Indian J Dairy Sci 77(6): 547-553
https://doi.org/10.33785/IJDS.2024.v77i06.009

RESEARCH ARTICLE

Growth performance and economics of feeding Soymilk in Murrah buffalo calves

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Received: 06 April 2023 / Accepted: 21 August 2023 / Published online: 23 December 2024

Abstract: This research was designed to evaluate the effect of Soymilk on growth and economics of feeding in Murrah buffalo calves. Total 15 buffalo calves were randomly divided into three treatment groups. Whole milk/dam's milk fed experimental calves were taken in control group. The experimental groups consist of Whole milk and Soymilk in 75:25 and 50:50 ratio. Standard feeding and management practices were followed throughout the experimental period. To assess the efficacy of Soymilk feeding on the growth performance, body weight and body measurements (body height, heart girth, abdominal girth and body length) were recorded at the start of the experiment and thereafter at fortnightly interval. The results of the study indicated that body weight parameters (average body weight, body weight gain, cumulative body weight gain and average daily body weight gain) and body measurements parameters (body height, cumulative body height gain, heart girth, cumulative heart girth gain, abdominal girth and cumulative body length gain) did not differ significantly among the control group and Soymilk fed treatment groups. The economics of feeding calculated at the end of experiment revealed that net profit in total feeding cost/kg weight gain was Rs. 106.92 and 130.35 for 25 percent and 50 percent Soymilk replacement group, respectively. It can be concluded that Soymilk has similar effect on growth performance of calves as whole milk and more economical than whole milk feeding, therefore Soymilk may possibly replace whole milk up to 50 percent level.

Keywords: body measurements, growth performance, economics, Soymilk, whole milk.

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Introduction

The largest contributor to the country's agriculture Gross Domestic Product (GDP) is dairy industry (Singh, 2015). Calves are the herd's future and the economical upbringing of calves is essential to the dairy industry's success (Sorathiya et al. 2019). Feeding and management of calves during the early stages of life have a significant impact on their future output. The first three to four month of a calf's life is the most crucial period and adequate balanced feeding is required for optimum growth during this phase. Feeding of milk to calves is crucial because it provides the necessary nutrients for tissue development (Kertz et al. 2017).

It is expensive to provide whole milk to calves for Indian farmers and feel burden to do so because they must sell their milk to people for a living (Shakya et al. 2017). This causes the calves to develop slowly, take longer to mature and have a dismal future in terms of productivity. For availability of milk for sale, milk replacer finds a very important role for dairy farmers. According to Khan et al. (2012), milk replacers are any feed ingredients or a combination of such elements that can be used to replace whole milk in a calf's diet. Milk replacer (MR) is a constituted feed consisting almost similar nutritional value as that of whole milk and cheaper than milk so that it gives economic benefit too (ICAR, 2013). There are many factors associated while choosing a milk replacer such as form, composition and cost effectiveness of milk replacer.

Soybean is the best source of plant protein containing about 40% of crude protein (dry basis) and rich in nutritive minerals and dietary fiber (Giri and Mangaraj, 2012). Soymilk is a white emulsion which resembles buffalo milk in both appearance and consistency (Yadav et al. 2018) and is prepared by soybean (*Glycine max*) seed. When compared with whole milk, it is a cheap source of protein and calories that can be utilized to effectively replace whole milk in developing nations to address the issue of malnutrition (Mazumder and Begum, 2016). Soymilk is very nutritious and a great source of high-quality proteins, B vitamins, and isoflavones and it is lactose-free (Fahmida, 2018) and also rich in iron, unsaturated fatty acids, and niacin, but low amounts of fat, carbohydrates, and calcium as compared with cow milk (Mazumder and Begum, 2016). Soybean protein is

comparable to milk protein in terms of suckling calves' growth performance when used as a protein source for milk replacers (Huang et al. 2015). The partial or total replacement of milk proteins with soy proteins in milk replacers does not impair calf performance and significantly improves the economic efficiency of calf diets (Ansia and Drackley, 2020). Various studies revealed that replacing soymilk for whole milk while feeding calves led to improved growth performance (Bartlett et al. 2006; Ghorbani et al. 2007; Masum et al. 2009; Roy et al. 2016 and Fahmida, 2018).

Therefore, the present study is envisaged to assess the efficacy of Soymilk feeding on growth performance and economics of feeding in Murrah buffalo calves.

Materials and Methods

The present investigation was carried out with prior approval by the Institutional Animal Ethics Committee (IAEC) Vide No.: VCC/IAEC/2022/1624-51, Dated: 10-05-2022 at buffalo farm of Department, Lala Lajpat Rai University of Veterinary and Animals Sciences, Hisar for a period of three months.

Experimental Design

For this experiment, a total 15 Murrah buffalo calves at the age of 5 days were randomly divided into three treatment groups, having 5 buffalo calves in each treatment on the basis of similar body weight and sex. In T_1 treatment group (control group) calves were reared on Whole milk while in T_2 and T_3 groups calves were reared on Whole milk and Soymilk at 75:25 and 50:50 ratio, respectively. The experimental animals were kept under loose housing pens with proper space in open and covered area. Feeding and general management practices remain the same in all the treatment groups except milk feeding. Milk feeding of the calves was done at around 5 am in the morning and at around 5 pm in the evening by using the milk feeding bottles. Whole milk was fed to T_1 group while in T_2 and T_3 group Whole milk and Soymilk was given at 75:25 and 50:50 ratio, respectively. During the entire study period, the calves were given balanced diet in form of green fodder, dry roughage and concentrate mixture to meet their dietary requirements for growth following standard feeding management. Buffalo calves were given ad lib fresh water throughout the experimental period. Before formulation of rations, the feed ingredients used in the diet formulations were analyzed for the proximate composition by adopting method of AOAC (2012).

Preparation of Soymilk

For this study, good quality soybean seeds were procured by the department and extraneous materials in soybean seeds were manually removed which were later analyzed for proximate composition. Then Soybean seeds were cleaned by washing with fresh water and after washing were soaked in water 4-5 times of their weight for 24 hours and water was changed after every 12 hours. Soaked soybean seeds were dehulled manually by rubbing between both palms and soaked and dehulled soybeans were dried overnight in hot air oven at 60^{O}C temperature. Dried soybeans were grinded in mill and then procured grinded soybeans were sieved by using 2mm sieve to obtain soypowder. Soypowder was stored in airtight container in hygienic condition. For preparation of one litre soymilk, 150 gram soypowder was dissolved in 1000 ml of luke warm water. With the help of stirrer, continuous stirring was done to mix soypowder properly with water and later it was strained with fine muslin cloth. Thereafter, this Soymilk was mixed with the Whole milk as per the treatment groups.

Parameters studied

The body weight of buffalo calves was taken at beginning of the experiment and thereafter at fortnightly intervals. The body weight was recorded in the morning by using digital weighing balance. Average body weight gain, average daily body weight gain and cumulative body weight gain over the experimental period were calculated for each treatment. Body measurements (body height, heart girth, abdominal girth and body length) of the experimental buffalo calves were recorded at the beginning and thereafter at 15 days intervals during the experiment with the help of measuring tape/rod on inch scale. The cumulative body measurements were calculated for each treatment through the course of experimental period. Cost of whole milk, feed ingredients (including price of dry roughage, green fodder, concentrate and soybean), prevailing at the time of purchase were collected from the university.

The means of data obtained from the study were compared by one way analysis of variance (ANOVA) as per the methods described by Snedecor and Cochran (1994). The data was analyzed using "SPSS" software (version-23). The mean differences among different treatments were separated by Duncan's (1955) multiple range tests. Consequently, a level of significant ($P<0.05$) was used as the criterion for statistical significance.

Results and Discussion

Body weight

The results of Soymilk feeding on body weight parameters (average body weight, average body weight gain, cumulative body weight gain and average daily body weight gain) of experimental calves have been shown in Table 5, 2, 6 and 3. The perusal of tables revealed that the body weight parameters i.e., average body weight, average body weight gain, cumulative body weight gain and average daily body weight gain of all the experimental buffalo calves were observed to be statistically non-significant among Whole milk and Soymilk fed treatment groups through the course of the experiment. The findings of body weight indicated that Soymilk feeding did not compromise the growth of experimental animals over the experimental period.

Analogous to our findings, Masum et al. (2009) reported statistically similar total average body weight gain and average daily weight gain of calves fed on cow milk, strained Soymilk and unstrained Soymilk. Masum et al. (2011) observed non-significantly different total weight gain of calves fed on whole milk and vitamin- mineral fortified Soymilk. Similar trend was also reported by Roy et al. (2012) and Huang et al. (2015) for body weights and average daily gain. The present study can be compared with Sarker et al. (2015) who reported that Black Bengal kids fed on whole milk alone and Soymilk at 25 and 50 percent level in milk replacers had similar total live weight gain. Shakya et al. (2017) revealed that the final body weight and average daily body weight gain of buffalo calves fed on whole milk and a milk replacer in which whole milk was replaced with Soymilk at 20 percent level did not differ significantly. Similarly, Yadav et al. (2018) found statistically similar fortnightly body weight (kg) and average daily weight gain (g/d) in the calves fed whole milk and fortified Soymilk. Fahmida (2018) also observed increased but statistically non-significant body weight and average daily gain in calves among groups fed Soymilk at 25 and 50 percent levels and whole milk fed treatment group. Toukourou and Moubarack (2021) concluded that use of Soymilk as a dietary supplement during the pre-weaning period has proved to be a promising strategy to improve the weight performance.

Table 1: Proximate composition (% DM Basis) of feed ingredients fed to experimental buffalo calves

Ingredients	DM%	CP%	CF%	EE%	Ash%	OM%
Wheat straw	90.00	3.00	35.46	1.02	12.97	87.03
Green fodder	27.43	6.12	23.50	6.50	6.50	93.50
Maize	88.08	9.01	2.80	3.56	1.75	98.25
Ground Nut cake (GNC)	91.47	42.70	9.15	7.68	7.80	92.20
Wheat	88.61	10.89	3.77	2.15	2.23	97.77
Barley	88.60	11.00	4.99	2.51	2.50	97.50
Soybean meal	88.60	45.00	8.00	1.75	8.64	91.36
Mustard cake	91.46	35.62	8.33	6.25	8.83	91.17
Concentrate	83.95	22.87	5.38	3.71	4.74	95.26

Table 2 Effect of Soymilk feeding on body weight gain (kg) of Murrah buffalo calves

Period of experiment (days)	Treatments		
	T_1	T_2	T_3
0-15	4.85 ± 0.56	4.40 ± 0.83	2.90 ± 0.40
15-30	4.27 ± 1.19	3.60 ± 0.91	3.24 ± 0.58
30-45	5.92 ± 1.96	6.65 ± 1.18	5.56 ± 1.22
45-60	5.80 ± 1.11	5.59 ± 1.20	5.26 ± 0.59
60-75	5.52 ± 0.65	7.82 ± 0.72	6.72 ± 0.72
75-90	6.64 ± 0.57	7.62 ± 0.41	6.72 ± 0.64

Values are means ± standard errors

Table 3 Effect of Soymilk feeding on average daily body weight gain (kg/day) of Murrah buffalo calves

Period of experiment (days)	Treatments		
	T_1	T_2	T_3
0-15	0.32 ± 0.04	0.29 ± 0.01	0.19 ± 0.03
15-30	0.28 ± 0.08	0.24 ± 0.06	0.22 ± 0.04
30-45	0.39 ± 0.13	0.44 ± 0.08	0.37 ± 0.08
45-60	0.39 ± 0.07	0.37 ± 0.08	0.35 ± 0.04
60-75	0.37 ± 0.04	0.52 ± 0.05	0.45 ± 0.05
75-90	0.44 ± 0.04	0.51 ± 0.03	0.45 ± 0.04
0-90	0.37 ± 0.03	0.40 ± 0.01	0.34 ± 0.02

Values are means ± standard errors

In contrary to our findings, Shukla (2014) found a significantly lower growth rate for calves fed on formulated soy based milk replacer than the whole milk fed group, respectively. This study also revealed that average daily gain (ADG) of calves fed whole milk was significantly higher than commercial and formulated milk replacer. Gadzama et al. (2017) unveiled that feeding of calves with Soymilk:cow milk (25:75) improved live weight gain and average daily gain than calves fed with cow milk alone. Similarly, Alam et al. (2021) also reported that significantly ($P<0.05$) higher average final live weight in kids fed soybean based milk replacer in comparison to naturally milk suckled kids.

Body measurements

The results of body measurements are presented in Table 5 and 6. The outcomes of present study revealed that body measurements (body height, cumulative body height gain, heart girth, cumulative heart girth gain, abdominal girth, cumulative abdominal girth gain, body length and cumulative body length gain) did not differ significantly during the entire period of experiment in Murrah buffalo calves under different treatments, except cumulative heart girth gain. There was significant ($P<0.05$) higher value observed in cumulative heart girth gain during the period of 0 to 45 days in which cumulative heart girth gain was significantly higher in T_2 (WM and SM in 75:25 ratio) group in comparison to T_1 (WM) and T_3 (WM and SM in 50:50 ratio) treatment groups, although it was statistically similar between T_1 and T_3 group.

Present findings are corroborated with Masum et al. (2009) who reported that non-significant differences were seen for increment in wither height, body length and heart girth in calves fed cow milk, strained Soymilk and unstrained Soymilk; Masum et al. (2011) who reported non-significantly increment in wither height, body length and heart girth between groups in which calves reared by cow milk and reared by combination of cow milk and fortified Soymilk (50:50) and Sarker et al. (2015) who reported that Black Bengal kids fed on whole milk alone and Soymilk at 25 and 50 percent levels had similar body measurements. The present results of body measurements agreed with Yadav (2016) who concluded that increase in the body height was similar fortnightly among whole milk and fortified Soymilk fed group. Similarly, Shakya et al. (2017) found statistically similar body length, heart girth and wither height in Murrah buffalo calves fed on whole milk and whole milk plus 20 percent Soymilk. Fahmida (2018) also revealed that no significant difference was found in body length, heart girth and body height of calves among whole milk feeding group and Soymilk feeding group (replacement up to 50%).

In contrast to this study, Gadzama (2017) reported significantly ($P<0.05$) improvement in body length, heart girth and body height of calves in Soymilk fed treatment groups than cow milk fed treatment group. Alam et al. (2021) observed that body height, heart girth and body length were significantly ($P<0.05$) higher in soybean based milk replacer fed kids than naturally suckled kids.

Economics of feeding

Major outcome of research was in terms of economics of Soymilk feeding which is presented in Table 4. The pursual of data indicated that profit in total feeding cost per kg weight gain of calves was Rs. 106.92 and 130.35 for Soymilk feeding group at 25% and 50% level, respectively than control group, suggesting that Soymilk feeding is more economical than Whole milk feeding without compromising the growth of calves.

Table 4 Economics of feeding Soymilk under different treatment groups

Variables	T_1	T_2	T_3
Cost of feeding dry fodder {cost/calf (Rs.)} @ Rs.11/kg	198.79	189.49	173.65
Cost of feeding green fodder {cost/calf (Rs.)} @ Rs.1.6/kg	145.54	138.77	128.42
Cost of feeding concentrate {cost/calf (Rs.)} @ Rs.27.5/kg	1235.32	1202.17	1143.88
Cost of feeding Soymilk {cost/calf (Rs.)} @ Rs.70/kg	0	833.805	1667.61
Whole milk feeding Cost {cost/calf (Rs.)} @ Rs.50/kg	13500	10125	6750
Total milk feeding cost/calf (Rs.)	13500	10958.80	8417.61
Total feeding cost/calf (Rs.)	15079.65	12489.23	9863.56
Profit in milk feeding cost/calf (Rs.)	0	(+) 2541.19	(+) 5082.39
Profit in total feeding cost/calf (Rs.)	0	(+) 2590.42	(+) 5216.09
Average body weight gain/calf (kg)	33	35.68	30.2
Total feeding cost/kg weight gain {cost/calf (Rs.)}	456.96	350.03	326.61
Profit in total feeding cost/kg weight gain {cost/calf (Rs.)}	0	(+) 106.92	(+) 130.35

Table 5 Effect of Soymilk feeding on average body weight (kg), body height (inch), heart girth (inch), abdominal girth (inch) and body length (inch) of Murrah buffalo calves

Days of experiment	Body weight (kg)			Body height (inch)			Heart girth (inch)			Abdominal girth (inch)			Body length (inch)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
0^{th}	43.80 ± 3.44	43.40 ± 2.06	43.40 ± 2.56	31.10 ± 1.00	30.60 ± 0.51	30.00 ± 0.32	33.00 ± 0.71	32.00 ± 0.63	32.00 ± 0.71	33.00 ± 0.71	33.60 ± 0.24	33.40 ± 1.25	26.00 ± 0.84	26.40 ± 0.51	26.20 ± 0.49
15^{th}	48.65 ± 3.48	47.80 ± 1.97	46.30 ± 2.71	32.30 ± 0.70	31.20 ± 0.37	31.60 ± 0.68	33.60 ± 0.68	33.40 ± 0.59	33.20 ± 0.80	34.80 ± 0.73	34.40 ± 0.98	36.00 ± 1.05	27.30 ± 0.97	27.60 ± 0.24	27.60 ± 0.24
30^{th}	52.92 ± 4.05	51.40 ± 1.56	49.54 ± 2.22	32.80 ± 0.86	32.30 ± 0.49	32.50 ± 0.45	35.00 ± 1.05	34.50 ± 0.58	34.20 ± 0.66	36.60 ± 1.03	36.60 ± 1.08	36.40 ± 0.60	29.20 ± 0.97	28.30 ± 0.39	28.40 ± 0.40
45^{th}	58.84 ± 5.44	58.05 ± 2.44	55.10 ± 3.18	33.40 ± 1.08	32.60 ± 0.48	33.00 ± 0.63	36.20 ± 1.07	36.50 ± 0.59	35.00 ± 0.63	38.10 ± 0.78	38.90 ± 0.51	37.20 ± 0.58	30.00 ± 0.95	29.00 ± 0.32	29.80 ± 0.37
60^{th}	64.64 ± 5.70	63.64 ± 1.77	60.16 ± 3.23	34.00 ± 0.71	33.30 ± 0.37	33.40 ± 0.43	37.40 ± 1.13	37.30 ± 0.44	36.60 ± 0.66	40.70 ± 1.80	39.80 ± 1.07	38.50 ± 0.45	30.80 ± 1.07	29.90 ± 0.33	30.20 ± 0.37
75^{th}	70.16 ± 5.30	71.46 ± 1.46	66.88 ± 3.71	34.80 ± 0.72	34.10 ± 0.40	34.40 ± 0.60	39.20 ± 0.82	39.00 ± 0.32	38.00 ± 0.95	41.60 ± 1.21	41.40 ± 0.75	40.80 ± 0.58	31.60 ± 0.75	31.20 ± 0.41	31.40 ± 0.68
90^{th}	76.80 ± 5.72	79.08 ± 1.30	73.60 ± 4.22	35.80 ± 0.98	35.20 ± 0.34	35.10 ± 0.78	40.80 ± 1.16	40.60 ± 0.29	39.10 ± 1.14	43.00 ± 1.22	43.50 ± 0.74	43.10 ± 1.08	32.50 ± 1.00	32.50 ± 0.32	32.60 ± 0.40
Overall	59.40 ± 4.49	59.26 ± 4.90	56.43 ± 4.20	33.46 ± 0.60	32.76 ± 0.60	32.86 ± 0.65	36.46± 1.08	36.19 ± 1.16	35.44 ± 0.97	38.26 ± 1.40	38.31 ± 1.37	37.91 ± 1.22	29.63 ± 0.88	29.27 ± 0.80	29.46 ± 0.84

Values are means ± standard errors

Table 6 Effect of Soymilk feeding on cumulative body weight gain (kg), cumulative body height gain (inch), cumulative heart girth gain (inch), cumulative abdominal girth gain (inch) and cumulative body length gain (inch) of Murrah buffalo calves

Period of experiment (days)	cumulative body weight gain (kg)			cumulative body height gain (inch)			cumulative heart girth gain (inch)			cumulative abdominal girth gain (inch)			cumulative body length gain (inch)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
0-15	4.85 ± 0.56	4.40 ± 0.83	2.90 ± 0.40	1.20 ± 0.41	0.60 ± 0.25	1.60 ± 0.51	0.60 ± 0.24	1.40 ± 0.51	1.20 ± 0.37	1.80 ± 1.24	0.80 ± 0.86	2.60 ± 0.40	1.30 ± 0.37	1.20 ± 0.37	1.40 ± 0.40
0-30	9.12 ± 0.95	8.00 ± 1.19	6.14 ± 0.63	1.70 ± 0.20	1.70 ± 0.54	2.50 ± 0.32	2.00 ± 0.55	2.50± 0.45	2.20 ± 0.20	3.60 ± 1.60	3.00 ± 1.14	3.00 ± 0.71	3.20 ± 0.58	1.90 ± 0.51	2.20 ± 0.49
0-45	15.04 ± 2.14	14.65 ± 0.87	11.70 ± 0.90	2.30 ± 0.20	2.00 ± 0.35	3.00 ± 0.45	3.20^{a} ± 0.37	4.50^{b} ± 0.45	3.00^{a} ± 0.32	5.10 ± 1.08	5.30 ± 0.37	3.80 ± 0.86	4.00 ± 0.45	2.60 ± 0.24	3.60 ± 0.68
0-60	20.84 ± 2.71	20.24 ± 1.11	16.76 ± 1.04	2.90 ± 0.33	2.70 ± 0.30	3.40 ± 0.49	4.40 ± 0.53	5.30 ± 0.80	4.60 ± 0.19	7.70 ± 2.24	6.20 ± 1.02	5.10 ± 0.93	4.80 ± 0.58	3.50 ± 0.45	4.00 ± 00.45
0-75	26.36 ± 2.57	28.06 ± 1.14	23.48 ± 1.68	3.70 ± 0.46	3.50 ± 0.22	4.40 ± 0.40	6.20 ± 0.34	7.00 ± 0.55	6.00 ± 0.32	8.60 ± 1.63	7.80 ± 0.73	7.40 ± 0.75	5.60 ± 0.51	4.80 ± 0.46	5.20 ± 0.80
0-90	33.00 ± 3.12	35.68 ± 1.27	30.20 ± 2.22	4.70 ± 0.41	4.60 ± 0.37	5.10 ± 0.56	7.80 ± 0.58	8.60 ± 0.62	7.10 ± 0.66	10.00 ± 1.70	9.90 ± 0.81	9.70 ± 0.61	6.50 ± 0.77	6.10 ± 0.40	6.40 ± 0.75

Values are means ± standard errors

Mean values with different superscripts in a row differ significantly ($P<0.05$)

These results of lower cost per kg gain in calves fed on Soymilk as compared to those fed on whole milk were in accordance with the findings of Kamble et al. (2003) who observed that cost per kg body weight gain was significantly higher in the treatment T_1 (whole milk) than T_2 (30 per cent Soymilk + 70 per cent whole milk) and T_3 (40 per cent Soymilk + 60 per cent whole milk) treatments respectively; Matter et al. (2005) who reported that values of feed costs for Soymilk fed group were significantly lower than those fed other groups and Ghorbani et al. (2007) who concluded that feed related weaning costs were lower for Soymilk fed group than whole milk fed group. Similar findings were observed by Masum et al. (2011) who revealed that the cost per kg gain in calves was lower for a combination of Soymilk and cow milk as against whole milk alone. Roy et al. (2012) also reported that the feeding cost per calf per day as 21.27 and 107.77 Taka for the soy and whole milk fed groups, respectively and Shukla (2014) reported that the feed cost per kg gain was lower for calves fed on soy based milk replacer than those fed on whole milk alone. In the same line, Shakya et al. (2016) found significantly lower recurring cost of rearing of the buffalo calves in Soymilk fed groups than whole milk fed group. Similarly, Yadav et al. (2018) revealed that total feeding cost (Rs/kg weight gain) was form to reduce by Rs. 176.42, 236.32 and 237.61 in T_2, T_3 and T_4 groups, respectively as compared to control group and also, Fahmida (2018) reported that the cost per kg gain was lowest in calves fed on Soymilk at 50 per cent Soymilk level followed by those fed on Soymilk at 25 percent level.

Conclusion

It can be concluded that Soymilk feeding up to 50% level with Whole milk had similar effect on growth as Whole milk without compromising the performance of calves and found to be more economical in comparison to Whole milk feeding; therefore Soymilk may possibly replace whole milk up to 50 percent level.

Acknowledgements

The authors are heartly thankful to the university for the necessary inputs and facilities provided for the smooth conduct of this research.

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