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RESEARCH ARTICLE

Supplementation of tomato pomace in *lassi* (a traditional Indian dairy product) and its effects on physico-chemical, functional attributes and shelf-life of *lassi*

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Abstract: Utilization of agriculture waste as food additives increased significantly due to their potential health and nutritional attributes. Tomato crop is widely grown across the globe and generates large amount of waste in the form of tomato pomace during the processing of tomato. Dried tomato pomace has a higher shelf-life and easier for food fortification. *Lassi* is a traditional Indian dairy product consumed as a refreshing beverage during summer. Considering the various health and nutritional benefits of tomato pomace present study was undertaken to supplement tomato pomace in *lassi*. Tomato pomace powder (TPP) was prepared by tray drying at 55-60 °C for 16-18 hrs. Pomace had 16.70% protein, 57.53% crude fibre, and 49.80% 2, 2 diphenyl-1-picryl hydroxyl (DPPH) inhibition activity, 311.7 mg gallic acid equivalents (GAE)/100g total phenolic content (TPC). Supplementation of tomato pomace was done at different rates of 0.5, 1.0, 1.5, and 2.0% (w/v) of milk during the heating of milk. 1% tomato pomace added *lassi* had a better sensory score and physico-chemical properties with an overall acceptability score of 7.5. In, addition 1 % tomato pomace *lassi* had 2.53% fat, 2.67% protein, 18.81% total solids, 0.66% ash, 21.81% DPPH inhibition antioxidant activity and 12.37 mg GAE/100 g. Tomato pomace powder added *lassi* was found stable up to 12 days of storage study while the control sample (without tomato pomace) was unacceptable after 9 days of storage. *Lassi* supplemented with tomato pomace rich in fibre and antioxidant activity. Utilization of tomato pomace in *lassi* fortification can be better alternative for tomato processor as *lassi* consumed very large segment of population.

Keywords: Antioxidant activity, Fibre, Fermentation, *Lassi,* Milk, Pomace, Tomato

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Introduction

India is the largest producer and consumer of milk and milk products and has a nearly 23% contribution to global milk production. A major share (approximately 60%) of milk is utilized in the manufacturing of traditional dairy products due to their huge demand across the country. Several technological and functional advances attempted to popularize or commercialize these traditional dairy products. Various functional ingredients are incorporated into traditional dairy products for their value addition (Arora et al. 2022, Aneja, 2002). Numerous traditional fermented dairy products *i.e. Dahi, Mishti doi, Shrikhand, Buttermilk, Lassi,* etc. popular due to their organoleptic, nutritional and functional attributes. Fermentation of milk improved nutritional value and bioavailability of nutrients. Lactic acid bacteria used in fermentation helps in eliminating toxic and anti-nutritional compounds available in different food formulations (García-Burgos et al. 2020).

Lassi is a popular refreshing beverage that is commonly consumed in the Northern part of India. It is prepared by fermentation of milk by specific strain of starter culture (lactic acid bacteria), followed by mixing with sugar, water and flavouring ingredients (optional). *Lassi* possess various positive effects on human health by improving the immune and gastrointestinal health (Datir et al. 2022). Consumer perception changes towards foods and food habits, they believe that food played important role in health (Mollet and Rowland, 2002). Food also prevents different nutritional-related diseases and improves the physical and mental health (Betoret et al. 2011).

Tomato (*Lycopersicon esculentum L.*) is the second-largest grown horticultural crop, worldwide. Annual tomato production is nearly 186.821 million metric tonnes across the globe (Branthôme, 2022) and India contributes around 11% of total tomato production (Kushwaha et al. 2018). As per World Processing Tomato Council (WPTC) in the year 2020, nearly 130 MT of tomatoes were processed and around 8 MT of tomato pomace was generated as waste. Presently, tomato pomace is used in many applications such as wheat flour mixes, dairy products, meat products and cattle feeds (Choo et al. 2021). Tomato pomace is rich in protein, fibre, antioxidants, carotenoids, and polyphenolic compounds (Isik and Topkaya, 2016). Tomato skin had a high amount of lycopene and polyphenolic compound compared to the pulp of tomato (George et al. 2004). Demand for fibre-incorporated products increased significantly due to their health benefits. Dietary fibre had several health-promoting properties against different diseases such as cardiovascular disease, diabetes - ii, obesity, improves immune systems and laxation effects (Barber et al. 2020). Tomato pomace had a good amount of fibre and antioxidant activity, which makes it a functional ingredient for food incorporation (Mudgil and Barak, 2016).

Alqahtani et al. (2020) prepared fibre and antioxidant enriched yoghurt by fortification of tomato pomace powder (0, 0.5, 1.0,1.5 and 2.0% of milk). Study reported that TPP incorporated yoghurt had higher total phenolic content and radical scavenging activity, 6.47±0.38 mg GAE/100 g (control); 12.56±0.33 mg GAE/100 g (2% TPP) and 15.82±0.35 µ mol TE/100 g (control), 17.56±0.31 µ mol TE/100 g (2% TPP), respectively. In, addition other parameter such as acidity, colour value a* and b* significantly increased on TPP fortification. Yoghurt enriched with 1% TPP showed highest sensory scores and acceptable up to 15 days of storage (4°C). Several authors attempted to incorporated tomato pomace in various food preparation for functionality improvement such as addition of tomato pomace solids in low fat cake as fat substitute (Namir et al. 2015); Gluten-free ready-to-cook snack's enriched with tomato pomace (Rehal et al.2022), Tomato pomace incorporated cookies (Bhat and Ahsan, 2015).

Considering the several nutritional and health-promoting properties of tomato pomace, the presents study was undertaken to prepare tomato pomace powder (TPP) and analysis of nutritional and functional properties of the powder was also carried out. Optimization of the level of tomato pomace powder in *lassi* was done based on physico-chemical, antioxidant activity and sensory properties of *lassi*. Shelf-life study of developed product evaluated and compared with control product.

Material and Methods

Material

Fresh and matured tomato (*Solanum lycopersicum L.*) of *Kashi aman* variety procured from local market of Varanasi, Uttar Pradesh in morning. Fresh cow milk collected from Dairy Farm, BHU and standardized at 3.0% Fat and 8.5% SNF *and lassi* were prepared by using a mixed starter culture of *Lactococcus lactis, Lactococccus diacetylactis* and *Lactococcus cremoris* (NCDC-217) procured from National Collection of Dairy Cultures (NCDC), Karnal. Cane sugar of commercial grade was brought from the local market of Varanasi, India. All the chemicals used during study were of Analytical Grade (AR) and were procured from reputed companies.

Preparation of Tomato Pomace Powder (TPP)

Fresh and matured tomato of *kashi aman* variety were sorted and properly washed using water and subjected to tomato pulper (Bajaj Processpack Pvt. Ltd., Noida, India) where the pulp is collected in a container and on completion of pomace remains in pulper strainer were segregated and dried at 55-60°Cin air circulated tray drier (Make: Balaji Processpack Pvt. Ltd., India) for 16-18 hr and further ground at room temperature by circulating tap water around jacket of low-temperature grinder, (Make: Balaji Processpack Pvt. Ltd., India) into fine particle (passed through 40 mesh size sieve).

Optimization of the level of TPP in Functional *Lassi*

The standardized milk is heated to 85°C for 10 min and TPP added (at different levels 0%(T_0), 0.5%(T_1), 1.0%(T_2), 1.5%(T_3), 2.0%(T_4) (w/v)) and mixed properly by continuous mixing and cooled to 30-37!. Milk is inoculated @ 2% with mixed starter culture (NCDC-217) and mixed properly. Further, incubated at 37± 1°C for 12 h and stored at 5°C for further use. *Lassi* was prepared by blending Dahi (75%), Water (25%) and Sugar (12%) by using a Hand Blender (Khera Instrument Pvt. Ltd. Delhi, India) and packed in 100 ml Polypropylene plastic cups. Optimization of TPP level was done on the basis of sensory (n=10), physico-chemical and antioxidant properties (n=3) of *lassi*.

Physico-chemical analysis of TPP and Functional *Lassi*

Chemical analysis

Fat, protein, total solids, crude fibre, ash and pH of TPP and *developed lassi* was determined by AOAC (2000) methods. Estimation of acidity and whey syneresis of *lassi* was done by protocol given by IS 1166: 1986 and Parnell-clunies et al. (1986), respectively. All the analysis done in triplicate (n=3).

Anti-oxidant activity

Antioxidant activity of tomato pomace powder (TPP) and TPP added *lassi* was determined by 2, 2 diphenyl-1-picryl hydroxyl (DPPH) free radical scavenging potentiality following method of Brand-Williams's (1995) with slight modification. In brief, 80 mg/ml (w/v) solution of the sample was prepared with absolute methanol and placed in a shaker for 2 hr, further centrifuge at 6000 rpm/10 min at 27°C. Supernatant (2.5 ml) was mixed with 5 ml of 2mM DPPH in methanol solution and vortexed. The mixture was incubated for 30 min in dark conditions and absorbance of sample and blank (80% Methanol solution) was measured at 517 nm. Antioxidant activity was calculated by the following equation and results are expressed as % free radical scavenging activity.

$$\text{Free radical scavenging activity (per cent)} = \frac{\text{Blank Absorbance} - \text{Sample Absorbance}}{\text{Blank Absorbance}} \times 100$$

-equation 1

Total phenolic compound (TPC)

Total phenolic content of TPP and TPP added *lassi* was determined by method given by Zheng and Wang, (2001) using Folin-Ciocalteus reagent. 100 mg/ml (w/v) solution of sample was prepared with 70% Acetone and placed in a shaker for 2 h, further centrifuge at 6000 rpm/15 min at 27°C. 20 µl supernatant was

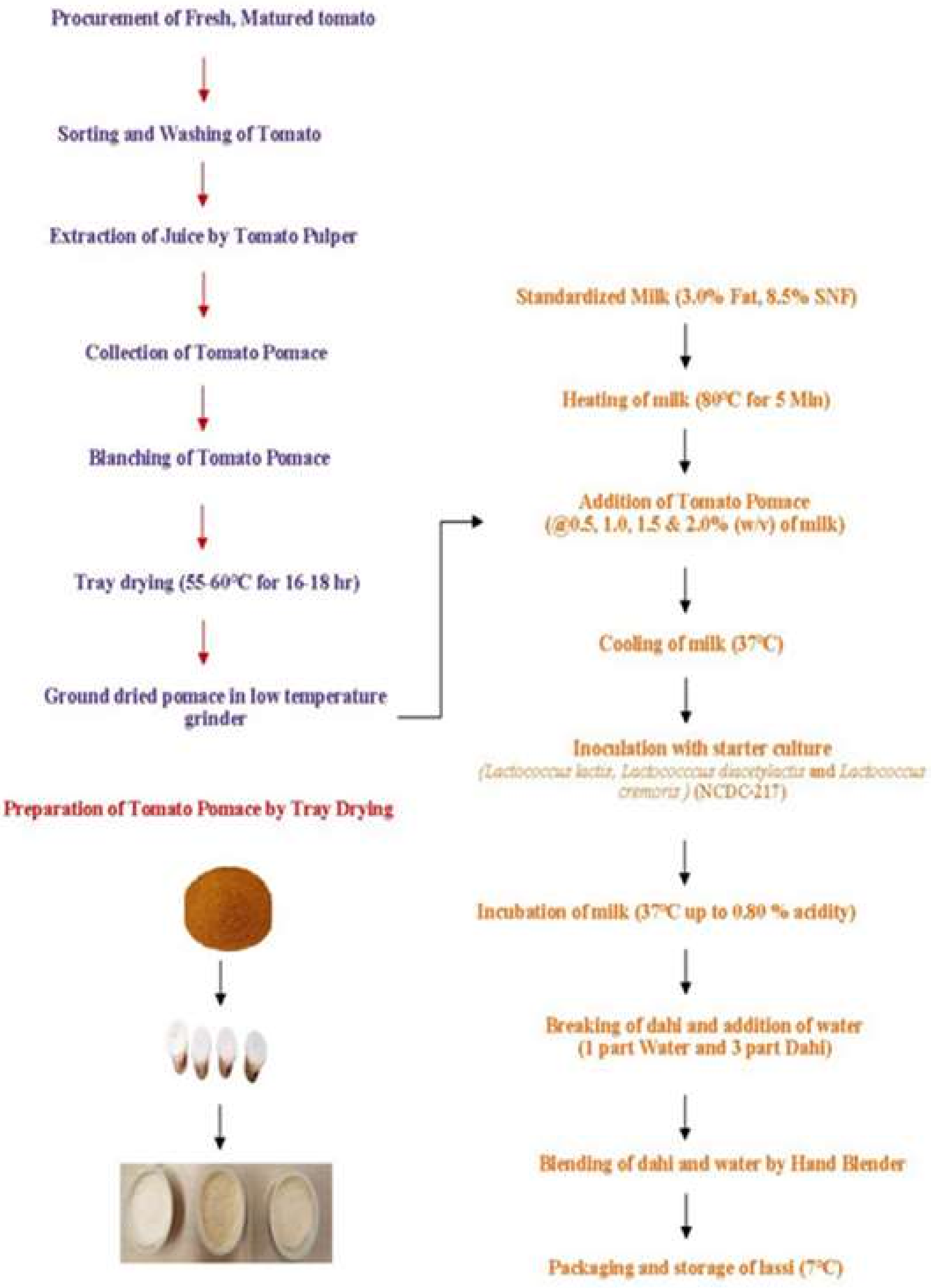

Fig. 1: Process flow diagram of Tomato Pomace incorporated *lassi*

mixed with 1.58 ml distilled water followed by addition of 100 µl Folin–Ciocalteus reagent. The mixture was vortexed vigorously and left to stand at room temperature for 15 min and 300 ìl of sodium carbonate solution (20%) was added. Further, the mixture was stored at room temperature for 2 h and absorbance was measured at 765 nm.

Microbiological analysis

The Coliform and Yeast and mold count were estimated using Violet Red Bile (VRBA) agar and Potato Dextrose (PDA) agar (added 1% Tartaric acid) at suitable dilution of sample. Colonies in the plates were counted and the count was expressed as cfu/ g (IS: 1479, 1962) after incubation at 30 ±1 and 25 ±1°C, respectively. All the analysis done in triplicate (n=3).

Sensory evaluation

TPP incorporated *lassi* were subjected to sensory evaluation by an expert and semi-trained panel of judges (Trained according to ISO: 8586-2: 2008) (n=10) for various sensory attributes, viz., flavour, color and appearance, body and texture, sweetness, and overall acceptability criteria using a 9-point hedonic scale described by Stone and Sidel, (2004). Labelled samples of freshly prepared products were given to the panel of judges.

Statistical analysis

The data relating to chemical, sensory and functional aspects of tomato pomace powder incorporated *lassi* were analysed using one-way ANOVA using SPSS 16.0 software (SPSS INC, Chicago, IL, USA) and all the tests were done in triplicate (n=3).

Results and Discussion

Chemical composition of TPP prepared by tray drying

Different chemical and functional properties analyses of TPP are shown in Table 1. The average composition of TPP was 4.59 ± 0.09% moisture, 3.19 ± 0.08% fat, 16.70 ± 0.05% protein, 57 ± 0.08% crude fibre, and 4.06 ± 0.04% ash. The prepared powder had a good amount of antioxidant compound that possess strong antioxidant activity in terms of DPPH inhibition activity and TPC with 49.80 ± 5.55 % inhibition and 311.7 ± 34.03 mg GAE/100g TPC, respectively. Similar finding was reported by Isik and Topkaya, (2016); Jafari et al. (2006) for dried tomato pomace chemical composition and antioxidant activity.

Table 1: Chemical and functional analysis of Tomato Pomace Powder prepared by Tray drying

Parameters	Percentage
Moisture (%)	4.59 ± 0.09
Fat (%)	3.20 ± 0.08
Protein (%)	16.72 ± 0.05
Crude fibre (%)	57.53 ± 0.08
Ash (%)	4.09 ± 0.04
DPPH activity (% of inhibition)	49.80 ± 5.55
Total phenolic content (mg GAE/100 g)	311.7 ± 34.03

Values reported as Mean ±SE (n=3)

Optimization of the level of tomato pomace powder in *lassi* on the basis of sensory, physico-chemical and functional attributes

Effect of tomato pomace incorporation on different physico-chemical and functional parameters of *lassi*

Functional *lassi* was prepared by incorporating tomato pomace powder at a different level in preparation of *lassi* and optimized the level of TPP based on physico-chemical analysis, antioxidant activity and sensory evaluation of prepared products. Different physico-chemical parameter used in optimization of tomato pomace level in *lassi* such as Fat (%), Protein (%), Total Solids (%), Ash (%), pH, Acidity (% lactic acid), Whey Syneresis (mL), DPPH antioxidant activity (% Inhibition), TPC (mg GAE/100g). Different physico-chemical and functional analysis values shown in Table 2.

Changes in TPP incorporated *lassi* was shown in Table 2. From the data different physico-chemical properties of *lassi* observed that fat content of TPP fortified *lassi* was non-significantly different ($p<0.05$) at a different level of addition, it is probably due to lesser amount of fat content in tomato pomace powder, Alqahtani et al. (2020) also reported non-significant ($p<0.05$) changes in fat content of stirred yoghurt fortified up to 2% level of tomato pomace.

Protein content of control and tomato pomace added *lassi* was significantly different ($p<0.05$) at different level of tomato pomace incorporation. Protein content of *lassi* was increased with TPP addition; increased level of protein content may be attributed to higher protein content in tomato pomace, Similar finding reported by Alqahtani et al. (2020). Increased protein content improved the functionality of *lassi* as in general *lassi* consider as low protein product, but little increase protein percentage ultimately improves nutrition quality. In, addition protein had water binding properties that improve consistency of *lassi* and increase acceptability of *lassi* (Schkoda et al. 2001). Desai et al. (2013) reported that high protein yoghurt had better sensory and texture attributes in terms of creaminess, viscosity and smoothness. In addition, Total solids content of tomato pomace incorporated *lassi* was significantly different ($p<0.05$) for control as well as different level of tomato pomace addition. Increased total solids in *lassi* improved consistency of *lassi* and higher thicker *lassi* more like by consumers and high solids sold at higher price in India. TPP incorporated *lassi* ash percentages was non-significantly differ ($p<0.05$) among the different rate of addition. It may be due to low ash content in tomato pomace and lesser rate of fortification in *lassi*. Results reported by Alqahtani et al. (2020) in-line with the current study.

Acidity of TPP fortified *lassi* was increased with the tomato pomace addition, it may due to organic acids present in pomace (Tikhonova et al. 2021) that contribute in acidity increase and that results in decrease of pH on addition of TPP. Whey Syneresis was decreased on addition of tomato pomace, it may due to increased protein in *lassi*, and protein and fibre helps in binding more that ultimately decreased that free water in *lassi*. Staffolo et al. (2004) reported that cultural dairy products fortified with dietary fibre had better sensory and textural properties. High concentrations of TPP incorporation visible sedimentation occur and that affect acceptability of *lassi*.

TPP added *lassi* were possess good antioxidant activity, it may attribute to antioxidant and phenolic compounds present in tomato pomace. DPPH inhibition activity were increased significantly at initial level of TPP fortification, but at higher level DPPH inhibition activity is constant, it may be due to insolubility of tomato pomace in *lassi* at higher concentration (1.5 and 2.0% TPP). Because, higher level of TPP sedimentation was occurs. Similar trend was observed for total phenolic compound (TPC). Varnaite et al. (2022); Alqahtani et al. (2020) reported similar trend of TPC and DPPH for cranberry and tomato pomace incorporated yoghurt.

Effects of tomato pomace addition on the sensory parameter of *lassi*

For, sensory analysis products were subjected to judging and grading for sensory attributes viz., (i) flavour, (ii) body and texture, (iii) sweetness, (iv) colour and appearance and (v) overall acceptability by experts and semi-trained panel (Age: 23-40 year) of judges using 9-point Hedonic scale. Scores obtained for sensory attributes of TPP incorporated *lassi* are shown in Table 3.

Overall acceptability of control and different level of tomato pomace addition varied with 8.1±0.19, 7.3±0.22, 7.5±0.18, 6.8±0.26, and 6.1±0.42 for control, 0.5, 1, 1.5 and 2.0% tomato pomace addition in *lassi*. Overall sensory score of control and different level of tomato pomace added *lassi* was significantly different ($p<0.05$). The highest acceptability was observed for the control sample, as tomato pomace addition affects flavour, colour and appearance and sweetness parameter of *lassi* extremely, while in tomato pomace added *lassi*, 1% TPP added *lassi* was having better sensory quality compared to other levels of pomace addition.

The flavour score of control and tomato pomace added *lassi* was non-significantly ($p<0.05$) differ up to 1% of pomace addition

Table 2: Physico-chemical parameters and antioxidant activity of the Tomato Pomace Powder incorporated *lassi*

Parameters	Treatment				
	TP_0	TP_1	TP_2	TP_3	TP_4
Fat (%)	2.49 ± 0.02^a	2.51 ± 0.04^a	2.53 ± 0.02^a	2.55 ± 0.01^a	2.56 ± 0.03^a
Protein (%)	2.48 ± 0.04^a	2.58 ± 0.02^b	2.67 ± 0.01^c	2.74 ± 0.04^d	2.83 ± 0.03^e
Total solid (%)	17.85 ± 0.02^a	18.32 ± 0.04^b	18.81 ± 0.01^c	19.55 ± 0.04^d	20.01 ± 0.05^e
Ash (%)	0.63 ± 0.01^a	0.64 ± 0.01^a	0.66 ± 0.03^a	0.71 ± 0.04^a	0.77 ± 0.02^a
Acidity (% lactic acid)	0.65 ± 0.09^a	0.67 ± 0.16^a	0.71 ± 0.21^a	0.75 ± 0.11^a	0.78 ± 0.18^a
pH	4.54 ± 0.18^a	4.49 ± 0.08^a	4.45 ± 0.11^a	4.40 ± 0.17^a	4.35 ± 0.25
Whey Syneresis (mL)	55.37 ± 2.85^a	52.17 ± 2.55^a	49.64 ± 1.55^a	45.97 ± 1.21^b	44.08 ± 1.89^b
DPPH (% Inhibition)	13.11 ± 2.57^a	16.65 ± 1.02^a	21.81 ± 1.89^b	27.02 ± 2.06^c	28.12 ± 3.19^c
TPC (mg GAE/ 100g)	6.16 ± 1.17^a	9.02 ± 0.94^b	12.37 ± 1.24^c	13.76 ± 1.06^c	15.08 ± 0.87^c

Values are reported as Mean ±SE (n=3), a-e different superscript differ significantly within the row ($p<0.05$)

Table 3: Sensory attributes of the Tomato Pomace Powder incorporated *lassi* evaluated using 9-point hedonic scale (1-9)

S.N.	Treatment	Flavour	Colour and Appearance	Body and Texture	Sweetness	Overall Acceptability
1	TP_0	8.0 ± 0.26^a	7.8 ± 0.18^a	7.1 ± 0.17^a	8.2 ± 0.17^a	8.1 ± 0.19^a
2	TP_1	7.9 ± 0.33^a	7.6 ± 0.22^a	7.4 ± 0.09^b	7.8 ± 0.29^b	7.3 ± 0.22^b
3	TP_2	7.8 ± 0.21^a	7.4 ± 0.38^a	7.3 ± 0.25^b	7.5 ± 0.15^b	7.5 ± 0.18^c
4	TP_3	7.1 ± 0.19^b	6.9 ± 0.14^b	6.9 ± 0.29^c	6.5 ± 0.32^c	6.8 ± 0.26^d
5	TP_4	6.5 ± 0.12^c	5.7 ± 0.24^b	5.9 ± 0.31^d	5.2 ± 0.49^d	6.1 ± 0.42^e

Values are reported as Mean ±SE (n=8), a-e different superscript differ significantly ($p<0.05$)

Table 4: Changes in physico-chemical parameters and microbial count of TPP incorporated and control *lassi* during the storage at 5°C

Parameters	Sample	0 days	3rd day	6th day	9th day	12th day
pH	Control	4.33±0.08[aa]	4.17±0.03[ba]	3.96±0.02[ca]	3.71±0.09[da]	ND
	Optimized	4.35±0.04[aa]	4.21±0.01[ba]	4.01±0.05[cb]	3.86±0.01[db]	3.51±0.03[e]
Acidity (%LA)	Control	0.74±0.0[aa]	0.79±0.02[aa]	0.86±0.03[ba]	0.93±0.04[ba]	ND
	Optimized	0.77±0.04[aa]	0.81±0.02[aa]	0.89±0.01[ba]	0.94±0.03[ca]	1.05±0.04[d]
Coliform	Control	Nil	Nil	Nil	Nil	ND
(cfu/ml)	Optimized	Nil	Nil	Nil	Nil	Nil
Yeast & Mould	Control	Nil	Nil	4	10	ND
(cfu/ml)	Optimized	Nil	Nil	NIL	11	21

Values are reported as Mean±SE, a-e and a-b different superscript used to denote differ significantly among the row and column ($p<0.05$). (*ND: Not done)

but at an increased rate of addition statistically different ($p<0.05$). Flavour score of TPP *lassi* was decreased with increasing the level of addition, it may be due to typical intense flavour of tomato pomace and the highest flavour score was obtained in the case of control sample. Similarly, Colour and appearance of *lassi* were non-significantly different ($p<0.05$) at an initial level of fortification, but at the increased level (above 1% TPP addition) of tomato pomace more darken the colour of *lassi* was observed that significantly decreased the score. Similar study of the addition of grape pomace in fermented probiotic goat milk reported that colour is intensified due to grape colour and overall acceptability is affected due to the higher flavour and intense colour of grape pomace extract (dos Santos et al. 2016). Sensory score of body and texture was significantly different ($p<0.05$) for control and tomato pomace *lassi*, which was improved on the addition of tomato pomace compared to the control sample, up to 1% pomace addition. Higher amount of fibre and protein content in tomato pomace probably improved better body and texture of *lassi*. The study of Varnaite et al. (2022) conclude that dietary fibre-rich cranberry pomace yoghurt had good water binding capacity and better rheological properties. No visible sedimentation was observed but above 1% TPP addition body and texture score reduces as sedimentation of tomato pomace observed in *lassi*, it may be due to insoluble portion of tomato pomace in milk. The sweetness score of TPP incorporated *lassi* decreased significantly with pomace fortification. Sweetness score may reduce due to the astringent compound present in tomato pomace.

The functional *lassi* with 1% of TPP had maximum overall acceptability due to the better scores in flavour, body and texture, sweetness, and, colour and appearance, which were significantly higher than any other levels of fortification. However, the TPP added *lassi* having up to 1% supplementation level with tomato pomace also exhibited average sensorial attributes, but beyond that level, the overall acceptability scores declined. Several researcher Alqahtani et al. (2020); Dabija et al. (2018); Sendra et al. (2010); Marchiani et al. (2016) attempted supplementation of plant fibre and pomace in yoghurt and similar fermented dairy products and reported that its positive or negative effects on sensory parameter of products depends on type of pomace and fibre and rate of addition.

Changes during storage in physico-chemical parameters and microbial count of TPP incorporated and control *lassi*

Control and optimized (1% of TPP) samples were packed in 100 ml Polypropylene (PP) and stored in refrigerated condition (5±1°C). Changes in different physico-chemical (pH, Acidity) and microbial (Coliform and Yeast and Mold count) parameters of control and TPP incorporated *lassi* were observed and shows in Table 4.

Control *lassi* (without tomato pomace addition) was found stable up to 9 days in refrigerated condition, while 1% tomato pomace incorporated *lassi* was found stable up to 12 days in sensory analysis. pH of control and optimized sample were decreased significantly with storage period and acidity of both the sample increased during storage, these changes attributed to production of lactic acid by growth of lactic acid bacteria and reduction of lactose in *lassi*. In, addition Du et al. (2021) reported that organic acids, polysaccharides and phenolic compounds presents in pomace served as prebiotics for LAB during yoghurt storage. Krishna et al. (2019) reported similar increased in pH and acidity of probiotic *lassi* up to 12 days storage period. Coliform count was not detected in control as well as optimized samples. Initially, yeast and mold count were absent in control and optimized sample of *lassi*. The presence of coliform count in dairy products indicates that production done under unsanitary condition and low hygiene practices followed, but absence of coliform count in present study indicate that *lassi* production done under hygienic and sanitary condition. Result reported Pawar et al. (2010) completely agreed with present study, in which coliform count absence up to 7 days of storage (at 5°C), it may be attributed to inhibition of lactic acid bacteria (LAB) (Debnath, 2017) and antimicrobial properties of LAB (Adeniyi et al. 2015). In control sample after 6 days of storage, yeast and mold observed and count increased significantly. In optimized sample yeast and mold count was observed after 9 days of storage significantly. Pawar et al. (2010)

reported similar trend of yeast and mold count for *lassi* (control) and nisin added *lassi* at 5°C storage temperature.

Conclusion

Functional ingredient in form of tomato pomace is incorporated in popular dairy beverages, *lassi*. In general, *lassi* has very low total solids by incorporation of tomato pomace several chemical constituents increased that improves consistency and acceptability of *lassi*. In, addition on tomato pomace at higher rate leads to sedimentation in *lassi* that had negative impact on acceptability. Tomato pomace added *lassi* had good amount phenolic compound and shows antioxidant activity properties. Incorporation of tomato pomace in dairy product be better alternative for tomato waste utilization and nutrition enrichment in similar products.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could be construed as a potential conflict of interest.

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Reference

Adeniyi BA, Adetoye A, Ayeni FA (2015) Antibacterial activities of lactic acid bacteria isolated from cow faeces against potential enteric pathogens. Afr Health Sci 15: 888-95

Alqahtani NK, Helal A, Alnemr TM, and Marquez O (2020) Influence of tomato pomace inclusion on the chemical, physical and microbiological properties of stirred yoghurt. Int J Dairy Sci 15: 152-160

Aneja RP, Mathur BN, Chandan RC, Banerjee AK (2002) Technology ofIndian milk products. In: Aneja RP, Mathur BN, Chandan RC,Banerjee AK (eds) Handbook on process technology modernization for professionals, entrepreneurs and scientists. Dairy India Yearbook, 230–240.

AOAC (2000) Methods of analysis, 17th editionn. Association of Official Analytical Chemists Washington, USA

Arora S, Patel AA, Sindhu R, Yadav U, Singh TP, Chaudhary G (2022) Studies on the organoleptic perception of different flavours and consumer acceptance of desiccated Chhana-murki. Indian J Dairy Sci 75: 125-132

Barber TM, Kabisch S, Pfeiffer AF, Weickert MO (2020) The health benefits of dietary fibre. Nutrients 2:3209

Betoret E, Betoret N, Vidal D, Fito P (2011) Functional foods development: Trends and technologies. Trends Food Sci & Tech, 22(9): 498-508

Bhat MA, Ahsan H (2015) Physico-chemical characteristics of cookies prepared with tomato pomace powder. J Food Process Technol 7: 543

Brand-Williams W, Cuvelier ME, Berset CLWT (1995) Use of a free radical method to evaluate antioxidant activity. LWT-Food Sci Tech 28(1):25-30.

Branthôme, F (2022) Worldwide (total fresh) tomato production exceeds 187 million tonnes in 2020, tTomato nNews https://www.tomatonews.com/en/worldwide-total-fresh-tomato-production-exceeds-187-million-tonnes-in-2020_2_1565.html. Accessed on: 26/07/22

Choo WS, Saik AYH (2021) Valorization of fruit and vegetable waste for bioactive pigments: extraction and utilization. In Valorn Agri-Food Wastes and By-Prds (pp. 61-81). Academic Press

Dabija A, Codinã GG, Gâtlan AM, Rusu L (2018) Quality assessment of yogurt enriched with different types of fibers. CYTA J Food 16:859-67

Datir RP, Menon RR, Manjunatha M, Sharma M, Tellabati R (2022) Optimization studies on mixing of curd and ingredients during *lassi* (stirred curd) manufacturing. Indian J Dairy Sci 75(2): 99-106

Debnath S (2017) Preliminary studies on the inhibition potential of Indian domestic curd against coliforms, an emerging periodontal pathogen. J Indian Soc Periodontol 21: 357–365

Desai NT, Shepard L, Drake MA (2013) Sensory properties and drivers of liking for greek yogurts. J Dairy Sci 96: 7454-7466

Dos Santos KM, de Oliveira IC, Lopes MA, Cruz APG, Buriti FC, Cabral LM (2017). Addition of grape pomace extract to probiotic fermented goat milk: the effect on phenolic content, probiotic viability and sensory acceptability. J Sci Food Agri 97(4): 1108-1115

Du H, Yang H, Wang X, Zhu F, Tang D, Cheng J, Liu X (2021) Effects of mulberry pomace on physicochemical and textural properties of stirred-type flavored yogurt. J Dairy Sci 104:12403-14

García-Burgos M, Moreno-Fernández J, Alférez MJ, Díaz-Castro J, López-Aliaga I (2020) New perspectives in fermented dairy products and their health relevance. J Funct Foods 72: 104059

George B, Kaur C, Khurdiya DS, Kapoor HC (2004) Antioxidants in tomato (*Lycopersium esculentum*) as a function of genotype. Food Chem. 84: 45-51

IS 1166: 1986 (Reaffirmed year 2018). Specifications for condensed milk, partly skimmed condensed milk (Second Revision). Bureau of Indian Standards, New Delhi

Isik F, Topkaya C (2016) Effects of tomato pomace supplementation on chemical and nutritional properties of crackers. Itali J Food Sci 28: 525

IS 1479 (Part II): (1977). Methods of test for dairy industry. Bacteriological analysis of milk. Bureau of Indian Standards, New Delhi

Jafari M, Pirmohammadi R, Bampidis V (2006) The use of dried tomato pulp in diets of laying hens. Int J Poultry Sci 5: 618-622

Krishna M, Venkateshaiah BV, Prabha R (2019) Development of long shelf life probiotic *lassi*. Asian J Dairy Food Res 38: 315-317

Kushwaha RK, Sharma NP, Baldodiya VK (2018) Profitability of tomato (Lycopersicon esculentum) production in some selected areas in Panna district of Madhya Pradesh. Int. J. Curr. Microbiol. App. Sci, 6 (Special issue): 2117-2124.

Marchiani R, Bertolino M, Belviso S, Giordano M, Ghirardello D, Torri L, Piochi M, Zeppa G (2016) Yogurt enrichment with grape pomace: Effect of grape cultivar on physicochemical, microbiological and sensory properties. J Food Qual 39:77-89

Mollet B, Rowland I (2002) Functional foods: At the frontier between food and pharma. Curr Opin Biotechnol 5(13): 483-485

Mudgil D, Barak S (2016) Development of functional buttermilk by soluble fibre fortification. Agro Food Industry Hi Technol 27: 44-47

Namir M, Suleiman AR, Hassanien MF (2015) Characterization and functionality of alcohol insoluble solids from tomato pomace as fat substitute in low fat cake. J Food Meas Charact. 9:557-63

Parnell-Clunies EM, Kakuda Y, Mullen K, Arnott DR, Deman JM (1986) Physical properties of yogurt: a comparison of vat versus continuous heating systems of milk. J Dairy Sci 69: 2593-2603

Pawar BK, Chaure RM, Choudhari DM, Kamble DK (2010) Effect of nisin on shelf life of *lassi.* J Dairy Foods Home Sci 29:79-85

Rehal JK, Aggarwal P, Dhaliwal I, Sharma M, Kaushik P (2022) A tomato pomace enriched gluten-free ready-to-cook snack's nutritional profile, quality, and shelf life evaluation. *Horticulturae* 8:403

Schkoda P, Hechler A, & Hinrichs J (2001) Influence of the protein content on structural characteristics of stirred fermented milk. Milchwissenschaft 56: 19-22

Sendra E, Kuri V, Fernández-López J, Sayas-Barbera E, Navarro C, Pérez-Alvarez JA (2010) Viscoelastic properties of orange fiber enriched yogurt as a function of fiber dose, size and thermal treatment. LWT - Food Sci Technol 43:708-714

Staffolo MD, Bertola N, Martino M (2004) Influence of dietary fiber addition on sensory and rheological properties of yogurt. Int Dairy J 14: 263-268

Stone H, Sidel JL (2004) Introduction to sensory evaluation. Sensory Evalu Practs (Third Edition). Academic Press, San Diego, 1-19

Tikhonova A, Ageeva N, Globa E (2021) Grape pomace as a promising source of biologically valuable components. In Bio Web of Conference (Vol. 34, p. 06002) EDP Sci.

Varnaitë L, Kerðienë M, Ðipailienë A, Kazernavièiûtë R, Venskutonis PR, Leskauskaitë, D (2022) Fiber-rich cranberry pomace as food ingredient with functional activity for yogurt production. Foods 11: 758

Zheng W, Wang SY (2001) Antioxidant activity and phenolic compounds in selected herbs. J Agri Food Chem 49: 5165-5170