ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

Process Technology Development for Lycopene Enriched Whey-Based Functional Beverage

Kavita A. Mane[1], Vasant N. Pawar[1*]

[1] *Department of Food Process and Product Engineering, MIT SoFT, MIT ADT University, Loni Kalbhor, Pune, INDIA.*

**Corresponding Author (Email: kavita83.more@rediffmail.com).*

Paper ID: 12A3E

Volume 12 Issue 3

Received 01 October 2020
Received in revised form 14 December 2020
Accepted 23 December 2020
Available online 04 January 2021

Keywords:
Lycopene source; Mango; Pineapple; Fruit juice quality; Sensory; Tomato; Whey; Tomato puree; Fruit juice beverages; Whey fruit juice pH; Ascorbic acid content; Titrable acidity; Total Soluble Solids (TSS); Physico-chemical properties.

Abstract

The food products contributing health welfares beyond nutritive value are getting recognition nowadays leading to exponential increases in consumption and manufacturing of functional food. The convenience-driven need base satisfaction of consumer makes the beverages the most favorable kind of functional food. Further, they are the finest transition facilitator of nutrients and bioactive compounds including lycopene. Lycopene is a potent antioxidant and its efficacy in reducing the risk of non-communicable diseases was assessed by various groups of scientists to justify relative health claims. This investigation is coiling around the development of process technology utilizing the potential of tomato lycopene as a functional ingredient to justify its suitability in food product development. Accordingly, tomato puree (potent lycopene source) as techno economically feasible ingredient of whey fruit juice beverage is collectively standardized with a specialty set of parameters like processing temperature and time against pharmaceutically accessible purified lycopene. Lycopene enriched whey fruit juice beverages were developed with different levels of tomato puree (0-20 percent) and evaluated for organoleptic and physico-chemical properties by using standard procedures. The results revealed a reducing trend in pH, ash content, and fat content of beverages whereas an increasing trend in TSS, acidity, protein content, total solids content, reducing and total sugar contents, ascorbic acid, and lycopene content of beverages with an increase in tomato puree level. The whey-based functional beverages prepared with 10 percent tomato puree emerged out as the finest treatment under investigation on the basis of organoleptic characteristics score and recorded 0.55mg per 100g bioactive lycopene as a nutraceutical.

Disciplinary: Food Science and Technology.

Cite This Article:

Mane, K. A., Pawar, V. N. (2021). Process Technology Development for Lycopene Enriched Whey-Based Functional Beverage. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 12*(3), 12A3E, 1-8. http://TUENGR.COM/V12/12A3E.pdf DOI: 10.14456/ITJEMAST.2021.47

1 Introduction

Carotenoids which are constituent parts of fruits and vegetables recorded their efficacy as a nutraceutical. Lycopene is the most efficient carotenoid antioxidant that protects the body by neutralizing the negative effects of oxidants (Malviya, 2014 and Lilwani and Nair, 2015). The antioxidant actions of lycopene are implied to maintain the strength of cell membranes to withstand against the risk of non-communicable diseases (Anon, 2017). Lycopene is a highly unsaturated hydrocarbon characterized by 11 conjugated bonds against 2 unconjugated bonds (Agarwal and Rao, 2000). Conjugated bonds of lycopene provide the antioxidant ability to molecules that specify its nature as a functional ingredient of food for human health (Malviya, 2014 and Lilwani and Nair, 2015).

Being a principal source of lycopene tomato and tomato derived food products contribute around 85% of dietary lycopene share in human (Levy and Sharoni, 2004). Lycopene from tomato products is more bio-accessible than fresh tomatoes (Shi and Maguer, 2000 and Agarwal and Rao, 2000). Heating tomatoes disrupt the cells and facilitate the lycopene release process, rendering it more readily available for absorption in the intestine (Cox, 2001).

Whey which is a potent source of lactose, proteins, minerals, and vitamins, obtained as a dairy industry by-product from paneer, cheese, chakka and chhana processing (Singh, and. Singh, 2012, Sirohi, 2002 and Darade, and Ghodake, 2012). In recent times, whey, a source of distinct bioactive compounds, is gaining attention by food industries as a value-added ingredient in developing functional foods with potential health benefits (Solak, and Akin, 2012). The key role of functional foods and beverages in the prevention and curing of diseases has been identified in recent years. Thus, this investigation is undertaken to develop lycopene enriched whey base functional beverage with process standardization and quality evaluation. The planning of clinical studies (In progress) will go a long way to compensate with lifestyle transition base specialty health claim. Health claims base outcome of the said project will lead one step ahead to monitor non-communicable disease portfolio (Diabetics, CVD, Cancer, and Obesity) through rejuvenation of human diet transition by superimposing the smart nutrition.

2 Methodology

2.1 Standardization of Lycopene Enriched Whey Beverage

The fully ripened, deep red colored tomatoes (local cultivar) were subjected to juice extraction after preliminary cleaning operations. The obtained liquefied mass was filtered through a sieve (100 mesh) which was further heat-treated at 90°C temperature for 1h in a water bath (Mane and Pawar, 2018) to obtain tomato puree. Lycopene content in tomato puree was determined by the standard extraction method (Ranganna, 2007). The whey was obtained by heating (82°C) and acidification (2% citric acid solution) of buffalo milk (Fat 6.4%) with continuous stirring. The whey was filtered through muslin cloth for the elimination of coagulated milk proteins (Sakhale et al.,

2012). The fresh, fully ripened pineapple and *Alphanso* mango fruits were subjected to juice extraction by the standard method (Lal et al., 1967 and Chavan et al., 2015).

The processed tomato puree as a potent source of lycopene was used to enrich the whey base fruit beverage and assessed for physicochemical and sensorial quality parameters. Lycopene enriched whey base fruit beverages were formulated by utilizing different proportions of whey and tomato puree as presented in Table 1. The ingredients like sugar, stabilizer (Guar gum), and citric acid were dissolved in preheated (60°C) whey (Sakhale et al., 2012). Fruit juice and tomato puree were added to whey and uniform blending was carried out for homogenized mixture. Thus prepared beverages were pasteurized at 80°C for 15min (Bhat and Singh, 2014), cooled, and kept under refrigeration (5±1°C).

2.2 Sensory Evaluation of Lycopene Enriched Whey Beverage

Organoleptic characteristics of lycopene enriched whey fruit juice beverages were assessed by sensory evaluation with a nine-point hedonic scale (Anon, 1971). The chilled beverages were analyzed by semi-trained judges to adjudge the organoleptic characteristics.

Table 1: Formulation of lycopene enriched whey fruit juice beverages

Sample	Formulation of lycopene enriched whey fruit juice beverage using pineapple fruit juice					
	Whey (%)	Pineapple juice (%)	Sugar (%)	Stabilizer (%)	Citric acid (%)	Tomato puree (%)
P_0	83.62	10	6	0.3	0.08	0
P_1	78.62	10	6	0.3	0.08	5
P_2	73.62	10	6	0.3	0.08	10
P_3	68.62	10	6	0.3	0.08	15
P_4	63.62	10	6	0.3	0.08	20
Sample	Formulation of lycopene enriched whey fruit juice beverage using mango fruit juice					
	Whey (%)	Mango juice (%)	Sugar (%)	Stabilizer (%)	Citric acid (%)	Tomato puree (%)
M_0	84.60	10	5	0.3	0.1	0
M_1	79.60	10	5	0.3	0.1	5
M_2	74.60	10	5	0.3	0.1	10
M_3	69.60	10	5	0.3	0.1	15
M_4	64.60	10	5	0.3	0.1	20

2.3 Physico-Chemical Analysis of Lycopene Enriched Whey Beverage

TSS (°B) was measured with a handheld refractometer, pH by a pH meter, acidity by titration using 0.1N NaOH, total solids content by drying the samples in a hot air oven at 105°C till constant weight is reached, ash content by muffle furnace, total sugar by anthrone method, reducing the sugar by DNS method and ascorbic acid content by titrating HPO_3 aliquot of the sample with standard dye solution (Ranganna, 2007 and Thimmaiah, 2016).

3 Result and Discussion

In this investigation, lycopene enriched whey fruit juice beverages were standardized using whey as a core base, fruit juice (pineapple and mango), and tomato puree as a potent source of lycopene. The optimized beverages were evaluated for quality (Sensory and physicochemical characteristics) to justify the overall acceptability of lycopene enriched whey-based functional beverages.

3.1 Organoleptic Properties of Lycopene Enriched Whey Beverage

The data on sensory evaluation of whey fruit juice beverages depicted in Table 2 revealed that the whey base beverages prepared with 10% tomato puree were most preferred by sensory panelists. The overall acceptability of whey fruit juice beverage prepared with 10% tomato puree was found superior (7.2) and very close to beverage free from puree (7.3) as in the case of pineapple fruit juice beverages. Whereas the overall acceptability of whey mango juice beverage was found more (7.6) in the beverage with 10% tomato puree as opposed to the beverage without tomato puree (7.4). The tomato puree concentration of 15% and above superimposed its effect as bitter taste and flavour so found less acceptable.

Moreover, the sensorial quality parameters of whey fruit juice beverage prepared by using 10% tomato puree recorded the highest relative score on the basis of visual, olfactory, and taste sensations. The tomato puree as a supplementary ingredient recorded its optimal concentration as 10% for standardizing commercially viable beverage recipes based on data on sensorial quality parameters.

Table 2: Organoleptic properties of lycopene enriched whey fruit juice beverage

Sample	Color & Appearance	Taste	Flavour	Mouthfeel	Overall Acceptability
P_0	7.3 ± 0.82^{a}	7.5 ± 0.71^{a}	7.1 ± 0.57^{bac}	7.3 ± 0.82^{ba}	7.3 ± 0.67^{bac}
P_1	7.0 ± 0.82^{ba}	7.2 ± 0.79^{ba}	7.1 ± 0.57^{bac}	7.0 ± 0.82^{ba}	7.1 ± 0.74^{bac}
P_2	7.1 ± 0.88^{a}	7.3 ± 0.67^{a}	7.2 ± 1.03^{bac}	7.1 ± 0.99^{ba}	7.2 ± 0.79^{bac}
P_3	6.7 ± 1.06^{ba}	6.6 ± 0.70^{ba}	6.3 ± 0.82^{bc}	6.7 ± 0.82^{ba}	$6.7 \pm 0.82b^{ac}$
P_4	6.5 ± 1.08^{b}	6.1 ± 0.74^{b}	6.1 ± 0.74^{c}	6.3 ± 0.95^{b}	6.3 ± 0.95^{c}
M_0	7.7 ± 0.48^{ba}	7.2 ± 0.79^{ba}	7.2 ± 0.79^{bac}	7.3 ± 0.67^{ba}	7.4 ± 0.52^{ba}
M_1	7.6 ± 0.70^{a}	7.3 ± 0.67^{a}	7.4 ± 0.70^{ba}	7.3 ± 0.82^{ba}	7.5 ± 0.71^{a}
M_2	7.6 ± 0.70^{a}	7.4 ± 0.84^{a}	7.7 ± 1.06^{a}	7.5 ± 0.85^{a}	7.6 ± 0.70^{a}
M_3	6.8 ± 1.14^{ba}	6.6 ± 0.84^{ba}	6.9 ± 1.10^{bac}	6.5 ± 0.71^{ba}	6.7 ± 0.67^{bac}
M_4	6.4 ± 0.84^{b}	6.1 ± 1.10^{b}	6.5 ± 0.97^{bac}	6.3 ± 0.67^{b}	6.4 ± 0.84^{bc}
Mean	7.07	6.93	6.95	6.93	7.02
LSD	1.2658	1.1537	1.2416	1.1896	1.0879
P	0.0044	<.0001	0.001	0.0038	0.0004
CV	12.3397	11.4736	12.3122	11.83105	10.6811

*Means with the different letters are varying significantly.

3.2 Physico-Chemical Properties of Raw Material

The data on physicochemical properties of whey as core base, pineapple, and mango fruit juices, and tomato puree as lycopene source are tabulated in Table 3 and are in close conformity with the earlier studies (Maia *et al.*, 2007, Sakhale *et al.*, 2012, Chavan *et al.*, 2015 and Madalageri *et al.*, 2017).

Table 3: Physico-chemical properties of raw material

Physicochemical parameters	Whey	Pineapple juice	Mango juice	Tomato puree
TSS (°B)	7 ± 0.00	11 ± 0.00	17 ± 0.01	7 ± 0.00
pH	5.02 ± 0.11	3.70 ± 0.16	4.72 ± 0.06	4.18 ± 0.01
Titrable acidity (%)	0.24 ± 0.01	0.56 ±0.02	0.33 ± 0.01	0.38 ± 0.01
Total solids (%)	6.71 ± 0.18	13.9 ± 0.46	17.42 ± 0.46	7.17 ± 0.03
Ash content (%)	0.72 ± 0.02	0.31 ± 0.01	0.48 ± 0.02	0.60 ± 0.02
Reducing sugar (%)	ND	5.17 ± 0.19	5.45 ± 0.04	4.88 ± 0.13
Total sugar (%)	ND	9.98 ± 0.32	17.21 ± 0.40	5.02 ± 0.06
Ascorbic acid (mg/100g)	ND	34.66 ± 0.06	54.78 ± 1.48	25.3 ± 0.46
Lycopene content (mg/100g)	ND	ND	ND	5.52 ± 0.08

3.3 Physico-Chemical Properties of Lycopene Enriched Whey Beverage

Lycopene enriched whey fruit juice beverages were prepared using different concentrations of lycopene (0, 0.27, 0.55, 0.81 and 1.1 mg/100g) (Figure 1) in the form of tomato puree (0- 20%) and analyzed for various quality parameters (pH, TSS, acidity, total solids, ash content, reducing sugar, total sugar and ascorbic acid content) as presented in Table 4.

Figure 1: The experimental lycopene enriched whey fruit juice beverages.

3.3.1 Total Soluble Solids (TSS)

The data depicted in Table IV indicated no significant difference in TSS of whey pineapple juice beverages (12.83-13.33°B) and whey mango juice beverages (13.00-13.50°B). These results are in close conformity with the earlier studies (Bangaraiah *et al.*, 2014) and revealed no observed difference in TSS with an increase in tomato puree level in beverage formulations.

3.3.2 pH

Data on pH of whey fruit juice beverages indicated no significant difference in pH of lycopene enriched whey fruit juice beverages (Table 4). It was found in the range from 4.62 to 4.75 for pineapple fruit juice beverages and 4.69 to 4.79 for mango fruit juice beverages.

3.3.3 Titrable Acidity

The acidity showed a significant increase in beverage samples with increases in tomato puree concentrations (Table 4). Whey fruit juice beverages with 20% tomato puree exhibited higher acidity values (0.33-0.36%) followed by beverages with 15% of puree (0.32-0.35%) and the lowest acidity value (0.28-0.31%) was observed with control beverages. Similar results were reported by earlier scientists (Siriki, 2004 and Bangaraiah *et al.*, 2014) and justify the positive effect of tomato puree level on the acidity of whey fruit juice beverages.

3.3.4 Total Solids Content

Data on total solids content tabulated in Table 4 indicated a significant increase in the total solids content of whey fruit juice beverages with an increase in tomato puree level. The higher (13.74-14.12%) total solid contents were found in a beverage with 20% tomato puree followed by beverage with 15% puree (13.56-13.96%) and the lowest total solids (12.86-13.08%) were observed

in the control whey-based beverages. This increasing trend in total solids contents may be the effect of more solids content in the tomato puree. The results are in close conformity with results reported by (Bhavsagar et al., 2010) and revealed a positive relationship between the total solids content and tomato puree concentration in lycopene enriched whey fruit beverages.

3.3.5 Ash Content

The ash content showed a significant decrease with an increase in tomato puree level of whey fruit juice beverage (Table 4). It was found higher (0.43-0.48%) in control beverages followed by beverages with 5% tomato puree (0.41-0.47%). The least ash content (0.34-0.39%) was found in the beverages with 20% of tomato puree. The data reported in the result conform with the results reported by earlier scientists (Bhavsagar et al., 2010).

3.3.6 Reducing and Total Sugars

Reducing sugar was found higher (4.53-4.81%) in whey fruit juice beverages with 20% tomato puree followed by beverage with 15% of puree (4.47-4.78%) and the least (4.12-4.24%) reducing sugar content was found in control whey fruit juice beverages (Table 4). There is a significant effect of tomato puree level on the reducing sugar content of the beverage. These results are analogous to the results of Siriki (2004) and Bangaraiah *et al.* (2014). There is a non-significant effect of tomato puree level on the total sugar content of the beverage. It was found more (11.23-11.51%) in a beverage with 20% tomato puree followed by beverage with 15% of puree (11.07-11.43%) and the least total sugar content (10.49-10.95%) was observed in the control beverages without tomato puree. This data results are in harmony with the results reported by earlier scientists. (Siriki, 2004 and Bangaraiah *et al.*, 2014).

Table 4: Physico-chemical properties of lycopene enriched whey fruit juice beverage

Sample	TSS (^{0}B)	pH	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Total solids (%)	Ash content (%)	Ascorbic acid (mg/100g)
P_0	12.83±0.48^{a}	4.75±0.09^{a}	0.31±0.01^{dc}	10.95±0.26^{ba}	4.24±0.13^{de}	12.86±0.17^{b}	0.43±0.01^{c}	4.11±0.09^{g}
P_1	13.00±0.37^{a}	4.73±0.03^{a}	0.32±0.00^{dc}	11.12±0.40^{ba}	4.44±0.20^{dec}	13.09±0.37^{ba}	0.41±0.00^{dc}	4.63±0.01^{f}
P_2	13.00±0.11^{a}	4.71±0.19^{a}	0.33±0.01^{bc}	11.32±0.48^{ba}	4.65±0.17^{bac}	13.36±0.39^{ba}	0.38±0.02^{de}	5.98±0.04^{e}
P_3	13.33±0.25^{a}	4.67±0.17^{a}	0.35±0.00^{ba}	11.43±0.22^{ba}	4.78±0.17^{ba}	13.56±0.54^{ba}	0.36±0.00^{fe}	7.16±0.06^{d}
P_4	13.33±0.36^{a}	4.62±0.19^{a}	0.36±0.01^{a}	11.51±0.37^{a}	4.81±0.02^{a}	13.74±0.53^{ba}	0.34±0.01^{f}	8.33±0.21^{c}
M_0	13.00±0.37^{a}	4.79±0.05^{a}	0.28±0.01^{e}	10.49±0.26^{b}	4.12±0.00^{e}	13.08±0.30^{ba}	0.48±0.02^{a}	5.85±0.24^{e}
M_1	13.17±0.53^{a}	4.76±0.06^{a}	0.30±0.00d^{e}	10.64±0.43^{ba}	4.25±0.13^{de}	13.35±0.28^{ba}	0.47±0.02^{ba}	6.74±0.03^{d}
M_2	13.33±0.48^{a}	4.75±0.03^{a}	0.31±0.01^{dc}	10.86±0.42^{ba}	4.32±0.02^{dec}	13.63±0.54^{ba}	0.44±0.01^{bc}	8.16±0.07^{c}
M_3	13.33±0.07^{a}	4.73±0.13^{a}	0.32±0.00d^{c}	11.07±0.26^{ba}	4.47±0.04^{dc}	13.96±0.15^{a}	0.41±0.02^{dc}	9.27±0.20^{b}
M_4	13.50±0.04^{a}	4.69±0.01^{a}	0.33±0.01^{bc}	11.23±0.17^{ba}	4.53±0.01^{dac}	14.12±0.29^{a}	0.39±0.01^{de}	10.59±0.26^{a}
Mean	13.18	4.72	0.02	11.06	0.34	13.48	0.41	7.08
LSD	0.9743	0.3366	0.0211	0.9896	0.3353	0.6582	0.0358	0.4339
P	0.3439	0.8237	<.0001	0.0254	<.0001	0.0114	<.0001	<.0001
CV	2.5565	2.4663	2.2727	3.094	2.5995	2.8274	3.0128	2.1186

*Means with the different letters are varying significantly.

3.3.7 Ascorbic Acid Content

Ascorbic acid content was found higher (8.33-10.59mg/100g) in beverages with 20% tomato puree followed by beverage with 15% of puree (7.16-9.27mg/100g). The least ascorbic acid content (4.11-5.85mg/100g) was found in the control beverages (Table 4). Earlier scientists recorded higher

values of ascorbic acid content in their study on whey base tomato RTS beverage but noted the same increasing trend with increases in tomato juice content (Siriki, 2004).

4 Conclusion

The prospect of lycopene, a bioactive compound in tomato puree matrix was assessed with process technology development to justify its suitability as a functional ingredient in whey beverage formulation. This indicated that the tomato puree which is a potent source of lycopene can be utilized conveniently in preparation of techno-economic whey beverage that can be beneficial for risk against non-communicable diseases. The lycopene-enriched whey beverage processing technology that emerged out from this investigation needs to be supported by clinical studies to justify its status as a functional beverage.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

6 References

A.O.A.C. (2007). Official Methods of Analysis. 18th Ed., Association of Official Analytical Chemists. Washington DC, USA.

Agarwal, S. and A. V. Rao. (2000). Tomato Lycopene and Its Role in Human Health and Chronic Diseases. *Can. Med Asso J, 163*(6), 739–744.

Anon. (1971). *Sensory Evaluation*. IS6373-1971. Indian Standard Institution.

Anon. (2017). *Health Benefits of Lycopene*. Retrieved from https://www.fitday.com

Bangaraiah, P., A. P., Kumar, V. Madhusudan Rao, and V. P. Kumar. (2014). Formulation of Whey Tomato Based Ready To Serve Fruit Beverage. *Res J Pharma BioChem Sci*, 5(6), 162-173.

Bhat, F. M. and R. Singh. (2014). Preparation and Quality Evaluation and Shelf Life Studies of Whey-Guava Beverage. *World J Agri. Sci.*, 10(3), 141-145.

Bhavsagar, M. S., H. B. Awaz, and U. L. Patange. (2010). Manufacture of Pineapple Flavoured Beverage from Chhana Whey. *J Dairying, Foods & H. S.*, 29(2), 110-113.

Chavan, R. S., T. Nalawade, and A. Kumar. (2015). Studies on the Development of Whey Based Mango Beverage. *J Food and Dairy Technol*., 3(2).

Cox, S. E. (2001). *Lycopene Analysis and Horticultural Attributes of Tomatoes*. Master of Science Thesis, Colorado State University Fort Collins, Colorado Spring, 31p.

Darade, R. V. and S. S. Ghodake. (2012). An Overview of Whey Beverages. *Res J Animal Hus & Dairy Sci*, 3(1), 41-44.

Kulkarni, N., P. Pawar, R. Pachori, and P. Sadar. (2017). Studies on the Development of Fermented Whey Beverage. *Int J Inno Res Adv Stud*, 4(8).

Lal, G., G. S. Siddappa and G. L Tandon. (1967). *Preservation of fruits and vegetables*. Indian council of agriculture research (ICAR), New Delhi. pp. 294 -297.

Levy, J, and Y. Sharoni. (2004). The Functions of Tomato Lycopene and Its Role in Human Health. *J Am. Bot.* Council, 62, 49-56.

Lilwani, S., and V. Nair. (2015). Extraction and Isolation of Lycopene form Various Natural Sources. *IOSR J Biotech and Biochem*, 1(5), 49-51

Madalageri, D. M., P. Bharati, and U. Kage. (2017). Physicochemical Properties, Nutritional and Antinutritional Composition of Pulp and Peel of Three Mango Varieties. *Int J Edu. Sci. Res*, 7(3), 2249-6947.

Malviya, N. (2014). Isolation and Quantification of Lycopene from Watermelon, Tomato and Papaya. *Res J Recent Sci*, 3, 68-70

Mane, K. A., and V. N. Pawar. (2018). Study on effect of processing parameters on lycopene content of tomato puree. *Int J Res Anal. Rev.*, 5(3), 512-517.

Ranganna, S. (2007). Handbook of Analysis and Quality Control for Fruits and Vegetables Products. Tata McGraw Hill Publication, 1-45.

Sakhale, B. K., V. N. Pawar and R.C. Ranveer. (2012). Studies on the Development and Storage of Whey based RTS Beverage from Mango cv. Kesar. *J Food Process Technol*. 3:3

Shi, J, and M. L. Maguer. (2000). Lycopene in Tomatoes: Chemical and Physical Properties affected by Food Processing. *Critical reviews in food science and nutrition*, *40*(1), 1-42.

Singh, A.K., and K. Singh. (2012). Utilization of Whey for the Production of Instant Energy Beverage by Using Response Surface Methodology. *Advan J Food Sci and Technol*, 4(2), 103-111.

Singh, D., R. Singh, and F. Bhatt. (2014). Development, Quality Evaluation and Shelf Life Studies of Whey Guava Beverage. *Int J Cur Engg Technol*, 4(3).

Siriki, H. B. (2004). *Formulation of Whey Based Ready-To-Serve fruit Beverages*. M. Sc. (FST). Thesis, Acharya N. G. Ranga Agril. University, Rajendranagar.

Sirohi, D. (2002).*Technological Studies on Production of Whey Based Mango-Herbal Beverages*. M.Tech. Thesis, Dept. of Agril. Processing and Food Engg. Faculty of Agril. Engg., Indira Gandhi Agricultural University Raipur (C.G.).

Solak, B. B., and N. Akin. (2012). Health Benefits of Whey Protein: A Review. *J Food Sci. Engg.*, 2, 129-137.

Tandon. M. (2012). *Evaluation of Physico-chemical and Sensory Characteristics of Whey Based Pineapple Beverage Using Stevia (Stevia Rebaudiana) as a Sugar Substitute*. M.Sc. (Dairy Chemistry) Thesis, College of Dairy Science & Food Technology, Durg.

Thimmaiah, S. K. (2016). *Standard Methods of Biochemical Analysis*. Kalyani Publishers, 53-62.

Kavita A. Mane is an Associate Professor at the Department of Food Process and Product Engineering, MIT Art, Design and Technology University. She is a member of AFST(I), ISAE, NSI, ISHRAE, PFNDAI and AIASA. She has bestowed with the AIFPA Research Innovation award in 2019 and the Best Teacher award in 2017. She is the recipient of the first prize for paper presentation at the 23rd National Convention of Agricultural Engineer.

Dr. Vasant N. Pawar is Dean and Principal (MITSoFT) at MIT Art, Design and Technology University, Pune under private education domain. His research interests are Food Science and TechnologyNutraciticals (Functional Foods).