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Studies on standardization, proximate composition and cost of production of *kalakand* blended with kiwi fruit (*Actinidia deliciosa*) pulp

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Abstract

The study was conducted on the topic “Studies on Preparation of *Kalakand* Blended with Kiwi Fruit (*Actinidia deliciosa*) Pulp”. The *kalakand* was prepared from standardized buffalo milk (6% fat and 9% SNF) using four treatments viz., T₁ (100 parts *khoa*, control), T₂ (97.5 parts *khoa* + 2.5 parts pulp), T₃ (96.5 parts *khoa* + 3.5 parts pulp) and T₄ (95 parts *khoa* + 5 parts pulp), with sugar at 30 percent. The products were evaluated for its proximate composition and cost of production. The experiment was conducted in a Completely Randomized Design with four replications. Increasing kiwi pulp significantly increased moisture and ash contents. The moisture content in T₁, T₂, T₃ and T₄ was 28.80, 29.44, 30.01 and 30.69 percent, respectively, while ash content was 2.31, 2.40, 2.50 and 2.61 percent, respectively. Fat content decreased from 22.21 percent in T₁ to 21.82, 21.63 and 21.38 percent in T₂, T₃ and T₄, respectively. Protein content was 15.46, 15.15, 14.97 and 14.63 percent in T₁, T₂, T₃ and T₄, respectively, whereas total solids content was 71.20, 70.56, 69.99 and 69.31 percent, respectively. The cost of production of *kalakand* was Rs.336.76, Rs.336.38, Rs.336.23 and Rs.336.00 per kg for T₁, T₂, T₃ and T₄, respectively. Thus, T₃ with 3.5 parts kiwi fruit pulp was identified as the appropriate formulation, providing desirable proximate composition with a comparable cost of production.

Keywords: *Kalakand*, kiwi fruit pulp, *Actinidia deliciosa*, standardization, proximate composition, cost of production

Introduction

India has maintained its status as the world's leading producer of milk since 1998, currently accounting for nearly one-fourth of global milk output. The nation's milk production has experienced substantial growth, rising from 146.30 million tonnes during the 2014-15 period to 247.87 million tonnes in 2024-25, which reflects a year-over-year growth rate of 3.58 percent. Consequently, the per capita availability of milk has increased from 319 g per day to 485 g per day, significantly exceeding the global average of approximately 350 g per day. This consistent growth is primarily driven by enhanced productivity of milch animals; specifically, during 2024-25, production increased by 4.97 percent from exotic and crossbred cattle, 3.51 percent from indigenous and non-descript cattle, and 2.45 percent from buffaloes. The states of Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat, and Maharashtra collectively generate 54.09 percent of the national milk output, with Maharashtra contributing 6.71 percent independently.

Scientifically acknowledged as a "complete food," milk possesses a balanced profile of high-biological-value proteins, essential fatty acids, lactose, and a diverse range of micronutrients. Within the Indian subcontinent, milk is predominantly consumed in processed forms, most notably as Traditional Indian Dairy Products (TIDPs). These traditional products hold a crucial position within the Indian dairy sector, making substantial contributions to the nutritional, economic, social, and cultural health of the population. Converting surplus milk into indigenous dairy products is highly advantageous, particularly when storage and transportation infrastructure for liquid milk is inadequate. Processing milk into TIDPs not only extends its keeping quality and preserves its valuable constituents but also generates rural employment and supplementary income, cementing these products as a dominant segment of the Indian dairy market.

Among the wide array of TIDPs, *kalakand* holds a prestigious status as a partially desiccated, acid-coagulated milk sweet renowned for its characteristic danedar (grainy) texture, caramelized flavour, and moist consistency. Technologically, its preparation requires the continuous heating of milk, or a mixture of *khoa* and sugar, alongside controlled acidification to facilitate the necessary grain formation. The conventional manufacturing process involves heating milk in a suitable vessel with continuous stirring to prevent scorching, followed by the addition of diluted citric acid to induce partial protein coagulation. The mixture is further heated and stirred until a semi-solid granular mass forms, after which sugar and optional flavouring agents like cardamom are incorporated before uniformly spreading the mass in greased trays to cool and set at room temperature.

Kalakand remains highly favoured across various socio-economic demographics and is a staple during cultural, social, and religious events such as weddings, birthday celebrations, inaugural functions, and festivals like Diwali, ensuring consistent year-round demand. The product serves as an effective mechanism for valorizing surplus milk, aiding the economic advancement of rural dairy enterprises. To adapt to evolving consumer tastes, markets in Maharashtra now offer diverse varieties of *kalakand*, including fig, mango, ash gourd, sapota, strawberry, plain, and Kashmiri variants. However, plain *kalakand* possesses a high moisture content of approximately 20-25 percent and high nutrient density, making it exceedingly vulnerable to microbial spoilage and restricting its ambient shelf life to a mere 2-3 days.

Simultaneously, the modern dairy industry is navigating an increasing consumer demand for "functional foods" that deliver health benefits alongside basic nutrition. Fortifying dairy matrices with fruits and vegetables is a promising strategy to address this trend, as fruits provide dietary fibre and natural antioxidants that can improve the physico-chemical properties of the product and offer protection against oxidative stress and chronic ailments such as cardiovascular disease. Kiwi fruit (*Actinidia deliciosa*), a member of the Actinidiaceae family and *Actinidia* genus, is an exceptional candidate for such fortification. In India, its cultivation occurs primarily in the mid-hills of the North-Eastern region, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir. Arunachal Pradesh is the dominant producer, yielding approximately 7.05 thousand tonnes and accounting for nearly 45 percent of the national output in 2023-24, followed by Manipur, Sikkim, Meghalaya, and Nagaland.

Kiwi fruit thrives in slightly acidic soils with a pH range of 6.0-6.5 under full sunlight or partial shade. It is consumed fresh and also processed into juices, purees, candies, spirits, syrups, and lyophilized products. It is recognized as a nutritional powerhouse loaded with vitamin C (ascorbic acid), vitamin E, and vital minerals like potassium and magnesium. It boasts a high concentration of phytonutrients, including lutein, flavonoids, and chlorophyll, which add considerable therapeutic value and promote digestive function, metabolic health, and immune response. Consuming these beneficial constituents helps reduce the risk of cardiovascular disease by lowering the platelet

aggregation response to collagen and reducing blood triglyceride levels.

Furthermore, the natural acidity and unique enzymatic profile of kiwi fruit, most notably the cysteine protease actinidin, can be exploited in dairy processing lines to influence coagulation and textural behaviour. Actinidin constitutes more than half of the soluble protein in kiwi fruit pulp and is capable of hydrolysing milk casein. Accordingly, kiwi fruit extract has been demonstrated to possess milk-clotting activity comparable to that of purified actinidin. This distinctive proteolytic activity provides a plausible biochemical foundation for the expected interaction between kiwi fruit pulp and the casein matrix of *khoa* during the manufacturing of a blended *kalakand* product.

Exploring these technological intersections is imperative to create value-added commodities that cater to modern, health-conscious consumers while preserving the essence of traditional sweets. Accordingly, the present research project, entitled "Studies on Preparation of *Kalakand* Blended with Kiwi Fruit (*Actinidia deliciosa*) Pulp", was undertaken with the objectives to standardize the process of *kalakand* preparation blended with kiwi fruit pulp, to study its sensory quality and proximate composition, to evaluate its microbiological shelf life, and to estimate the cost of production of the product.

Materials and Methods

The present research was conducted during 2025-2026 in the Department of Animal Husbandry and Dairy Science, College of Agriculture, Latur. Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Materials

Fresh standardized buffalo milk containing 6% fat and 9% solids-not-fat (SNF), fresh & matured kiwi fruit and crystalline cane sugar were procured from local market.

Methods

Treatment combinations

Kalakand blended with kiwi fruit pulp was prepared using sugar at 30 percent by weight of the *khoa* in the control, and at 30 percent by weight of the *khoa* and kiwi fruit pulp blend in the treatment groups, as follows:

T₁-100 parts of *khoa* by weight (control)

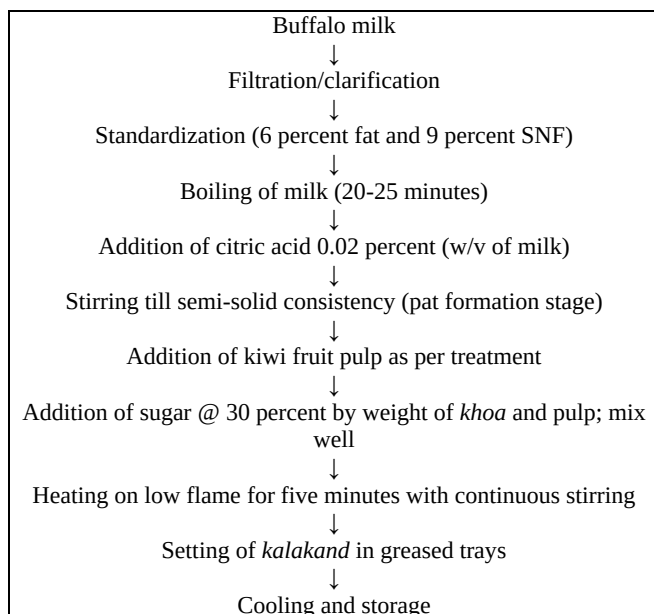
T₂-97.5 parts of *khoa* + 2.5 parts of kiwi fruit pulp by weight

T₃-96.5 parts of *khoa* + 3.5 parts of kiwi fruit pulp by weight

T₄-95.0 parts of *khoa* + 5.0 parts of kiwi fruit pulp by weight

Preparation of *kalakand* blended with kiwi fruit pulp

Standardized buffalo milk containing 6% fat and 9% SNF was filtered and concentrated by boiling for 20-25 min with continuous stirring and scraping. Citric acid (0.02% w/v) was added for partial coagulation, and heating continued until a semi-solid *danedar* mass was obtained. Kiwi pulp was incorporated according to the treatment, followed by sugar at 30 percent by weight of the *khoa* and pulp blend. The mixture was cooked for 5 min over low flame with continuous stirring, transferred to greased trays, set at 25-30 °C, cut into uniform pieces and used for further analysis.

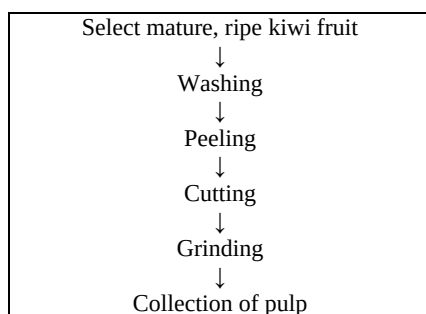


(Maske *et al.* 2023) ^[10]

Fig 1: Preparation of *kalakand* blended with kiwi fruit pulp

Preparation of kiwi fruit (*Actinidia deliciosa*) pulp

Fully ripe and sound kiwi fruits were washed, peeled and cut into small pieces. The pieces were ground in a mixer grinder to obtain a smooth and uniform pulp, which was collected in clean containers and used immediately for preparation of kiwi fruit blended *kalakand*.



(Ingale *et al.* 2020) ^[4]

Fig 2: Preparation of kiwi fruit pulp

Statistical Analysis

The data obtained was analyzed statistically by using Completely Randomized Design (CRD) as Panse and Sukhatme (1967).

Proximate Composition Analysis

The *kalakand* blended with kiwi fruit pulp was chemically analyzed for moisture, fat, protein, ash and total solids using standard procedures. Moisture was determined as per Anonymous (1959) ^[1], fat by IS: 1224 (Part II), 1977, protein by Lowry *et al.* (1951) ^[9], ash by IS: SP (Part XI), 1981, and total solids by IS: 1479 (Part II), 1961.

Cost of production

The cost of production of *kalakand* was calculated by considering the cost of *khoa*, kiwi fruit pulp, sugar, citric acid, labours and fuel. The cost of the ingredients was based on the prevailing market rates during the period of investigation.

Results and Discussion

Proximate composition of *kalakand* blended with kiwi fruit pulp

Kalakand samples prepared under each treatment was analyzed for moisture, fat, protein, ash and total solids. The results are described in following Tables

Moisture content of *kalakand* blended with kiwi fruit pulp

The mean moisture content of control (T₁) and *kalakand* blended with kiwi fruit pulp T₂, T₃ and T₄ was 28.80, 29.44, 30.01 and 30.69 percent, respectively. The moisture content of control (T₁) was lowest (28.80%) and differed significantly from all other treatments. Among the treatments, T₄ recorded the highest moisture content (30.69%) and differed significantly from the other treatments. The moisture content increased significantly with increasing levels of kiwi fruit pulp. The significant increase in moisture content of *kalakand* blended with kiwi fruit pulp was due to the higher moisture content (84.33 percent) of kiwi fruit pulp. The present findings are in agreement with those of Thikare *et al.* (2020) ^[13], who reported an increase in moisture content from 26.49 to 31.47 percent in strawberry pulp incorporated *kalakand*. Similar observations were made by Bhandage *et al.* (2020) ^[2], who recorded an increase in moisture content from 40.13 to 48.05 percent with increasing levels of kiwi pulp in *shrikhand*.

Table 1: Moisture content of *kalakand* blended with kiwi fruit pulp (per cent)

Treatment	Replication				Mean
	R ₁	R ₂	R ₃	R ₄	
T ₁	28.70	28.90	28.84	28.75	28.80 ^d
T ₂	29.47	29.30	29.53	29.45	29.44 ^c
T ₃	30.00	30.02	29.95	30.08	30.01 ^b
T ₄	30.72	30.68	30.62	30.75	30.69 ^a
S.E.±0.0384 C.D. at 5% 0.1184					

Means bearing different superscripts differ significantly ($p < 0.05$).

Fat content of *kalakand* blended with kiwi fruit pulp

The mean fat content of control (T₁) and *kalakand* blended with kiwi fruit pulp T₂, T₃ and T₄ was 22.21, 21.82, 21.63 and 21.38 percent, respectively. The fat content of control (T₁) was higher (22.21%) and differed significantly from all treatments. Among the treatments, T₄ recorded the lowest fat content (21.38%) and differed significantly from each other. The fat content decreased significantly with increasing levels of kiwi fruit pulp. The significant decrease in fat content of *kalakand* blended with kiwi fruit pulp was due to the lower fat content (0.51 percent) of kiwi fruit pulp. The results of the present investigation are in close agreement with those of Maske *et al.* (2023) ^[10], who reported a decrease in fat content from 21.33 to 17.48 percent with increasing levels of kinnow juice in *kalakand*. Similar results were recorded by Bhandage *et al.* (2020) ^[2], who observed a gradual decrease in fat content from 8.75 to 8.21 percent with increasing incorporation of kiwi pulp in *shrikhand*.

Table 2: Fat content of *kalakand* blended with kiwi fruit pulp (per cent)

Treatment	Replication				Mean
	R ₁	R ₂	R ₃	R ₄	
T ₁	22.14	22.25	22.18	22.28	22.21 ^a
T ₂	21.76	21.95	21.70	21.85	21.82 ^b
T ₃	21.58	21.70	21.65	21.60	21.63 ^c
T ₄	21.35	21.42	21.40	21.36	21.38 ^d
S.E.±0.0353 C.D. at 5% 0.1088					

Means bearing different superscripts differ significantly ($p < 0.05$).

Protein content of *kalakand* blended with kiwi fruit pulp

The mean protein content of control (T₁) and *kalakand* blended with kiwi fruit pulp T₂, T₃ and T₄ was 15.46, 15.15, 14.97 and 14.63 percent, respectively. The protein content of control (T₁) was higher (15.46%) and differed significantly from all treatments. Among the treatments, T₄ recorded the lowest protein content (14.63%) and differed significantly from each other. The protein content decreased significantly with increasing levels of kiwi fruit pulp. The significant decrease in protein content of *kalakand* blended with kiwi fruit pulp was due to the lower protein content (1.09 percent) of kiwi fruit pulp compared with *khoa*. The results of this study are in line with those of Shalini *et al.* (2015) [11], who observed a decrease in protein content from 18.66 to 13.44 percent with increasing levels of papaya pulp in *kalakand*. Comparable findings were documented by Thikare *et al.* (2020) [13], who recorded a decline in protein content from 16.38 to 13.65 percent in strawberry pulp incorporated *kalakand*.

Table 3: Protein content of *kalakand* blended with kiwi fruit pulp (per cent)

Treatment	Replication				Mean
	R ₁	R ₂	R ₃	R ₄	
T ₁	15.50	15.46	15.47	15.42	15.46 ^a
T ₂	15.22	15.00	15.23	15.15	15.15 ^b
T ₃	14.98	14.90	15.05	14.95	14.97 ^c
T ₄	14.65	14.56	14.70	14.62	14.63 ^d
S.E.±0.0351 C.D. at 5% 0.1081					

Means bearing different superscripts differ significantly ($p < 0.05$).

Ash content of *kalakand* blended with kiwi fruit pulp

The mean ash content of control (T₁) and *kalakand* blended with kiwi fruit pulp T₂, T₃ and T₄ was 2.31, 2.40, 2.50 and 2.61 percent, respectively. The ash content of control (T₁) was lowest (2.31%), while T₄ recorded the highest (2.61%) and differed significantly from all other treatments. T₂ and T₃ were statistically at par with each other. The ash content increased significantly with increasing levels of kiwi fruit pulp. The significant increase in ash content was due to the mineral contribution of kiwi fruit pulp, particularly potassium, magnesium, calcium and phosphorus. This observation was consistent with those of Thakur *et al.* (2017), who observed an increase in ash content from 2.43 to 3.10 percent in custard apple incorporated *kalakand*. A comparable trend was noted by Uikey *et al.* (2019) [14], where the ash content increased from 2.10 to 2.93 percent with increasing levels of inulin incorporation.

Table 4: Ash content of *kalakand* blended with kiwi fruit pulp (per cent)

Treatment	Replication				Mean
	R ₁	R ₂	R ₃	R ₄	
T ₁	2.29	2.32	2.27	2.36	2.31 ^d
T ₂	2.48	2.39	2.41	2.32	2.40 ^c
T ₃	2.60	2.42	2.48	2.49	2.50 ^b
T ₄	2.71	2.53	2.59	2.61	2.61 ^a
S.E.±0.0326 C.D. at 5% 0.1007					

Means bearing different superscripts differ significantly ($p < 0.05$).

Total solids content of *kalakand* blended with kiwi fruit pulp

The mean total solids content of control (T₁) and *kalakand* blended with kiwi fruit pulp T₂, T₃ and T₄ was 71.20, 70.56, 69.99 and 69.31 percent, respectively. The total solids content of control (T₁) was highest (71.20%), while T₄ recorded the lowest (69.31%). All treatments differed significantly from one another. The total solids content decreased significantly with increasing levels of kiwi fruit pulp. The significant decrease in total solids content was due

to the high moisture content (84.33%) and low total solids content (15.67%) of kiwi fruit pulp. The results of the present study are in close agreement with those of Thikare *et al.* (2020) [13], who observed a decrease in total solids from 73.51 to 68.53 percent with increasing levels of strawberry pulp in *kalakand*. A similar trend was reported by Bhandage *et al.* (2020) [2], who recorded a decline in total solids from 59.87 to 51.96 percent with increasing incorporation of kiwi fruit pulp in *shrikhand*.

Table 5: Total solids content of *kalakand* blended with kiwi fruit pulp (per cent)

Treatment	Replication				Mean
	R ₁	R ₂	R ₃	R ₄	
T ₁	71.30	71.10	71.16	71.25	71.20 ^a
T ₂	70.53	70.70	70.47	70.55	70.56 ^b
T ₃	70.00	69.98	70.05	69.92	69.99 ^c
T ₄	69.28	69.32	69.38	69.25	69.31 ^d
S.E.±0.0384 C.D. at 5% 0.1184					

Means bearing different superscripts differ significantly ($p < 0.05$).

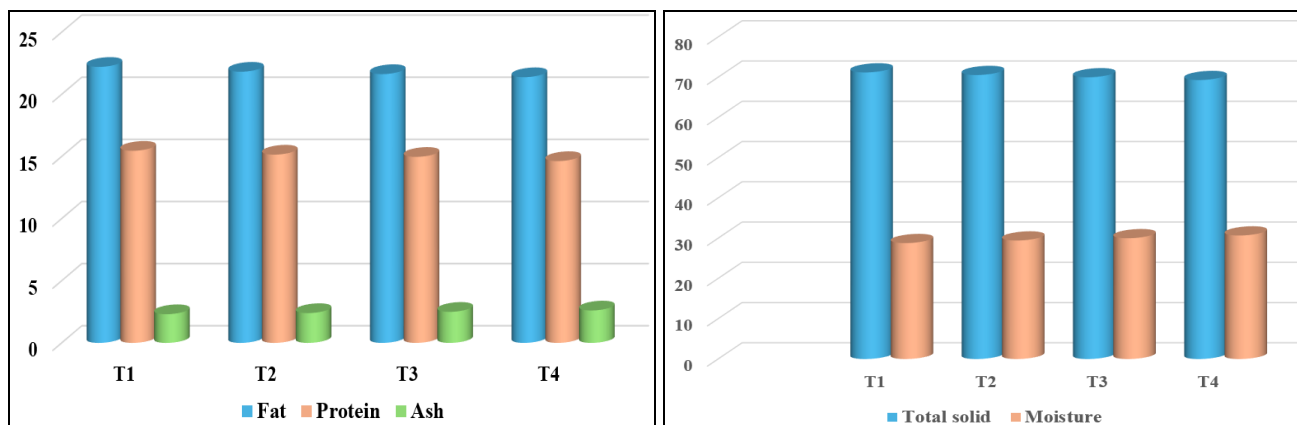


Fig 3: Graphical presentation of proximate composition of *kalakand* blended with kiwi fruit pulp

Cost of Production

Table 6: Cost of production of *kalakand* blended with kiwi fruit pulp

Sr. No.	Particulars Rs.	Cost (Rs./Kg.)	T1		T2		T3		T4	
			Qty/gm	Amt. (Rs.)	Qty/gm	Amt. (Rs.)	Qty/gm	Amt. (Rs.)	Qty/gm	Amt. (Rs.)
1	<i>Khoa</i>	380	1000	380	975	370.5	965	366.7	950	361
2	Kiwi fruit pulp	360	-	-	25	9	35	12.6	50	18
3	Sugar @ 30%	42	300	12.6	300	12.6	300	12.6	300	12.6
4	Citric acid	1000	0.2g	0.20	0.2g	0.20	0.2g	0.20	0.2g	0.20
5	Labour charges	120/8hrs	-	30	-	30	-	30	-	30
6	Fuel charges	-	-	15	-	15	-	15	-	15
7	Product obtained	-	1300	437.8	1300	437.3	1300	437.1	1300	436.8
8	Cost per 1000 gm	-	1000	336.76	1000	336.38	1000	336.23	1000	336.00

The cost of production of *kalakand* was Rs.336.76, Rs.336.38, Rs.336.23 and Rs.336.00 per kg for T₁, T₂, T₃ and T₄, respectively. The highest cost was recorded for the control T₁, whereas the lowest cost was recorded for T₄. The marginal reduction in cost with increasing incorporation of kiwi fruit pulp was due to partial replacement of *khoa*, which had a slightly higher price than kiwi fruit pulp. The

quantities of sugar and citric acid and the labour and fuel charges remained constant among the treatments.

Treatment T₃, containing 96.5 parts of *khoa* and 3.5 parts of kiwi fruit pulp, was identified as the most acceptable treatment on the basis of sensory evaluation and had a production cost of Rs.336.23 per kg. Thus, T₃ provided a suitable balance between sensory acceptability and cost of production.

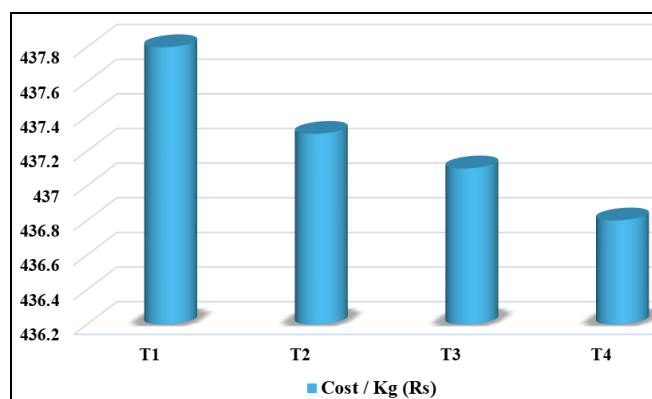


Fig 4: Graphical presentation of cost of production *kalakand* blended with kiwi fruit pulp

Conclusions

The process of *kalakand* preparation was successfully standardized by incorporating kiwi fruit pulp at different levels. The incorporation of kiwi fruit pulp significantly influenced the proximate composition of *kalakand*. With increasing levels of kiwi fruit pulp, moisture and ash contents increased, whereas fat, protein and total solids contents decreased. the present investigation successfully standardized kiwi fruit (*Actinidia deliciosa*) pulp blended *kalakand* using buffalo milk (6 percent fat, 9 percent SNF),

identifying treatment T₃ (96.5 parts *khoa* and 3.5 parts pulp) as the optimal formulation. This specific blend provided the best balance of sensory acceptability, desirable proximate composition, and an economical production cost of Rs. 336.23 per kg.

The study evaluated a control (T₁, 100 parts *khoa*) alongside three blended variations (T₂: 2.5 parts pulp, T₃: 3.5 parts pulp, and T₄: 5 parts pulp), all incorporating sugar at 30 percent by weight of the *khoa* and pulp blend. Increasing the kiwi pulp significantly altered the product's proximate

composition: moisture increased from 28.80 percent in T₁ to 30.69 percent in T₄ due to the pulp's high moisture content, while ash increased from 2.31 percent to 2.61 percent. Conversely, the addition of pulp led to a corresponding decrease in fat (22.21 percent to 21.38 percent), protein (15.46 percent to 14.63 percent), and total solids (71.20 percent to 69.31 percent). Production costs remained highly comparable across all treatments, marginally decreasing from Rs. 336.76 per kg for the control down to Rs. 336.00 per kg for T₄, as the slightly cheaper kiwi pulp partially replaced the khoa.

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