content of yoghurt decreased from 85.81% to 78.37% as the levels of dragon fruit pulp and sugar were increased from T_0 to T_6. Treatment T_0 had the highest moisture content of 85.81%, while T_6 had the lowest i.e., 78.37%. The treatments' variations in moisture content were statistically significant ($P<0.05$). Because dragon fruit pulp has a low moisture content that is comparable to cow milk, there is probably a trend towards decreased moisture content with higher levels of sugar and dragon fruit pulp.

The outcomes agree with the findings of Sameem *et al.* (2018), who found that the dragon fruit pulp had the low mean moisture %. From treatment T_1, (46.52) was obtained, then T_2 (45.25) and T3 (43.98). In T_0 (control), the bare minimal moisture percent of 42.7 was attained.

Fat : The fat content differed significantly ($P<0.05$) with the addition of dragon fruit pulp and sugar at varying levels (Table 2). The highest fat content was observed in the control sample

T_0 (3.48%), while the lowest was recorded for treatment T6 (3.07%). These findings show that the fat percentage of the finished product dropped as the amount of sugar and dragon fruit pulp rose. This is probably because dragon fruit pulp has a lower fat content (0.4%).

Wulansari *et al.* (2016) reported that fat content is affected by different fruits added in the yoghurt (P>0.01). The highest fat content was in control yoghurt (4.52%) than the dragon fruit yoghurt sample P_1 (3.69%). According to Patil *et al*. (2018), there was a substantial drop in the fat content of yoghurt samples as the level of jamun juice increased.

Protein : The yoghurt samples showed a substantial (P<0.05) difference in protein content. The designed product has a protein level ranging from 2.99% to 3.47% (Table 2). Treatment T_0 had highest protein content (3.46%) over other treatments while the lowest protein content of 2.88% was recorded for treatment T_6. It was found that adding dragon fruit pulp to the yoghurt reduced the amount of protein in the yoghurt samples. This could be because the pulp has a low protein content i.e 1.1%.

According to Patil *et al.* (2018), there was a substantial decrease in the protein content of yoghurt as the jamun juice level rose. The protein content of treatment T_0 (control) was 4.55%, which was significantly greater than that of the other treatment combinations. According to Roy *et al*. (2016) the protein content in yoghurt samples decreased with the increase of pulp content. The highest protein found in control sample (3.80%) and lowest found (3.53%), (3.52%) in W3 (watermelon yoghurt) sample P_3 (papaya yoghurt) samples respectively.

Ash : Table 2 presents the values for ash content in the yoghurt, was found to be decreased from treatment T_0 to T_6, which primarily consists of mineral compounds. The average ash content in the yoghurt ranged from 0.70% to 0.80%. As the level of dragon fruit pulp in the yoghurt increased, the ash content decreased. This trend can be attributed to the lower mineral content in dragon fruit pulp compared to yoghurt. Each treatment, from T_0 to T_6, differed significantly from the others.

The recorded trend of decrease in ash content in yoghurt was similar to the findings of product developed by Andharepatil (2020) reported the mean average values for ash percentage of dragon fruit shrikhand were

Table 2. Chemical quality of yoghurt sample

Treatment combination	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Reducing sugar (%)	Total sugar (%)	Total solid (%)	Titratable acidity (%)	pH
T_0	85.81^a	3.48^a	3.47^a	0.68^a	4.22^e	4.22g	12.19g	0.68^d	4.38^a
T_1	79.08g	3.36^b	3.33^b	0.67^b	4.28^d	12.37^f	21.18^a	0.70^{cd}	4.16^b
T_2	78.89^f	3.31^c	3.28^c	0.65^c	4.30^d	12.43^e	21.23^b	0.71^c	4.18^b
T_3	78.75^e	3.24^d	3.17^d	0.64^d	4.38^c	12.68^d	21.36^c	0.72^{bc}	4.05^c
T_4	78.59^d	3.19^e	3.14^e	0.62^e	4.40^c	12.82^c	21.39^d	0.73^b	4.08^{cd}
T_5	78.49^c	3.11^f	3.06^f	0.61^f	4.46^b	13.02^b	21.51^e	0.76^a	3.99^d
T_6	78.37^b	3.07g	2.99g	0.60g	4.51^a	13.15^a	21.54^f	0.77^a	3.98^d
SE	0.021	0.02	0.008	0.01	0.01	0.008	0.003	0.006	0.022
CD @ (5%)	0.064	0.06	0.024	0.03	0.03	0.024	0.010	0.020	0.068

Mean of four replications

decreased as 1.90, 1.70, 1.40 and 1.35 for the treatments T_1, T_2, T_3 and T_4.

Reducing sugar : These variations (shown in Table 2) were statistically significant ($P<0.05$), demonstrating that the quantity of dragon fruit pulp significantly influenced the reducing sugar content in the yoghurt. Each treatment showed notable differences, with treatment T_6 recording the highest reducing sugar content at 4.51% and treatment T_0 the lowest at 4.22%. The observed increase in reducing sugar content with higher levels of dragon fruit pulp can be attributed to the presence of reducing sugars, such as fructose, in the dragon fruit pulp.

Similar findings were reported by Patil *et al*. (2018) found that fresh yoghurt samples had decreasing reducing sugar contents ranging from 6.68 to 6.94 percent. Jamun juice yoghurt's reducing sugar content rose as the amount of juice grew; this could be because juice has a higher reducing sugar content than milk. Roy *et al*. (2016) reported that the addition of banana pulp to yoghurt increases the carbohydrate percent. Carbohydrate content in B_3 sample was appreciated because reported (reducing sugars) glucose (5%) and fructose (6.5%) in banana pulp.

Total sugar : Table 2 display the recorded data for the final product's total sugar content. Treatment T_0 samples had the lowest total sugar level (4.22%), whereas treatment T_6 samples had the highest content (13.15%). Treatments T_0, T_1, T_2, T_3, T_4, T_5 and T_6 differed from one another considerably ($P<0.05$). The product's overall sugar content may have grown as a result of the 10% sugar content in the dragon fruit pulp.

Similar findings were noted by Patil *et al*. (2018), who found that the fresh yoghurt samples' total sugar level varied from 6.68 to 7.04 percent. The total sugar content rose as the jamun juice level grew; this could be because of the juice's sugar content. Roy *et al*. (2016) reported that the addition of papaya pulp and watermelon pulp to yoghurt, increased its carbohydrate (total sugar). This might be because of both papaya and watermelon contains significant amount of sugars (fructose, glucose and sucrose).

Total Solids : According to Table2 the treatment T_0, T_1, T_2, T_3, T_4, T_5 and T_6 were significantly different from each other. Treatment T0 had the lowest total solids content at 12.19%, while T_1 had the highest at 21.18%. The findings showed that when the amount of dragon fruit pulp rose from T_1 to T_6, the total solids content of the yoghurt increased. This could be because the pulp has a low moisture content and a high total solids content and also due to added sugar.

These results concur with those obtained by Patil *et al*. (2018) Yoghurt's total solids content dropped as the amount of jamun juice increased. It could be because juice has less total solids than the milk that was used. The average total solids content of the fresh yoghurt samples was found to vary between 14.9 (J_3A_1) and 15.53 (control) percent. Sameem *et al*. (2018) who reported the highest mean value for total solids percentage in dragon fruit Shrikhand (57.33) was obtained from the treatment T_3 (control) followed by T_2 (56.02%), T_1 (54.75%). The T0 obtained the minimum score (53.48%).

Titrable Acidity : The acidity levels in yoghurt shown Table 2. The treatment T_6 had highest acidity, which was 0.77% acidity, corresponding to 8 percent dragon fruit pulp and 10 percent sugar. Conversely, the lowest acidity was in treatment T_0, with 0.68 percent, which was control treatment. This suggests that as the level of dragon fruit pulp increased, so did the acidity of the yoghurt. Treatments T_5, and T_6 were at par in acidity levels.

The trend of increasing acidity with higher levels of fruit pulp aligns with the observations of Patil *et al*. (2018), acidity rose as jamun juice concentration increased; this could be because jamun juice has a higher acidity. The acidity of the yoghurt samples ranged from 0.79 to 0.88 percent L.A. Sameem *et al*. (2018), reported that the highest average titrable acidity percentage in dragon fruit Shrikhand was recorded in treatment T_3 (1.26%), followed by T_2 (1.19%) and T_1 (1.08%). The lowest acidity level (0.93%) was observed in the control group, T_0.

pH : The pH value of yoghurt samples is presented in Table 2. The pH values of yoghurt samples significantly ($P<0.05$) declined due to addition of dragon fruit pulp to yoghurt. The maximum decline in pH value (3.98) was observed in yoghurt (T_6) prepared using 8 per cent dragon fruit pulp. The above results were comparable with the findings of following research workers.

Zainoldin *et al*. (2009) reported that the pH values of dragon fruit yoghurt showed significant decline as the pulp percentage increases as follows- control P (4.05), followed by R_1 (4.01), R_2 (3.99) and R_3 (3.95). According to Patil *et al*. (2018), yoghurt samples had mean pH values ranging from 4.55 to 4.62. The pH fell with increasing levels of jamun juice, it can be owing to increased acidity with rising juice level in yoghurt manufacturing.

Conclusion

The better quality yoghurt can be prepared by using 6% dragon fruit pulp and 8% sugar (overall acceptability score 8.48). The sensorily best quality yoghurt sample (T_3) had following chemical composition moisture, fat, protein, total solid, ash, acidity, pH, reducing sugar, non-reducing sugar, and total sugar in percentages of 78.75, 3.24, 3.17, 21.36, 0.62, 0.72, 4.05, 4.38, 8.30, and 12.68, respectively.

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