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Chemical and microbioligical qualities of basundi blended with sweet potato (*Ipomoea batatas* L.)

PC Deshmukh, BD Patil and VB Jaybhay

Abstract
The basundi blended with sweet Potato (*Ipomoea batatas*) pulp was prepared and subjected to chemical and microbiological evaluation. The levels of sweet potato 8, 10 and 12 percent sweet potato pulp and 5 and 6 percent of sugar were selected for experimental study. The mean chemical composition of fresh basundi samples prepared under different treatment combinations ranged from 9.38 to 11.54% fat, 7.35 to 9.10% protein, 26.01 to 34.68% total sugar, 1.47 to 1.62% ash, total solid 48.24 to 52.88% total solid, and 47.12 to 51.76% moisture content, respectively. The mean SPC counts ranges from 3.00 cfu x 10^3(T^0) to 15.33 x 10^3 (T^6) per gm. There was no growth of Yeast and moulds counts (YMC) and coliform counts observed in the basundi. The data generated during the course of this investigation was tabulated and analyzed using Completely Randomized Design (CRD) for treatment combination. However, effect of sweet potato and sugar levels and their interaction effect were analysed by Factorial Completely Design (FCRD) with three replications.

Keywords: Basundi, sweet potato, chemical evaluation, microbiological evaluation

Introduction
Milk is a rich source of all vital nutrients in the appropriate proportions for human growth and development. The traditional milk products are being made in India since time immemorial. These products have religious, social, cultural, nutritional, medicinal and economical importance. Various indigenious milk products are dahi, paneer, chakka, shrikand, khoa, rabri, basundi and various traditional sweets. *Basundi* is primarily a heat-dessicated indigenous product found in western India, primarily in Maharashtra and Gujarat. Basundi, like rabri, khoa, mithai, and kheer, belongs to the condensed milk category and can be compared to sweetened condensed whole milk. (Raghavan, 1960) [22]. *Basundi* is an important indigenous whole milk product prepared by partial dehydration of the milk with sugar. The dehydration of milk is karahi on direct fire. The original volume of milk is reduced to about 40 to 50 percent. The value of the product depends upon a relative creamy consistency, white to light brown colour, sweetish caramel aroma and soft textured flakes uniformly distributed throughout the product.
Sweet potato is a high-nutritive food that is under utilized for a variety of reasons. Carbohydrates, Beta carotene, and fibre are all abundant in sweet potatoes. Many Asian and African countries regard it to be a staple and co-staple meal (Woolfe, 1992) [26]. Sweet potatoes have a lot of starch as a storage component. It is a good source of energy for humans due to its high starch content. Because of the nutritive value of sweet potato they were selected as one of the food for long term space travel (Wilson *et al*., 1998) [25]. Sweet potatoes are recognized as an anti-diabetic food because they may assist in the stabilisation of blood sugar levels and the reduction of insulin resistance (Kusuano and Abe, 2000) [14].
Hence, considering the medicinal and nutritional value of sweet potato, it is planned to undertake the research work on preparation of *basundi* blended with sweet potato (*Ipomoea batatas*).

Materials and Methods
Materials
Cow milk was obtained from the RCDP (Research Cum Development Programme) on Cattle at Mahatma Phule Krishi Vidhyapeth, Rahuri central campus for preparation of *basundi* samples. Sweet potatoes were freshly purchased from the local market, Good quality sugar was procured from local market.
The *basundi* samples were prepared in iron *karahi* with 30 cm diameter and 8.5 cm depth and the stainless steel ladle was used for stirring and scraping, The Electronic precision balance was

used for weighing samples and instruments such as Incubator, Autoclave, Muffle furnace, Hot air oven, Laminar air flow, Colony counter were used during research work.

Methodology

The *Basundi* will be prepared by method suggested by Mukhekar, (2015) [15] with slight modifications.

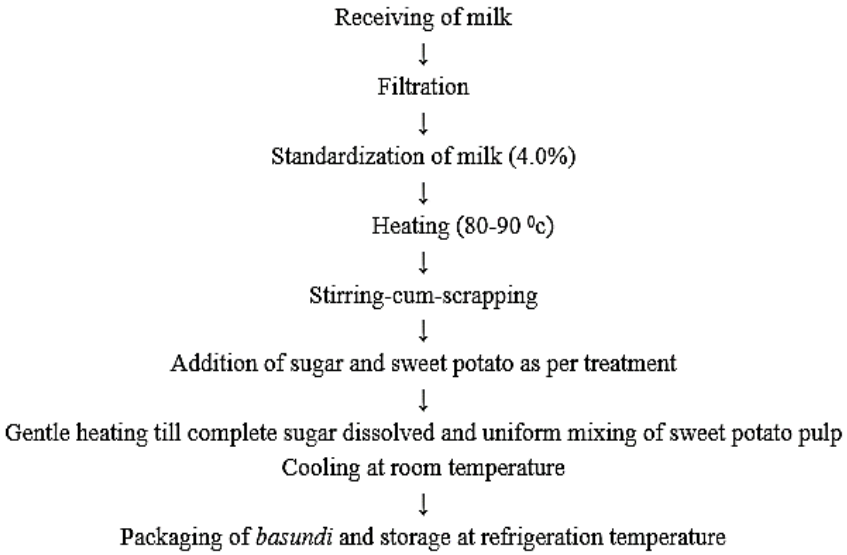

Fig 1: Flow diagram for preparation of *basundi* with sweet potato.

Treatment combination for experimental trials

The experiment was laid down with 7 treatment combinations and 3 replications. The entire data of the experiment has been properly tabulated, analyzed and interpreted.

$T_{0\ (Control)}$	*Basundi* + 5% Sugar + 0% sweet potato
$T_{1\ (P1\ S1)}$	*Basundi* + 5% Sugar + 8% sweet potato
$T_{2\ (P1\ S2)}$	*Basundi* + 6% Sugar + 8% sweet potato
$T_{3\ (P2\ S1)}$	*Basundi* + 5% Sugar + 10% sweet potato
$T_{4\ (P2\ S2)}$	*Basundi* + 6% Sugar + 10% sweet potato
$T_{5\ (P3\ S1)}$	*Basundi* + 5% Sugar + 12% sweet potato
$T_{6\ (P3\ S2)}$	*Basundi* + 6% Sugar + 12% sweet potato

Chemical analysis of basundi samples

Fat content of milk was estimated on the basis of Gerber Method as prescribed in IS: 1224 (Part I) (1977) [11]. Protein content of milk was determined by the Microkjeldhal method as described in IS: 1479 (Part-II) (1961) [12]. Total sugar content of *basundi* was determined by the volumetric (lane-Eynon) method as a described in IS: SP: 18 (Part XI) (1981) [10]. The total ash content of milk sample was determined by method given in IS: 1479 (Part-II) (1961) [12]. Total solids content of milk was estimated on the basis of Gravimetric Method as prescribed in IS-1479 (Part-II) (1961) [12]. The moisture content of *basundi* sample was determined by procedure prescribed in IS: 1708 (Part-I) (1986) [13].

Microbial analysis of basundi samples

1) Standard plate counts
2) Yeast and Mould counts
3) Coliform counts

Statistical design

The data generated during the course of this investigation was tabulated and analysed using Completely Randomized Design (CRD) to compare control with other treatments. However, effect of sweet potato pastes and sugar levels and their interaction effect was analysed by Factorial Completely Randomized Design (FCRD) with three replications (Snedecor and Corchan, 1994) [24].

Results and Discussion

Chemical quality/evaluation of basundi

Chemical quality of *basundi* samples of different treatment combinations are depicted in Table 1.

Table 1: Effect of treatment combinations on chemical quality of basundi samples.

Treatment	Fat	Protein	Total sugar	Ash	Total solids	Moisture content
T_0 (control)	11.54^a	9.10^a	26.01^d	1.62	48.24^d	51.76^a
T_1 (P_1S_1)	10.96^b	8.37^b	30.00^c	1.54	50.87^c	49.13^b
T_2 (P_1S_2)	10.70^b	8.10^b	30.56^c	1.53	50.89^c	49.11^b
T_3 (P_2S_1)	10.15^c	7.78^c	32.41^b	1.51	51.85^b	48.15^c
T_4 (P_2S_2)	9.89^c	7.75^c	32.80^b	1.50	51.94^b	48.06^c
T_5 (P_3S_1)	9.40^d	7.43^d	34.51^a	1.48	52.82^a	47.18^d
T_6 (P_3S_2)	9.38^d	7.35^d	34.68^a	1.47	52.88^a	47.12^d
S.E.±	0.09	0.10	0.24	0.07	0.12	0.02
CD at 5%	0.28	0.30	0.73	NS	0.36	0.08

Fat

It was observed that the mean fat content in *basundi* blended with sweet potato pulp was 11.54, 10.96, 10.17, 10.15, 9.89, 9.40 and 9.38 percent for treatment T_0, T_1, T_2, T_3, T_4, T_5 and T_6, respectively. However, treatments T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. The fat content of *basundi* was significantly ($P<0.05$) influenced by the addition of sweet potato. As the pulp level increases the fat content of *basundi* samples decreases. This might be due to low fat content in sweet potato. The results are comparable with the findings of

Patel (1999) [17], who developed procedure for making *basundi* on commercial scale. He reported the fat content of *basundi* 11.61 percent. Patel and Upadhyay (2001) [18] studied the physico chemical composition of *basundi* and reported the fat content 11.52 percent. Sharma (2006) [23] cited Indian Standard Specifications (IS 1966, 1973) for condensed milk, stating that the fat percentage in *basundi* could not be less than 9 percent.

Table 2: Effect of levels of sweet potato, sugar and their interactions on fat content of basundi samples.

Treatments	P_1	P_2	P_3	Fat (%)
S_1	10.96	10.15	9.40	10.17
S_2	10.70	9.89	9.38	9.99
	10.83	10.02	9.39	10.08
	P	S	P x S	
SE	0.07	0.05	0.10	
CD at 5%	0.22	NS	NS	

From the Table 2, it is seen that, sweet potato levels had significant (P<0.05) effect on the fat content of *basundi* samples. The pulp level P_1 (8% sweet potato) showed significantly higher fat percent (10.83) than P_2 (10.02) and P_3 (9.39). Sugar levels had non-significant effect on fat content of *basundi* samples. The interaction effect of sweet potato pulp level and sugar levels was non-significant on fat content of *basundi* samples. The findings are comparable with Bhutkar *et al*. (2015) [2] and Gaikwad *et al*. (2016) [9], who found that adding bottle gourd pulp to cow milk *basundi* and date fruit smash to fibre fortified *basundi*, reduced fat content in treated products. Naik *et al.* (2015) [16] reported that the fat content decreased in *basundi* as the level of jackfruit pulp increase due to very low fat.

Protein

From Table 1, it was observed that the protein content of the product ranged from 9.10 to 7.35 percent for treatment T_0, T_1, T_2, T_3, T_4, T_5 and T_6. However, treatments T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. The differences were statistically significant (P<0.05) among the various treatments. It was observed that as the level of sweet potato pulp increases the protein content of the product decreases. This might be due to low protein content in sweet potato. The average protein content values found in this study are similar to those published by Patel (1999) [17], Patel and Upadhyay (2001) [18], Pathode (2003) [21], Chougule (2012) [3]. Naik (2015) [16] recorded the protein content in *basundi* blended with jackfruit pulp 7.35 to 8.48 percent. Gaikwad *et al*. (2016) [9] also recorded the protein content in *basundi* using date fruit 8.76 to 9.54 percent.

Table 3: Effect of levels of sweet potato, sugar and their interactions on protein content of basundi samples.

Treatments	P_1	P_2	P_3	Protein
S_1	8.37	7.78	7.43	7.86
S_2	8.10	7.75	7.35	7.73
	8.24	7.77	7.39	7.80
	P	S	P x S	
SE	0.07	0.06	0.10	
CD at 5%	0.23	NS	NS	

From Table 3, it is seen that, sweet potato levels had significant (P<0.05) effect on protein content of *basundi* samples. The pulp level P_1 (8% sweet potato) showed significantly higher protein content (8.24%) than P_2 (7.77%) and P_3 (7.39%). Sugar levels had non-significant effect on protein content of *basundi* samples. The interaction effect was also non-significant on protein content of *basundi* samples.

The findings of the study are comparable with Patel and Upadhyay (2001) [18], Patel and Upadhyay (2003b) [20], Dubal (2009) [6], Mukhekar (2015) [15] and Yadav (2015) [27].

Total sugar

From Table 1, it was revealed that, all treatment combinations had significant (P<0.05) effect on the total sugar content of *basundi* samples. Total sugar content of *basundi* samples ranged from 26.01 to 34.68 percent. However, treatments T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. Total sugar content increased with increasing level of sweet potato pulp, it might be due to sugar content in the sweet potato. The results of this study are consistent with the values given by Aneja *et al*. (2002) [1] who reported 24.26% total sugar content of laboratory made *basundi* samples. The findings correspond with Patel and Upadhyay (2001) [18], who observed total sugar levels in market samples ranging from 21.9 to 27.76 percent.

Table 4: Effect of levels of sweet potato, sugar and their interactions on total sugar content of basundi samples.

Treatments	P_1	P_2	P_3	Total sugar (%)
S_1	30.00	32.41	34.51	32.31
S_2	30.56	32.80	34.68	32.68
	30.12	32.61	34.59	32.49
	P	S	P x S	
SE	0.18	0.15	0.26	
CD at 5%	0.56	NS	NS	

From Table 4, it was seen that, sweet potato had significant (P<0.05) effect on total sugar content of *basundi* samples. The pulp level P_3 (12 percent sweet potato) showed significantly higher total sugar (34.59) than P_2 (32.61) and P_1 (30.12). Sugar levels had non-significant effect on total sugar of *basundi* samples. The interaction effect of sweet potato and sugar levels was non-significant.

The results are in accordance with the reports of Aneja *et al*. (2002) [1], Pathode (2003) [21], Patel and Upadhyay (2003b) [20]), Gaikwad and Hembade (2011) [6], Gaikwad *et al.* (2016) [9]

Ash

It was revealed that, all treatments had non-significant effect on ash content of fresh *basundi* samples. Ash content of fresh *basundi* samples were ranged from 1.47 to 1.62 percent. Treatment T_0 (control) had higher ash percent and ash content slightly decreased as pulp level increased. This might be due to higher blending of sweet potato pulp level which contains less amount of ash i.e. 0.66 percent and also low amount of ash in milk. Patel (1999) [17] reported the ash content of *basundi* as 1.72 percent. Patel and Upadhyay (2001) [18] reported the physico chemical composition of *basundi* and reported the ash content as 1.33 percent. Dubal (2009) [5] reported that the average ash content of *basundi* at 5, 10, 15, 20 percent added pulp was 1.58, 1.50, 1.39 and 1.27 percent, respectively.

Table 5: Effect of levels of sweet potato, sugar and their interactions on ash content of basundi samples.

Treatments	P_1	P_2	P_3	Ash (%)
S_1	1.54	1.51	1.48	1.51
S_2	1.53	1.50	1.47	1.50
	1.54	1.51	1.48	1.51
	P	S	P x S	
SE	0.05	0.04	0.07	
CD at 5%	NS	NS	NS	

From the Table 5, It was seen that, sweet potato pulp levels, sugar levels and their interactions had non-significant (P>0.05) effect on ash content of fresh *basundi* samples. The results are in agreement with the values reported by Aneja *et al*. (2002) [1]. They stated that average ash content of market samples of *basundi* ranged from 1.3 to 1.5 percent. Patel and Upadhyay (2003a) [19] found that *basundi* with addition of sugar 5, 6 and 7% had 1.26, 1.39, and 1.38 percent ash, respectively. Gaikwad *et al*. (2016) [9] reported the non-significant differences on ash content of *basundi* samples.

Total solid

The influence of addition of sweet potato pulp in the *basundi* samples was significant (*P*<0.05). The mean values of total solids in different samples ranged from 48.24 (control) to 52.88 (T_6) % (Table 1). However, treatments T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. As the sweet potato level increased the total solids content of *basundi* samples also increased. It might be due to high total solids present in sweet potato than the milk. Patel (1999) [17] reported that *basundi* has a total solids content of 47.35 percent. Patel and Upadhyay (2001) [18] examined the physico-chemical composition of *basundi* and found that the total solid content was 46.62 percent. Dubal (2009) [5] reported that the average total solids percentage of *basundi* 5, 10, 15 and 20% levels of mango pulp ranged from 42.91 to 47.65%. Naik (2015) [16] analyzed that the overall total solid content of *basundi* combined with jackfruit pulp was 46 to 48.23%.

Table 6: Effect of levels of sweet potato, sugar and their interactions on total solid content of basundi samples.

Treatments	P_1	P_2	P_3	Total solid (%)
S_1	50.87	51.88	52.82	51.86
S_2	50.89	51.94	52.88	51.90
	50.88	51.91	52.85	51.88
	P	S	P x S	
SE	0.09	0.07	0.13	
CD at 5%	0.28	NS	NS	

From Table 6, it was seen that, sweet potato levels had significant (*P*<0.05) effect on total solids content of *basundi* samples. The pulp level P_3 (12% sweet potato) had significantly higher total solids (52.85%) than P_2 (51.91%) and P_1 (50.88%). The interaction effect of pulp and sugar levels was non-significant on total solid content of *basundi* samples. The results are comparable with Gaikwad *et al*. (2016) [9] who reported significant differences in *basundi* due to addition of date fruit. The findings are also in agreement with the results observed by Patel (1999) [17], Patel and Upadhyay (2001) [18], Patel and Upadhyay (2003b) [20].

Moisture content

It was revealed that, the moisture content of *basundi* samples significantly (*P*<0.05) influenced due to different treatment combinations. The moisture content under different treatments ranged from 47.12 to 51.76 percent. However, treatments T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. Moisture percent decreased with increasing levels of sweet potato, it might be due to high total solid content in sweet potato.

The above findings are similar to those of Gaikwad and Hembade (2011b) [7], who found that *Ujani basundi* had a moisture content of 38.06 percent. Gaikwad and Hembade (2012) [8] also reported the moisture content of *Ujani basundi* was 54.60 percent.

Table 7: Effect of levels of sweet potato, sugar and their interactions on moisture content of basundi samples.

Treatments	P_1	P_2	P_3	Moisture content
S_1	49.13	48.12	47.18	48.14
S_2	49.11	48.06	47.12	48.10
	49.12	48.09	47.15	48.12
	P	S	P × S	
SE	0.02	0.01	0.02	
CD at 5%	0.06	NS	NS	

From the Table 7, it was seen that, sweet potato levels had significant (*P*<0.05) effect on moisture content of *basundi* samples. The pulp level P_1 (8% sweet potato) had significantly higher moisture content (49.12) than P_2 (48.09) and P_3 (47.15). Sugar levels had non-significant effect on moisture content of *basundi* samples. The interaction effect of sweet potato pulp and sugar was non-significant on moisture content of *basundi* samples. The results are in agreement with the findings of Dhumal *et al.* (2016) [4] who reported decreased in moisture content of *basundi*.

Microbiological quality of fresh *Basundi* samples

The samples of fresh sweet potato *basundi* were subjected to microbiological analysis *viz.*, Standard Plate Counts (SPC), Yeast and Mould counts (YMC) and Coliform counts.

Standard plate count

Table 8: Effect of treatment combinations on SPC count of basundi samples.

Treatments	Standard plate count (cfu × 10^3 per gm)
T_0	3.03^d
T_1 (P_1S_1)	5.30^c
T_2 (P_1S_2)	7.33^c
T_3 (P_2S_1)	12.33^b
T_4 (P_2S_2)	12.50^b
T_5 (P_3S_1)	14.67^a
T_6 (P_3S_2)	15.33^a
SE (+)	0.69
CD at 5%	2.10

From the Table 8, it was revealed that the SPC counts of *basundi* showed significant (*P*<0.05) difference among all treatments. The SPC counts ranged from 3.03 to 15.33 cfu x 10^3 per gm. However, treatment T_1 and T_2, T_3 and T_4, T_5 and T_6 were at par with each other. It was revealed that there was a significant increase in SPC of the sample as influenced by addition of sweet potato in the *basundi* samples. The SPC of the control sample (T_0) were significantly lower than the counts observed in the rest of the experimental *basundi* samples. This might be attributed due to the addition of sweet potato as it contains more amount of starch and carbohydrates and as carbohydrates supports bacterial growth. Gaikwad and Hembade (2011b) [7] assessed the microbiological quality of *Ujani basundi* produced by traditional manufacturers in Ujani and neighboring communities. The SPC counted between 16,800 and 2,60,000 people. Gaikwad *et al.* (2016) [9] reported that the SPC count of date fruit crush *basundi* with treatment

T_0, T_1, T_2, T_3, T_4, and T_5 were 6.5 x 10^3, 9 x 10^3, 12 x 10^3, 15 x 10^3, 19 x 10^3 and 23 x 10^3 cfu per gram, respectively.

Table 9: Effect of levels of sweet potato, sugar and their interactions on SPC counts of basundi samples.

Treatments	P_1	P_2	P_3	SPC
S_1	5.30	12.33	14.67	10.77
S_2	7.33	12.50	15.33	11.72
	6.32	12.42	15.00	11.24
	P	S	P x S	
SE	0.53	0.43	0.75	
CD at 5%	1.63	NS	NS	

From Table 9, it was seen that, sweet potato pulp levels had significant (P<0.05) effect on SPC counts of fresh *basundi* samples. The pulp level P_3 (12% sweet potato) showed significantly higher counts (15.00 cfu x 10^3 per gm) than P_2 (12.42 cfu x 10^3 per gm) and P_1 (5.83 cfu x 10^3 per gm). Sugar levels had non-significant effect on SPC counts of fresh *basundi* samples. The interaction effect was non-significant. The results are comparable with Gaikwad *et al.* (2016) [10] who reported significant differences in *basundi* samples due to the addition of date fruit crush. The results are also comparable with Gaikwad and Hembade (2011b) [7].

Yeast and Mould count (YMC)

It was observed that all the *basundi* samples under study did not show any presence of yeast and mould.

Coliform count

It was observed that all the *basundi* samples under study did not show any presence of coliform growth.

Conclusion

Sweet potato levels 8, 10 and 12 percent and sugar levels 5 and 6 percent were optimized for preparation of *basundi*. The better acceptable sweet potato *basundi* could be prepared by 10 percent pulp and 5 percent sugar.

The sensorially best sweet potato *basundi* had the chemical composition 10.15 percent fat, 7.78 percent protein, 32.41 percent total sugar, 1.51 percent ash, 51.85 percent total solid and 48.15 percent moisture content. The SPC count of the best treatment combination T3 (P_2S_1) was 12.33 x 10^3 cfu/g. Yeast and mould count and coliform count of fresh *basundi* samples were nil for all treatments.

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