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Development and Evaluation of Candy from Banana, Dates and Skim Milk Powder

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Abstract: This study aimed to develop a homemade candy incorporating banana, dates, and skim milk powder as the primary components. Bananas and dates contribute valuable nutritional elements, including antioxidants, vitamins, and minerals, while skim milk powder fortifies the product with protein and enhances its texture. Seven different formulations were prepared, varying the ratios of banana and date pulps, ranging from 100:0 (control) to 70:30. Extensive analyses were conducted, encompassing sensory evaluation, Nutritional and qualitative analysis (proximate composition, physicochemical properties, phytochemicalcontentand antioxidant activity) and shelf-life and storage study which is upto 8 weeks. The results revealed that Treatment T7, comprising 70% banana pulp and 30% date pulp, exhibited superior sensory attributes, including taste, flavour, colour, texture, mouthfeel and overall acceptability. Furthermore, this formulation demonstrated increased levels of phenolic compounds, flavonoids, and antioxidant activity compared to the control. Nutritional analysis of this best-performing formulation shown a moisture content of 10.42%, ash content of 2.84%, fat content of 6.33%, crude fibre content of 1.62%, protein content of 4.62%, carbohydrate content of 74.17% and an energy value of 372.17 kcal. Physio-chemical analysis showed balanced pH levels, a total soluble solids (TSS) content of 83.85°Brix and desirable colour attributes (L* value of 30.01, a* value of 7.01 and b* value of 11.11). Furthermore, the research evaluates the shelf life of the candies, monitoring microbial growth, yeast and mould counts, and sensory changes over an 8-weeks period at ambient conditions. The results indicated a shelf-life of approximately 6-7 weeks before significant sensory deterioration occurs. This research not only offers a healthier confectionery option but also contributes to sustainable and health-conscious practices in the food industry. The successful development of this banana-date-skim milk powder candy demonstrates the potential for creating nutritious, appealing and shelf-stable confectionery products using natural ingredients.

Keywords: Candy; Banana; Dates; Skim milk powder; Sensory Evaluation; Proximate analysis, Shelf life; Storage

Aim: To develop and evaluate the sensory parameters, nutritive and qualitative parameters and shelf life of candy made using banana, dates and skim milk powder as major ingredients

Introduction

With an increasing emphasis on healthy lifestyles, there has been a shift towards seeking out food products made from natural and wholesome ingredients. This trend has led to the exploration of alternative ingredients and innovative methods in food production, with a focus on creating products that not only taste delicious but also offer nutritional benefits. One such endeavour in the realm of healthy snacks is the development of homemade candy using natural ingredients. Candies are extremely popular sweets enjoyed by people of all ages, particularly children, due to their appealing sensory qualities like taste and smell as well as their affordable cost. Therefore, there is the need forgood candy products that incorporate functional, nutritious constituents to align with consumer demand for healthier options (Sessler et al., 2013).This research outlines the development and evaluation of a homemade confectionery product composed primarily of a combination of banana, dates, and skim milk powder as the key constituents.This unique combination of ingredients offers a nutritious alternative to traditional candy, providing consumers with a guilt-free indulgence option.The choice of ingredients in this candy formulation is deliberate, aiming to harness the natural goodness of each component while ensuring a satisfying taste experience.

Pereira andMaraschin (2015) as well as Singh et al. (2016), found that bananas contain an abundance of bioactive compounds with antioxidant properties. These compounds include carotenoids, flavonoids, phenolic compounds, amines, Ascorbic acid, and Tocopherol. The antioxidant activities of these banana nutrients are thought to confer various health benefits for humans. Ripe bananas claim significant levels of vitamins A (Carotene), C (Ascorbic acid), and B-complex vitamins (Niacin, thiamine and riboflavin). They also contain moderate amounts of vitamin B6, also known as pyridoxine (Qamar and Shaikh, 2018).Another major ingredient is date fruit, which exhibited significant radical scavenging activity due to the presence non-enzymatic antioxidants, including phenolic compounds, flavonoids and ascorbic acid, andas well as, enzymatic antioxidants like catalase, peroxidase and superoxide dismutase (Biglari et al., 2008; Awad et al., 2011), which is known to have health benefits (Vayalil, 2011).

Skim milk powder, prized for its high protein content and creamy texture (Pugilese et al., 2017). Research has shown that skim milk powder is said to enhance the flavour, improve the colour, create a better texture and mouthfeel, and increase the shelf life of candies. Given its high protein content, incorporating skim milk powder into candy formulations can be an excellent way

to fortify these confections with additional protein, making them a more nutritious option (Liang and Hartel, 2004; Munir et al., 2016).

Through a systematic exploration of different formulations, this research aims to optimize the nutritional and qualitative parameters of banana-date-skim milk powder candy along with its sensory attributes and shelf life.The development of candy from banana, dates, and skim milk powder represents a promising avenue for innovation in the realm of functional foods. The natural sweetness of bananas and dates, complemented by the creamy richness of skim milk powder, promises a delightful indulgence without the need for excessive added sugars or artificial flavourings.

Material and methods

Fully ripened bananas (Musa acuminataColla), dried date fruit (Phoenix dactylifera), skim milk powder (brand: Farmer fresh), honey (brand: Dabar), butter (brand: Amul), and salt (brand: Tata) were purchased from markets of Jalandhar, Punjab. The majority of the chemicals and additives utilized in this research study were of analytical grade quality and available from the university laboratory.

Extraction of Pulp

The selected ripen bananas were peeled and cut into small pieces, then transfer it in to a blender to create a smooth, uniform banana pulp. For preparing date pulp, the pits were removed from the dates, and the flesh was kept apart. These date flesh were soaked in water for a few hours. After soaking, the date pieces were drained and blended until a smooth, consistent date pulp was achieved.

Preparation and Standardization of Candy

The control candy formulation consisted of 100g banana puree, 40g skim milk powder, 30ml honey, 12g butter, 0.5g salt, and 3g pectin. Seven different formulations were prepared by changing the ratio for banana pulp and date pulp were 100:0 (control); 95:5; 90:10; 85:15; 80:20; 75:25 and 70:30 w/w. Across all formulations, the amounts of skim milk powder, honey, butter, salt, and pectin matched the control.

Table 1:Different level of pulp and ingredients for standardization of candy

	Amount of pulp		Other ingredients					
Treatment Number	**Banana pulp %**	**Dates pulp %**	**Skim milk powder g/100ml pulp**	**Butter g/100ml pulp**	**Salt g/100 ml pulp**	**Honey ml/100 g**	**Pectin g/100ml pulp**	**Water ml**
T1	100	0	40	12	0.5	30	3	40
T2	95	5	40	12	0.5	30	3	40
T3	90	10	40	12	0.5	30	3	40
T4	85	15	40	12	0.5	30	3	40
T5	80	20	40	12	0.5	30	3	40
T6	75	25	40	12	0.5	30	3	40
T7	70	30	40	12	0.5	30	3	40

Preparation of Candy

The candy-making process begins with blending banana and dates pulp, followed by cooking the mixture until it reduces to half its original volume, enhancing flavour and sweetness. Skim milk powder, dissolved in water, is then incorporated, enriching the mixture with proteins and adding creaminess. Heating continues until the total soluble solids (TSS) content reaches a desired level, typically 70–75° Brix, intensifying sweetness and viscosity. Further ingredients like honey, butter fat, and salt are added to balance flavours and enhance richness, enhancing the candy's completeness. The mixture undergoes another heating phase until TSS content achieves 80–82° Brix, ensuring proper consistency and texture. Just before completing the process, potassium sorbate at a concentration of 200 ppm was added to act as a preservative for the candy. Once the candy base is prepared, it spread onto a prepared surface, marked into rectangular shapes, and left to cool and set for 6-7 hours, allowing flavours to meld and textures to solidify. Finally, the set candy is cut into small pieces and stored in flexible pouches to maintain the freshness for prolonged enjoyment.

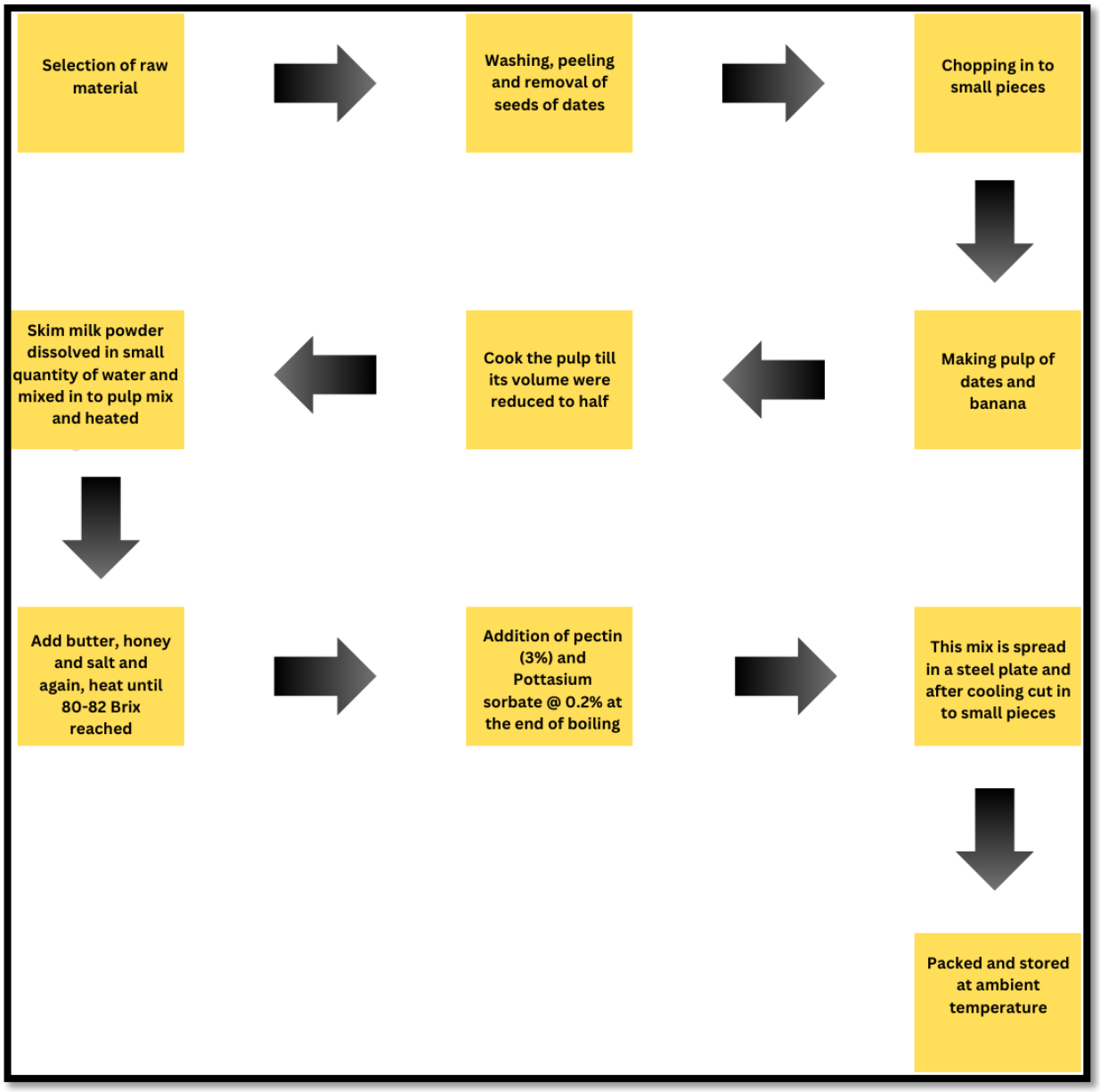

Fig 1: Flow chat for the preparation of Banana, dates and skim milk powder candy

Sensory evaluation

The sensory evaluation was carried out by panelists using a 9 point hedonic scale from 1 to 9 (Mohite et al., 2020).A semi-trained panel of 12 members were participated in the evaluation of product on several sensory attributes including taste, flavour, colour, texture, mouthfeel, and overall acceptability. The panelists individually rated the product sample for each sensory attribute by selecting a number on the 9-point scale that best reflected their perception and preference level. Their scores were then compiled and analyzed statistically to determine the sensory profile and acceptability of the product.

Nutritional and qualitative analysis

Proximate Analysis

Moisture, ash, fat, crude fibre, protein, carbohydrate and energy value of candy was determined as per method mentioned by the AOAC (2016).

Physio-chemical analysis

TSS, pH,titrable acidity and sugars

The total soluble solids, pH and titrable acidity were measured according to the standard procedures outlined by Ranganna, (2001). A hand refractometer was used to measure the total soluble solids. To measure the titrable acidity, the sample was titrated against a 0.1 Normal sodium hydroxide solution, employing a few drops of phenolphthalein as a colour indicator.An electronic pH meter model Cyber scan 510 was employed to measure the pH value, which indicates the acidity level. Estimation of total, reducing and non-reducing sugars were done by Lane and Eynon (1923).

Colour analysis

The colour (L*, a*, and b* values) of candy was determined according to AOAC 2005, using a Hunter colorimeter (MiniScan XE Plus, CIPHET, Ludhiana, India) with a 25 mm aperture set for D65 illumination and a 10° standard observer angle.

Phytochemical analysis

Total phenolic content and total flavonoid content

TPC and TFC in the candy were determined by spectrophotometrically according to the Folin–Ciocalteu and quercetin standard method respectively, as described by Mir et al., (2015). The results obtained were expressed as mg GAE/g for TPC and (QE)/g for TFC.

Antioxidant activity

The antioxidant activity was analysed by DPPH method outlined in the AOAC guidelines from 2005. The results were calculated as a percentage of inhibition, calculated by applying:

DPPH Inhibition percentage (%) = $(A_0 - A_S)/A_0 \times 100$.

Vitamin C

Vitamin C in the sample was assessed by method explained by Ranganna, (2000).

Shelf-life and storage study

a) **Microbial analysis**

Total plate count and Yeast and mould count

The total plate count study starts with dilution of the material until it reaches a concentration of 10-5 Each 1 ml of dilution sample is put into a 15-20 ml petri plate for microbial total analysis. To freeze the material in the petri dish, it is lifted. After this incubation is done, which is accomplished by placing a petri dish upside down in the incubator. The incubation period is 24-48 hours at 36°C. Last done calculation and recording colony growth (Arifan et al., 2019). To quantify the yeast and mould levels present in the samples, the dilution plate technique outlined by Cruikshank et al. in 1975 was employed. PDA was utilized as the growth medium for enumerating the fungal population within the samples.

b) Physical changes on storage

The prepared candy were packed in flexible aluminium pouch and stored at room temperature. Then open the candy at 7 days interval to analyse and observed the changes in its physical characters and assessed its storage stability up to 8 weeks. The changes occurred in the candy were noted and its storage stability were analysed.

Results and discussion

Sensory evaluation

Table 2: Sensory evaluation chart of Banana, dates and skim milk powder based candy

Treatment	Taste	Flavour	Colour	Texture	Mouth feel	Overall acceptability
T1	7.25	7.58	7.50	7.41	7.41	7.41
T2	7.41	7.33	7.58	7.41	7.33	7.58
T3	7.25	7.41	7.75	7.25	7.66	7.66
T4	7.50	7.58	7.33	7.41	7.50	7.58
T5	7.50	7.75	7.41	7.41	7.83	7.83
T6	7.66	7.91	7.83	7.83	7.83	7.91
T7	8.16	8.59	8.08	8.00	8.16	8.33

The sensory evaluation identified Treatment T7 as the best formulation among the seven developed candies based on its superior performance across all evaluated attributes. T7 exhibited highest values for taste (8.16), flavour (8.59), colour (8.08), texture (8.00), mouthfeel (8.16) and overall acceptability (8.33) followed

by T6. The formulation's success can be attributed to the optimal use of dates, which enhanced sweetness, flavour, and colour, combined with the complementary flavours of banana and the creamy texture provided by skim milk powder. This well-balanced and appealing candy formulation offers a delightful sensory experience, making it the preferred choice among the panellists.

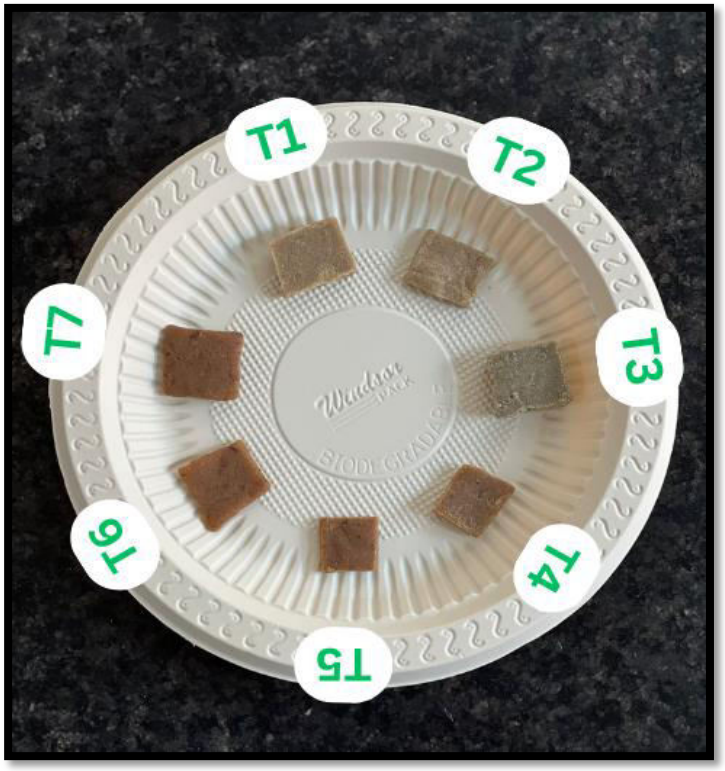

Figure 2: Banana, dates and skim milk powder based candy at different formulations

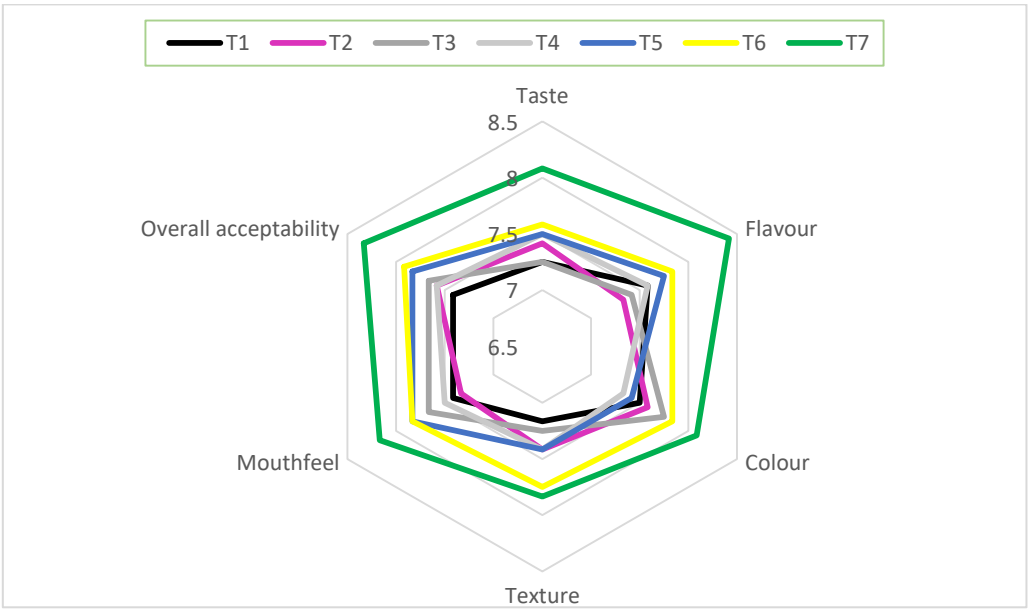

Figure 3: Graphical representation for sensory evaluation of candy

Nutritional and qualitative analysis

Proximate analysis

Table 3 Proximate analysis of candy at different treatments

Table 3 represents the proximate analysis variations across the different candy treatments (T1-T7).The candy samples from treatment T6 exhibited the maximum moisture level at 11.12%, whereas the T2 candy had the minimum moisture content of 10.34%.Although there were slight variations in moisture content among the remaining treatments, this may due to changes occur during the cooking, may depend on the physiochemical characteristics of raw materials etc., they were not as significant. The results reported by Yadav et al. (2017), provides further support for the validity and consistency of the obtained results.Treatment 7 exhibited the highest ash content at 2.84%, while control candy (T1) registers at 2.11%. In the remaining treatments (T2 to T6), ash percentage slightly increases from 2.10% to 2.71%. This uptick in ash percentage is attributed to the heightened concentration of dates, Mallah et al. (2017) Found that the range for dates were 1.35% to 1.95% and which is twice that of bananas. This marginal rise in ash percentage may be linked to the increased concentration of dates. The results we got were comparable with da silva et al. (2016).In our investigation crude fibre%ranged from 1.31% in the control candy to 1.62% in T7, with T6 following closely at 1.53%. Treatments T2 to T5 exhibited a range of 1.29% to 1.48% by slight increase. These findings align with the research conducted by da Silva et al. (2016), further validating the results. The control candy exhibited a protein content within the range of 4.59% which is at par to T7. Interestingly, minimal variations in protein content were noted among the different treatments. Notably, Treatment 7 showcased the highest protein content at 4.62% and lowest

Treatment	**Moisture (%)**	**Ash (%)**	**Fat (%)**	**Crude Fibre (%)**	**Protein (%)**	**Carbohydrate (%)**	**Energy Value (Kcal)**
T1	10.83	2.11	5.90	1.31	4.59	75.26	372.49
T2	10.34	2.10	5.78	1.29	4.38	76.12	373.98
T3	10.75	2.36	6.22	1.39	4.44	74.84	373.08
T4	10.60	2.47	6.13	1.43	4.49	74.88	372.66
T5	10.55	2.54	6.03	1.48	4.55	74.85	371.89
T6	11.12	2.71	6.27	1.53	4.41	73.95	369.93
T7	10.42	2.84	6.33	1.62	4.62	74.17	372.17
C.D	**0.08**	**0.05**	**0.06**	**0.04**	**0.03**	**0.16**	**0.60**

protein content was exhibited by Treatment 2 showing 4.38%. This consistency underscores the stability of protein levels across various formulations. Supporting our findings, Yadav et al. (2021) conducted a study on a candy formulated with banana, ginger, and skim milk powder. Their research revealed a protein content ranging from 2.21 - 4.69 %, aligning closely with our observations. This correlation strengthens the reliability and consistency of our study's outcomes regarding protein content in candy formulations.In the candy formulation, T2 exhibited the highest carbohydrate content, measured at 76.12%, while T6 had the lowest, with a carbohydrate content of 73.95%. Comparatively, the control candy contained 75.26% carbohydrates. These values indicate variations in carbohydrate composition across different candy formulations. It is noteworthy that the range of carbohydrate content observed in candy came between the findings from previous studies done by da Silva et al. (2016) in their research on sugar cane candies with roasted peanut and extruded rice bran andOnyekwelu and Nkemakonam(2018) in their study on candies from tiger nut and coconut milk blends. This consistency in carbohydrate content across different candy formulations, as observed in our study and supported by previous research, underscores the reliability and relevance of our findings.The results indicated that T6 showed the lowest energy value of 369.93 Kcal and highest were obtained for T2 showing 373.98 Kcal.These value were comparable to the findings found by Ray et al. (2021) ensures the validity of our product.

Table 4: Physiochemical analysis of developed candy at different treatments

Treatment	**TSS(°Brix)**	**pH**	**Titrable acidity (%)**	**Total sugar (%)**	**Reducing sugar (%)**	**Non reducing sugar (%)**
T1	82.58	6.10	0.25	53.63	36.89	16.74
T2	82.67	6.12	0.25	55.23	38.58	16.64
T3	82.90	6.27	0.24	57.10	40.48	16.62
T4	82.98	6.46	0.23	58.72	41.97	16.75
T5	83.54	6.55	0.21	60.67	43.81	16.86
T6	83.70	6.62	0.20	62.83	45.65	17.18
T7	83.85	6.81	0.19	63.97	47.93	16.03
C.D.	**0.09**	**0.06**	**0.01**	**0.64**	**0.53**	**N/A**

The physicochemical properties of the banana, date, and skim milk powder-based candies were evaluated across seven treatment formulations (T1-T7) with

varying ratios of banana and date pulps. A key parameter, total soluble solids (TSS), exhibited significant variations, with T7 (30% date pulp) recording the highest value of 83.85°Brix, while the control candy T1 (100% banana pulp) had the lowest TSS of 82.58°Brix. The TSS values demonstrated a gradual increasing trend with higher date pulp incorporation, suggesting that the inherent composition of date pulp, likely its higher sugar and soluble solids content, contributed substantially to elevating the TSS levels in the candies and potentially influenced the sweetness and flavour profile. These findings validate a previous study by Yadav et al. (2021), which reported similar trends in TSS for banana-based confections incorporating other components.

The pH values ranged from 6.10 (T1) to 6.81 (T7), exhibiting a clear increasing trend as the date pulp concentration increased from T1 to T7. This pH range falls within the desirable slightly acidic to neutral region for most candy products (Lees and Jackson, 1992). The observed pH increase can be attributed to the relatively higher pH of dates compared to bananas (Codex Alimentarius Commission, 2005), indicating that the date pulp addition effectively modulated the pH of the candy formulations.An inverse relationship was observed between titrable acidity and date pulp concentration, with values decreasing from 0.25% (T1, 100% banana pulp) to 0.19% (T7, 30% date pulp). This trend can be explained by the higher natural acidity of bananas, primarily due to the presence of citric and malic acids (Tapre and Jain, 2012), compared to the relatively low acidity of dates (Baraem et al., 2006). As the more acidic banana pulp was gradually replaced by the less acidic date pulp in the formulations, the titrable acidity decreased correspondingly.

The total sugar content of the candy formulations exhibited a substantial increasing trend as the date pulp concentration increased. Treatment T7, containing 30% date pulp, displayed the highest total sugar percentage of 63.97%, while T1, with 100% banana pulp, had the lowest value of 53.63%. This observed trend can be attributed to the inherently higher natural sugar content of dates compared to bananas. Dates are known to be rich in sugars, primarily consisting of fructose and glucose (Rahman and Al-Farsi, 2005), whereas bananas contain a lower proportion of these sugars, with sucrose being the predominant sugar component (Mosa et al., 2016). Consequently, as the higher-sugar date pulp progressively replaced the lower-sugar banana pulp in the formulations, the overall sugar content of the candies increased correspondingly. A similar increasing trend was observed for reducing sugars, with values ranging from 36.89% in T1 to 47.93% in T7. This trend aligns with the higher reducing sugar composition of dates, primarily consisting of fructose and glucose (Al-Farsi et al., 2005), compared to the lower reducing sugar content of bananas. In the case of non -reducing sugar T6 exhibited the higher value and lowest were exhibited by T7

Colour analysis

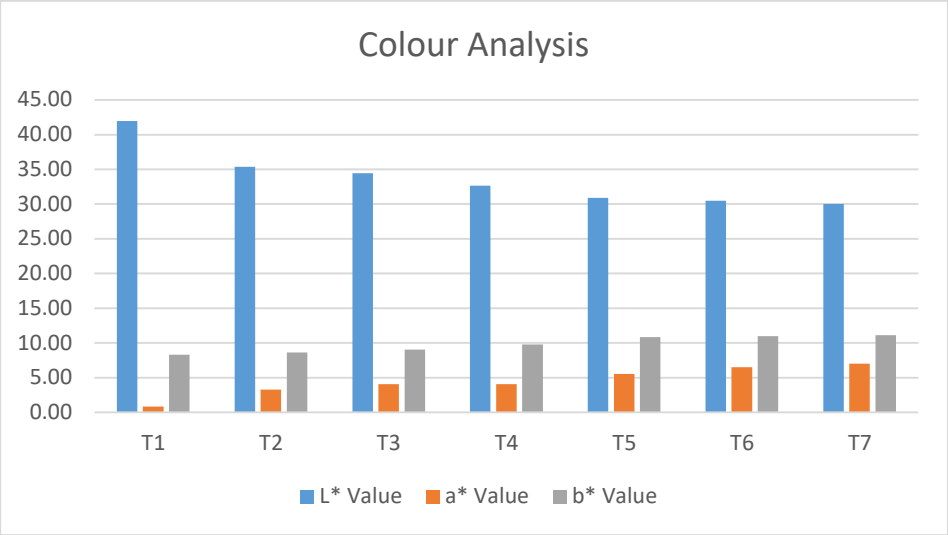

Figure 4: Graphical representation of L*, a* and b* value of developed candy

The colour properties of the banana-date candies were instrumentally measured using the Lab* system. There were clear colour differences across the candy treatments corresponding to the ratio of banana to date pulp. Treatment 1 (T1) with 100% banana pulp had the highest L* value of 41.94, indicating a lighter yellow colour. As date pulp was increased from T2 to T7, the L* values progressively decreased to around 30, showcasing a darker brown colour development. The a* values transitioned from slightly positive (reddish) for the banana-heavy samples like T1 (a* = 0.85) to moderately positive reddish-brown shades in the date-enriched candies, with T7 having a* value of 7.01. Similarly, the b* values representing yellowness/browning intensities increased from 8.29 for T1 up to 11.11 for T7 containing 30% dates, demonstrating the browning effect of the date content. Similar trend in decrease in L* value and increase in a* and b*value were noted by Yadav et al. (2021) while decreasing the concentration of banana pulp and increasing the concentration of ginger pulp along the treatments used for the development of functional candy.As date content increased in the formulations from T2 to T7, there was a cumulative browning effect from the cultivation of these darker date pigments, causing corresponding decreases in L* lightness along with increases in a* redness and b* yellowness/browning intensities according to the Lab* colour space.The distinctive colour properties of banana and date components enables developing candies with engineered colour profiles tailored for specific applications or consumer preferences. More banana-forward candies like T1 provide a bright, vibrant yellow appearance while more date-enriched options offer deeper, richer brown shades.

Phytochemical analysis

Table 5:Phytochemical analysis of banana, dates and skim milk powder based candy

Treatment	TPC (mg GAE/g)	TFC (mg QE/g)	Antioxidant activity (%)	Vitamin C (mg/100g)
T1	3.83	2.22	30.13	6.02
T2	4.06	2.48	31.05	6.55
T3	5.72	2.05	33.97	6.47
T4	6.73	2.00	33.83	6.32
T5	7.68	1.91	31.94	6.20
T6	8.46	1.68	32.84	5.87
T7	8.70	1.75	35.93	5.92
C.D.	**0.22**	**0.03**	**0.75**	**0.06**

Total phenolic and flavonoid content

The phytochemical analysis of banana, date, and skim milk powder-based candies revealed significant differences in Total Phenolic and Flavonoid content across different formulations (T1-T7). The control candy (T1), containing no date pulp, exhibited the lowest TPC at 3.83 mg GAE/g. In contrast, T7, with the highest date pulp content, showed the highest TPC at 8.70 mg GAE/g, demonstrating a clear correlation between increased date pulp and higher phenolic content. This trend suggests that incorporating dates into the candy formulations significantly boosts their phenolic compound levels, potentially enhancing their health-promoting properties.This enhancement in phenolic content aligns with findings by Yadav et al. (2021), who reported similar increases in phenolic content with the addition of other fruit-based ingredients.

The highest TFC was found in T2 (2.48 mg QE/g), followed by the control candy T1 (2.22 mg QE/g). The lowest TFC was recorded in T6 (1.68 mg QE/g). Other formulations showed varying TFC levels: T3 (2.05 mg QE/g), T4 (2.00 mg QE/g), T5 (1.91 mg QE/g), and T7 (1.75 mg QE/g). These variations suggest that while date pulp increases TPC, its effect on TFC is less consistent, possibly due to different processing conditions and the inherent properties of the dates. Our results aligned closely with the conclusions drawn by Yadav et al. (2021).

Antioxidant activity

From the study, T7 exhibited the highest antioxidant activity at 35.95%, whereas the control candy (T1) showed the lowest activity at 30.15%. The other treatments exhibited only slight differences in their values. When the results of Control candy and Formulated Candy were compared with each other, significantly higher DPPH values were obtained for formulated candy because of the presence of high phytochemicals in date pulp. These findings align with similar DPPH values reported by Yadav et al. (2021). Yin et al. (2018) observed that heating near 100°C can slightly enhance antioxidant activity, suggesting that cooking temperatures might influence these properties. The variation in antioxidant activity across different processing methods is not solely due to the gain or loss of natural antioxidants. It can also be due to the presence of highly heat-stable natural antioxidants, the synergistic interaction between antioxidant compounds, and the formation of new compounds with pro-oxidant or antioxidant properties (Nicoli et al., 1999).

Vitamin C

Ascorbic acid, a form of vitamin C, serves as a potent antioxidant, protecting plants from damage induced by reactive oxygen species. Beyond its antioxidant role, ascorbic acid contributes to photosynthesis by safeguarding the photosynthetic machinery from oxidative harm. It also participates in regulating plant hormone levels, facilitating enzymatic reactions, and aiding in cell wall formation (Pehlivan, 2017). Banana is the primary source of vitamin C in our candy and also skim milk powder also contributing a small amount. T2 exhibited the highest vitamin C content at 6.55 mg/100g, followed by T3 with 6.47 mg/100g. The lowest vitamin C content was observed in T6, with 5.87 mg/100g. The remaining samples had vitamin C contents as follows: T4 (6.32 mg/100g), T1 (6.02 mg/100g), T7 (5.92 mg/100g), and T5 (6.20 mg/100g). Nhan and Quyen, (2023) found that the amount of vitamin C in strawberry soft candy varied depending on cooking temperature and time. Similarly, the final vitamin C content in our candies likely depends on these cooking factors, highlighting the importance of optimizing processing conditions to preserve this essential nutrient.

Shelf-life and storage study

Microbial analysis

Table 6: Microbial count (cfu/ml) of developed candy for 8 weeks

Treatment	T1	T2	T3	T4	T5	T6	T7
0th day	-	-	-	-	-	-	-
1st week	1.3×10^1	1.3×10^1	1.2×10^1	1.3×10^1	1.3×10^1	1×10^1	1×10^1
2nd week	1.4×10^1	1.4×10^1	1.4×10^1	1.4×10^1	1.4×10^1	1.2×10^1	1.2×10^1
3rd week	1.6×10^1	1.5×10^1	1.5×10^1	1.6×10^1	1.5×10^1	1.3×10^1	1.3×10^1
4th week	1.8×10^1	1.6×10^1	1.6×10^1	1.7×10^1	1.6×10^1	1.4×10^1	1.4×10^1
5th week	1.9×10^1	1.8×10^1	1.7×10^1	1.8×10^1	1.7×10^1	1.5×10^1	1.5×10^1
6th week	2×10^1	2×10^1	1.9×10^1	1.9×10^1	1.9×10^1	1.7×10^1	1.6×10^1
7th week	2.4×10^1	2.4×10^1	2.2×10^1	2.2×10^1	2.1×10^1	1.9×10^1	1.9×10^1
8th week	2.6×10^1	2.5×10^1	2.5×10^1	2.6×10^1	2.5×10^1	2.2×10^1	2.1×10^1

The Table 6shows microbial counts in various candy formulations (T1 to T7) over 56 days, measured at nine intervals. Microbial counts generally increased over time, with T6 and T7 consistently having lower counts compared to T1 through T5. Initially, all formulations had no microbial growth. By the first week, counts ranged from 1×10^1 to 1.3×10^1 cfu/ml, and by the eighth week, counts had doubled to between 2.1×10^1 and 2.6×10^1 cfu/ml, with T7 having the lowest and T1 the highest counts. This suggests these treatments inhibited microbial growth, due to high sugar content, which can lower water activity and extend shelf life. According to Gilbert (2000), the acceptable limit for total aerobic counts in ready-to-eat foods is below 104 – 106 cfu/ml, interestingly, for all formulations, the yeast count remained consistently at 0 CFU throughout the entire period. The study confirms the findings of Kiranmai et al. (2018) who conducted shelf life of tamarind candy blended with mango pulp upto 90 days, until 60 days there were the presence of yeast and mould were not detected. This indicates that the treatments may have effective inhibitory properties against yeast growth

Physical changes on storage

Table 7: Storage analysis of developed candy in flexible aluminium pouch

Day	Observation
1st week	There is no variation in colour, odour, texture and flavour.
2nd week	There is no variation in colour, odour, texture and flavour.
3rd week	There is no variation in colour, odour, texture and flavour.
4th week	There is no variation in colour, odour, texture and flavour.
5th week	There is no variation in colour, odour, texture and flavour.
6th week	No change in colour, odour, taste and slight change in texture
7th week	Slight change in colour were observed. Odour remained same and taste changed slightly for the treatments except T7. Slight Change in texture observed for whole treatments.
8th week	Slight change in colour observed for whole treatments. Odour and taste changed along with change in texture for whole treatments.

for 8 weeks

The shelf-life and changes occurring in the candy were assessed over 8 weeks at room temperature. Stored in flexible aluminium pouches, candies from treatments T1 to T7 were observed weekly for changes in colour, odour, texture, and taste. For the first 5 weeks, no significant changes were noted in any sensory attributes, maintaining their initial appearance, aroma, texture, and flavour. By week 6, candies began to firm up slightly, but colour, odour, and taste remained unchanged. In week 7, further textural changes and slight darkening of colour were observed, with T7 retaining its distinct date flavour. By week 8, significant colour degradation, noticeable off-notes in odour and taste, and continued firming of texture were evident. These results suggest the candies have a shelf

life of about 6-7 weeks at ambient temperature before sensory quality declines. This finding aligns with Sawant et al. (2020), who reported similar stability in hard candies stored under refrigerated conditions. Despite a relatively short shelf life, the candies showed reasonable stability for at least 6 weeks, allowing time for production, distribution, and consumption.

Conclusions:

The present study successfully developed a nutritious and delicious candy formulation by incorporating banana, dates, and skim milk powder as the primary ingredients. Through a systematic approach, various combinations of these ingredients were explored, and Treatment T7, containing 70% banana pulp and 30% date pulp, emerged as the most promising formulation based on its superior sensory attributes, including taste, flavour, colour, texture, mouthfeel, and overall acceptability followed by T6 having 85% banana pulp and 25% dates pulp. The incorporation of dates into the candy formulation significantly enhanced the nutritional profile by increasing the levels of beneficial phytochemicals, such as phenolic compounds and flavonoids, and boosting the antioxidant activity of the product. The physicochemical analysis revealed that the candy formulations exhibited desirable properties, including appropriate levels of total soluble solids, pH, titratable acidity, and sugars. The colour analysis demonstrated the ability to engineer specific colour profiles by adjusting the ratios of banana and date pulps, offering flexibility in product development.The microbial analysis and storage study indicated that the developed candies had a shelf life of approximately 6-7 weeks when stored at room temperature in flexible aluminium pouches, without affecting its texture.Overall, this research approach successfully developed a nutritious and indulgent homemade candy that caters to the growing consumer demand for healthier snack options. The unique combination of banana, dates, and skim milk powder offers a guilt-free indulgence with a desirable taste and texture, while also providing valuable nutrients and bioactive compounds. The findings of this study pave the way for further exploration and commercial development of functional and innovative candy products that align with current health trends.

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