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Studies on shelf life of date (*Phoenix dactylifera* L.) peda

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Abstract

Present investigation entitled "Process standardization of date (*Phoenix dactylifera* L.) peda" was undertaken during the year 2020-2021. Initially, the pre-experimental trails were conducted to choose the form of date to be used for preparation of *peda*. The *peda* samples were subjected to sensory evaluation. On the basis of results of sensory evaluation, treatments were finalized for experimental trails.

The 15%, 20% and 25% levels of date syrup were chosen for experimental trails. The sugar level 25% of *khoa* was kept constant for all the treatments.

The experimental date *peda* samples were stored at 30 °C temperature during storage period of 9 days. The samples were analyzed for sensory, chemical and microbiological qualities on day 0 (fresh), 3, 6 and 9th day of storage period. Under chemical analysis fat, protein, total solids, ash, reducing sugar, total sugar, vitamin A, total fibre, titratable acidity (% LA), pH, moisture and free fatty acids were determined at different stages of storage period. The mean colour and appearance score for date *peda* samples varied from 7.31 (T₃) to 8.40 (T₀), 7.30 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.28 (T₂) and 7.18 (T₃) to 7.40 (T₁), on day 0, 3, 6 and 9th day of storage. The body and texture score varied from 7.29 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.40 (T₀), 7.22 (T₃) to 8.18 (T₂) and 7.18 (T₃) to 8.00 (T₂), on day 0, 3, 6 and 9th day of storage. The flavour score of *peda* samples varied from 7.31 (T₃) to 8.41 (T₂), 7.25 (T₃) to 8.40 (T₂), 7.22 (T₃) to 8.20 (T₂) and 7.16 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage at 30 °C. The overall acceptability score varied from 7.27 (T₃) to 8.39 (T₂), 7.25 (T₃) to 8.36 (T₂), 7.22 (T₃) to 8.31 (T₂) and 7.20 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage at 30 °C.

The fat, protein, total solids, reducing sugar, total sugar, titratable acidity, pH, total fibre, ash, moisture, free fatty acids and vitamin A of date *peda* samples ranged from 21.38 to 23.45%, 15.13 to 15.58%, 83.57 to 87.12%, 13.23 to 16.62%, 42.57 to 44.15%, 0.33 to 0.48% LA, 6.18 to 6.35, 0.0 to 2.49%, 2.82 to 3.22%, 14.92 to 16.43%, 0.09 to 0.26% oleic acids and 61.73 to 206.76 IU, respectively up to 9 days of storage period.

The SPC of date *peda* samples increased from 2.40 x 10² cfu/g to 4.20 x 10² cfu/g on a day 0, 2.80 x 10³ cfu/g to 4.80 x 10³ cfu/g on a 3rd day, 3.00 x 10³ cfu/g to 5.00 x 10³ cfu/g on a 6th day and 3.40 x 10³ cfu/g to 5.80 x 10³ cfu/g on 9th day of storage. The YMC count ranged from 1.40 x 10² cfu/g to 3.00 x 10² cfu/g on a 3rd day, 1.80 x 10³ cfu/g to 3.60 x 10³ cfu/g on a 6th day and 2.20 x 10³ cfu/g to 4.00 x 10³ cfu/g on a 9th day. No coliform counts were observed in the product during of 9 days storage period.

Keywords: Date, peda, sensory quality, chemical quality, microbiological quality, storage

Introduction

Peda is popular indigenous *khoa* based heat desiccated milk product, which is prepared from cow milk, buffalo milk or a combination thereof. It has been reported that the quantity of *pedha* produced in India exceeds any other indigenous milk based sweet using *khoa* as a raw material (Mahadevan, 1991) [25]. *Peda* is indisputable product having economic importance especially in rural parts of India, as it provides good means of utilizing economically small quantity of surplus milk. Economically, it has a unique importance in the market because it is liked by all classes of people. *Peda* has special importance in various celebrations like wedding, inaugural functions, to celebrate success in examinations or in such other events. Hindus, mostly offer *peda* to God as a 'Prasad' which is then distributed to public.

Peda is highly nutritious product as it contains almost all milk solids plus sugar and other additives. It is indigenous milk sweet prepared by heating a mixture of *khoa* and sugar until the desired granular, hard texture and flavor develops. Several varieties of *peda* are sold in the market namely, in Uttar Pradesh *Mathura peda* are small and round in shape, have caramel flavour and have a longer keeping quality. In Gujrat and western part of the country *white pedas* are preferred, which are usually made from buffalo milk. Certain other varieties of *pedha* like *Elaichi pedha*, *Malai pedha*, *Keshar pedha*, *Rajkot pedha* etc. are also found in the markets of different parts of the India. There are different types of famous *peda* brands recognized by locality or producer.

To place few examples from Maharashtra are *Chitale*, *Ghodake* and *Kaka halwai peda*. Similarly *kandi pedha* from Satara is recognized for its brown colour and caramalized flavour and in Ahmednagar city (M.S.) *Rajur pedha* is famous for its flavour.

All the types of *peda* have distinct characteristics and method of manufacture vary from region to region. The base for all these types of *peda* is, however, *khoa* and cane sugar in different proportions. Other ingredients are also incorporated to cater the special need of flavour, body and texture characteristics. Many research workers have tried to utilize different ingredients in the form of vegetables, fruits and nuts in milk products such as *gajar ka halwa*, *kaju burfi* and *sohan halwa* with an aim to improve nutrient, fiber content, texture, mouthfeel and flavor. Cereals like rice and wheat in the form of maida and suji was also tried in milk products, such as *kheer*, *gulabjamun* (De *et al.*, 1980). Cereals, medicinal plants, nuts and fruits like dried date in *brown peda* (Gotarne, 2011) [14], *rice bran brown peda* (Dixit, 2017) [9], *ginger peda* (Gavhane *et al.*, 2015) [12], *bottle gourd pulp peda* (Ghule *et al.*, 2013) [13], *red pumpkin pulp peda* (Bhutkar *et al.*, 2015) [5], *inulin fiber peda* (Sankpal *et al.*, 2018) [31] *etc.*

The date palm (*Phoenix dactylifera* L.) is one of the major fruit trees in Egypt (EI-Assar *et al.*, 2005) [11]. The date palm (*Phoenix dactylifera* L.) belongs to the Arecaceae (or palmae) family and consists of three parts: flesh with thin crust, date pit, and cap. The word 'Date' to refer to the fleshy part of the fruit. Date is very sweet, comprises about 50–88% of the total weight according to cultivar, stage of ripening, and water content. Sugars make up about two thirds of date flesh with water about one fifth. The rest of date weight includes protein, fat, crude fibre, minerals, different vitamins (especially vitamin B), tannins and many other components (Hashempoor, 1999) [15].

Date fruit has anti-tumor activity (Ishurd and Kennedy, 2005) [19], antioxidant and anti-mutagenic properties). Polysaccharides isolated from dates showed an antitumor activity (Ishurd and Kennedy, 2005) [19].

The date fruit has 3.1-7.1% moisture, 2.3-6.4% protein, 5.0-13.2% fat and 0.9-1.8% ash (AI-Farsi *et al.*, 2007) [1]. Dates are rich in sugar ranging from 65% to 80% on dry weight basis mostly of inverted form glucose and fructose (Lambiotte, 1982) [23]. Date syrup contains in addition to sugar, macro and micro elements particularly high iron content (AI-Khateeb, 2008) [2]. The consumption of dates benefit in glycaemic and lipid control of diabetic patients (Miller *et al.*, 2002) [27]. Date syrup as a natural and nutritional additive is one of the best choice for milk flavoring and a safe alternative to added sugar to produce dairy products. Dates or date products provide unique functionality when used with other products including sweetening, flavouring and increasing nutritional quality.

The fruit has been recommended in folk remedies for the treatment of various infectious diseases and cancers (Duke, 1992) [10]. Moreover, most of the carbohydrates in this product are in the form of fructose and glucose, which are easily absorbed by the human body. The presence of natural antioxidants and phenolics in dates make them suitable against different maladies like infectious and bacterial diseases, diabetes, hyperlipidaemia, and cancer.

Incorporation of plant origin material in milk or milk products, directly or indirectly adds dietary fiber in human food. So far the research on incorporation of plant and fruit origin materials in milk and milk products has been focused on value addition to improve acceptability, taste and flavor

development.

Materials and Methods

The material used and methods employed for conducting the experiments are as follows.

Materials

Fresh, clean, composite samples of buffalo milk utilized for preparation of *peda* was procured from local source. The khunti with flattened end with a relatively sharp edge with long handle was used for stirring cum-scrapping the milk. Good quality, clean, crystalline, white cane sugar was procured from local market. Good quality fresh date syrup manufactured by Lion dates Impex Pvt Ltd. Chennai was used during study. An iron karahi having 31 cm diameter and 8.5 cm depth was used for the desiccation of milk. Lab HOSP make hot air oven Mumbai (India) was used for determination of moisture and drying purpose. Electronic weighing balance manufactured by CONTECA, Pune was used for weighment purpose. Tempo make, Nashik (India) muffle furnace was used for determination of ash content in the samples. A colony counter with magnifying len was used for counting the colonies formed by microorganisms. An instrument manufactured by Kirloskar Electronic Ltd., Mumbai (India) was used for microbiological work. Stainless steel trays with 45 cm length, 25 cm width and 2 cm height were used for keeping *peda* samples. B.O.D. Incubator manufactured by STEELMET NOVATECH, Pune (India) was used for incubation purpose. Rectangular cardboard boxes with butter paper lining was used as packaging material for *peda*.

Methods

Preparation of date *peda*

The *peda* samples were prepared as per the procedure described by Dharma Pal *et al.*, (1998) with suitable modifications.

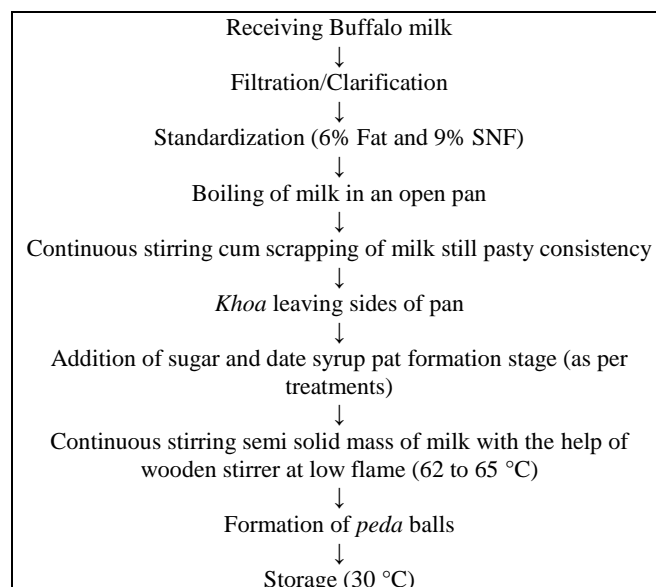


Fig 1: Flow diagram for manufacturing of *peda*

Sensory evaluation

The samples of *peda* under pre-experimental and experimental trails were subjected to the organoleptic evaluation by adopting 9 point hedonic scale as per IS: 6273 Part I and Part II (1971). A panel of five semi-trained judges was formulated for this purpose. The samples were coded

every time to conceal their identity and offered to the judges for evaluation of the quality attributes.

The trials were conducted to choose the form of date to be used in the preparation of *peda*. The *peda* samples were subjected to sensory evaluation. On the basis of results of sensory evaluation, the treatments were chosen for experimental trails.

Treatment details

On the basis of the results of sensory evaluation during pre-experimental trials 15%, 20% and 25% levels of date syrup were chosen for experimental trails. The sugar level 25% of *khoa* was kept constant for all the treatments.

T₀: *Khoa* + without date syrup + 25% sugar

T₁: *Khoa* + Date syrup @15% on *khoa* weight basis + 25% sugar

T₂: *Khoa* + Date syrup @ 20% on *khoa* weight basis+ 25% sugar

T₃: *Khoa* + Date syrup @ 25% on *khoa* weight basis + 25% sugar

Microbiological Quality

Standard Plate Count (SPC)

Standard plate count (SPC) of *peda* samples was enumerated by the method described in IS: 5550(1970).

Coliform Count

Coliform count of *peda* samples was enumerated by the method described in IS:5550 Part- I (1970).

Yeast and Mould Count

Yeast and mould count (YMC) of *peda* samples was enumerated by the method described in IS: 5550 (1970).

Storage Studies

The *peda* samples were packaged in sterilized cardboard boxes and stored at 30 °C. The samples were analysed for sensory, chemical and microbiological quantities on day 0 (fresh), 3, 6, 9 or till the samples become sensorially unacceptable.

Statistical design and analysis of data

The experiment was laid out in completely Randomized Design (CRD) with five replications for experimental trials. The data was tabulated and analyzed according to Snedecor and Cochran (1994) [33].

Results and discussion

The results of the present investigation are presented and discussed here under following headings.

The samples of date *peda* prepared under different treatments were stored at room temperature (30 °C) for 9 days. The samples were withdrawn and monitored at pre-determined intervals of 3 days and analyzed for sensory, chemical and microbiological qualities on day 0, 3, 6 and 9. The analysis of stored samples was discontinued when the product was declared spoiled by the panel of judges.

Changes in sensory quality of date *peda* during storage

Colour and Appearance

The data regarding changes in colour and appearance of date *peda* samples during storage is presented in Table 1.

Table 1: Changes in colour and appearance of date *peda* during storage

Treatment	Colour and appearance			
	Day 0	Day 3	Day 6	Day 9
T ₀	8.40 ^a	8.40 ^a	8.00 ^b	7.38 ^a
T ₁	8.10 ^b	8.15 ^b	8.00 ^b	7.40 ^a
T ₂	8.31 ^a	8.30 ^a	8.28 ^a	7.36 ^a
T ₃	7.31 ^c	7.30 ^c	7.25 ^c	7.18 ^b
SE±	0.040	0.049	0.043	0.043
CD at 5%	0.120	0.148	0.128	0.128

The mean colour and appearance score for date *peda* samples varied from 7.31 (T₃) to 8.40 (T₀), 7.30 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.28 (T₂) and 7.18 (T₃) to 7.40 (T₁), on day 0, 3, 6 and 9th day of storage. It was revealed that the colour and appearance of date *peda* samples was significant ($p < 0.05$) at all the stages of storage at 30 °C. Colour and appearance score of *peda* samples was significantly ($p < 0.05$) decreased during storage at 30 °C.

As storage period enhanced original colour become dullish during storage of 9th days. The appearance of *peda* samples changes from fresh soft to harder as storage period enhanced. The changes taken place in the colour and appearance of the *peda* samples are reflected in the sensory score during storage.

The decrease in colour and appearance score of the date *peda* samples also might be due to bio-chemical changes taken place in the product and increased microbial load in the *peda* samples at 30 °C during storage.

The mean value for colour and appearance score of *peda* sample prepared with 25% date syrup (T₃) was 7.31 on 0 day which decreased to 7.30 on 3 day, 7.25 on 6 day and 7.18 on 9th day of storage at 30 °C. The product was became unacceptable due to visible mold growth observed on day 9th of storage on the surface of the *peda* sample.

Narwade (2003) [29] similar results have been observed in *peda* samples. Londhe *et al.* (2012) [24] reported decrease in colour and appearance score of brown *peda* during storage at 30 °C. Makhecha (2012) [26] examined decrease in colour and appearance score of Thabdi *peda* during storage at room temperature.

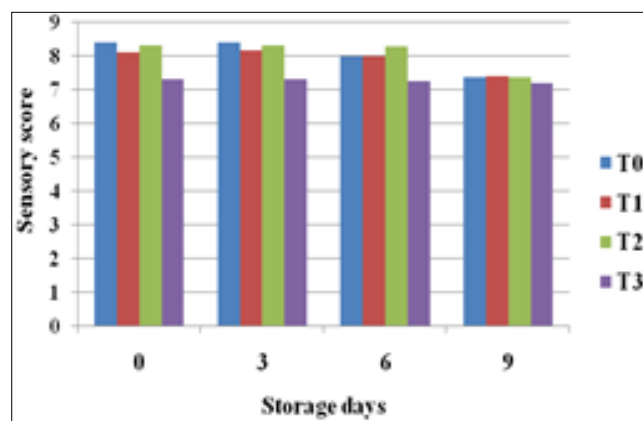


Fig 1: Changes in colour and appearance of date *peda* during storage

Body and Texture

The mean body and texture score of fresh and stored samples of date *peda* is depicted in Table 2.

Table 2: Changes in body and texture of date *peda* during storage

Treatment	Body and texture			
	Day 0	Day 3	Day 6	Day 9
T ₀	8.40 ^a	8.40 ^a	7.90 ^b	7.80 ^b
T ₁	8.02 ^b	8.22 ^b	7.90 ^b	7.80 ^b
T ₂	8.30 ^a	8.28 ^{ab}	8.18 ^a	8.00 ^a
T ₃	7.29 ^c	7.25 ^c	7.22 ^c	7.18 ^c
SE±	0.035	0.053	0.059	0.055
CD at 5%	0.105	0.161	0.179	0.166

The body and texture score varied from 7.29 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.40 (T₀), 7.22 (T₃) to 8.18 (T₂) and 7.18 (T₃) to 8.00 (T₂), on day 0, 3, 6 and 9th day of storage. It was revealed that, the body and texture of date *peda* samples was significant ($p < 0.05$) at all the stages of storage at 30 °C. The *peda* sample prepared without date syrup (T₀) had highest body texture score (8.40) among other *peda* samples in the study.

The *peda* sample prepared with 20% date syrup (T₂) had maintained better body and texture score (8.00) up to 9th day of storage at 30 °C. The body and texture score was 8.30, 8.28, 8.18 and 8.00 on day 0, 3, 6 and 9th day of storage at 30 °C.

On a day 6th and 9th day of storage, the *peda* sample prepared with 25% date syrup had the body and texture score *i.e* 7.22 declined up to 7.18.

The score for body and texture of the samples of date *peda* was decreased as the storage period advanced. The decline in score of the body and texture during storage may be due to loss of moisture and developed fungal growth on of the product during storage. The *peda* samples of T₀, T₁ and T₃ became unacceptable due to development of fungal growth on the surface and harder texture of *peda* samples.

Narwade (2003) [29] highlighted that the body and textural score declined from 8.47 to 6.45 of *pedha* samples packed in HDPE during storage of 12 days. Londhe *et al.* (2012) [24] reported that decrease in body and texture score of brown *peda* during storage at 30 °C.

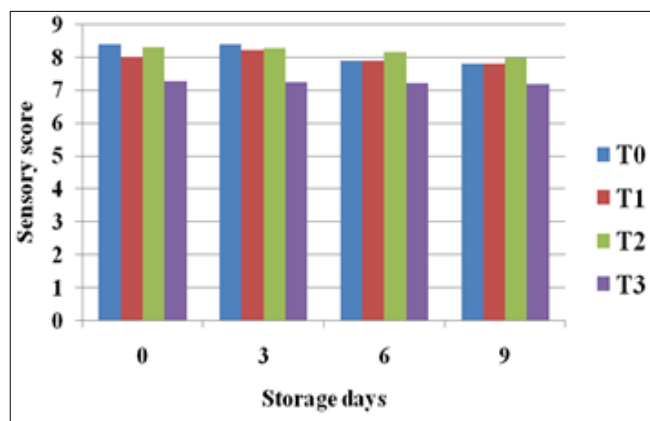


Fig 2: Changes in body and texture of date *peda* during storage

Flavour

The mean flavour score of fresh and stored samples of date *peda* is presented in Table 3. Flavour is probably the important criteria for measuring the quality of product, which in turn determine its acceptability. The flavour of any food product including *peda* is most important sensory attribute, as far as consumer likes is concerned because it determines its acceptance or rejection.

Table 3: Changes in flavour of date *peda* during storage

Treatment	Flavor			
	Day 0	Day 3	Day 6	Day 9
T ₀	8.37 ^a	8.35 ^a	8.00 ^a	7.80 ^b
T ₁	8.21 ^b	8.18 ^b	8.00 ^a	7.80 ^b
T ₂	8.41 ^a	8.40 ^a	8.20 ^a	8.00 ^a
T ₃	7.31 ^c	7.25 ^c	7.22 ^b	7.16 ^c
SE±	0.036	0.036	0.071	0.060
CD at 5%	0.108	0.110	0.214	0.181

It was seen that the mean flavour score of *peda* samples varied from 7.31 (T₃) to 8.41(T₂), 7.25 (T₃) to 8.40 (T₂), 7.22 (T₃) to 8.20 (T₂) and 7.16 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage at 30 °C. The sensory score for flavour attribute of *peda* samples significantly ($p < 0.05$) differed on day 0, 3, 6 and 9th of storage at 30 °C. The *peda* samples significantly ($p < 0.05$) differed among themselves on 0, 3, 6 and 9th days of storage. On a day 6th and 9th of storage all the *peda* samples significantly differed among themselves. On a 9th day of storage the flavour score declined to 8.00 (T₂) to 7.16 (T₃). This decline in the flavour score might be due to diminished freshness of the product, off flavour developed in the product, increased microbial load and physico-chemical changes taken place in the product during storage. The *peda* sample prepared with 20% date syrup (T₂) maintained acceptable flavour score (8.00) during storage of 9th days period at 30 °C. The flavour score of *peda* sample prepared with 20% date syrup (T₂) declined from 8.41 to 8.00 during storage. Similar observations were noticed by Narwade (2003) [29] in respect of *peda* samples. Londhe *et al.* (2012) [24] reported decrease in flavour score in *brown peda*.

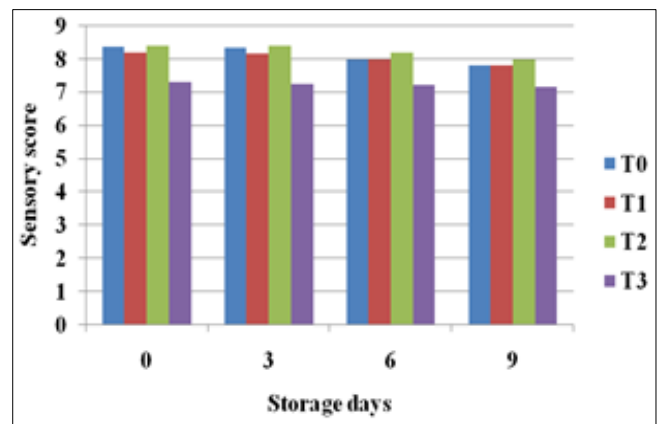


Fig 8: Changes in flavour of date *peda* during storage

Overall Acceptability

The overall acceptability score of fresh and stored samples of date *peda* is presented in the Table 4. The mean overall acceptability score varied from 7.27 (T₃) to 8.39 (T₂), 7.25 (T₃) to 8.36 (T₂), 7.22 (T₃) to 8.31 (T₂) and 7.20 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage. The overall acceptability of *peda* samples significantly ($p < 0.05$) decreased during storage of 9 days at 30 °C. All *peda* samples significantly differed among themselves at all the stages of storage period. It might be due to deterioration of the *peda* samples during storage. No doubt freshness of the date *peda* proved to be better on the day of production. The decreased score of overall acceptability with advancement of storage period may be attributed due to the declined sensory scores of colour and appearance, body and texture and flavour of the product, increased acidity content and microbial count in the

product during storage.

The overall acceptability score of all *peda* samples declined gradually during storage of 9 days storage period. The *peda* sample prepared with 20% date syrup (T_2) had highest overall acceptability score (8.39) among other *peda* samples under study during storage at 30 °C.

The overall acceptability score declined from 8.35 to 7.70, 8.20 to 7.80, 8.39 to 8.00 and 7.27 to 7.20 *peda* samples T_0 , T_1 , T_2 and T_3 , respectively.

The declined in overall acceptability in respect of *peda* prepared from 20% date syrup (T_2) score was 8.39 to 8.00. It was least declined in the sensory score as compare to other *peda* samples in the study. Hence the *peda* sample (T_2) was found better as far as overall acceptability is concerned.

Table 4: Changes in overall acceptability of date *peda* during storage

Treatment	Overall acceptability			
	Day 0	Day 3	Day 6	Day 9
T_0	8.35 ^a	8.35 ^a	8.29 ^a	7.70 ^b
T_1	8.20 ^b	8.16 ^b	8.11 ^b	7.80 ^b
T_2	8.39 ^a	8.36 ^a	8.31 ^a	8.00 ^a
T_3	7.27 ^c	7.25 ^c	7.22 ^c	7.20 ^c
SE ±	0.035	0.039	0.045	0.045
CD at 5%	0.105	0.118	0.135	0.136

The results are also in agreement with Sirsat (2012) reported that the overall acceptability score decreased significantly at 5, 10 and 15 per cent level of addition of ash gourd pulp as compared to control. Similar results have been observed in *brown peda* samples by Londhe *et al.* (2012) [24].

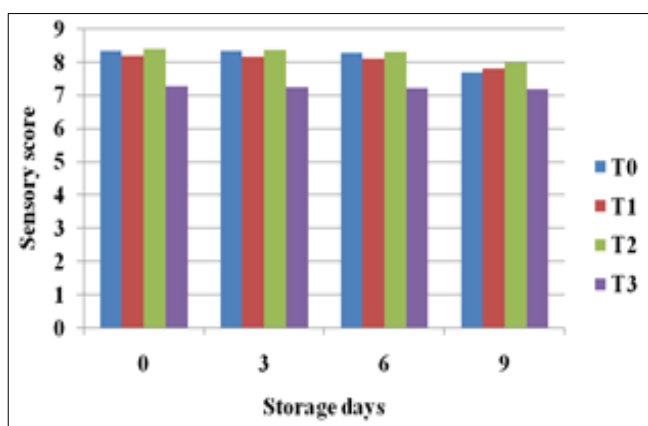


Fig 9: Changes in overall acceptability of date *peda* during storage

Changes in chemical composition of date *peda* during storage

Fat

The mean fat content of fresh and stored samples of date *peda* is presented in Table 5.

The mean fat content of *peda* samples varied from 21.58% (T_3) to 23.45% (T_0), 21.49% (T_3) to 23.40% (T_0), 21.43% (T_3) to 23.37% (T_0) and 21.38% (T_3) to 23.35% (T_0) on day 0, 3, 6 and 9th of storage. The fat content of *peda* samples significantly ($p < 0.05$) influenced during all the stages of storage. It was revealed that, the fat content in *peda* samples decreased as the storage period increased in all the *peda* samples. This might be due to the lipolytic activities of microbes in the samples. All treatments significantly differed among themselves during storage of 9th days.

Table 5: Changes in fat content of date *peda* during storage

Treatment	Fat (%)			
	Day 0	Day 3	Day 6	Day 9
T_0	23.45 ^a	23.40 ^a	23.37 ^a	23.35 ^a
T_1	22.52 ^b	22.45 ^b	22.40 ^b	22.36 ^b
T_2	21.56 ^c	21.53 ^c	21.50 ^c	21.45 ^c
T_3	21.58 ^c	21.49 ^c	21.43 ^c	21.38 ^c
SE ±	0.073	0.061	0.053	0.043
CD at 5%	0.219	0.185	0.160	0.130

More (2019) [28] reported the mean fat content in red pumpkin *burfi* samples decreased as the storage period enhanced at 30±1 °C.

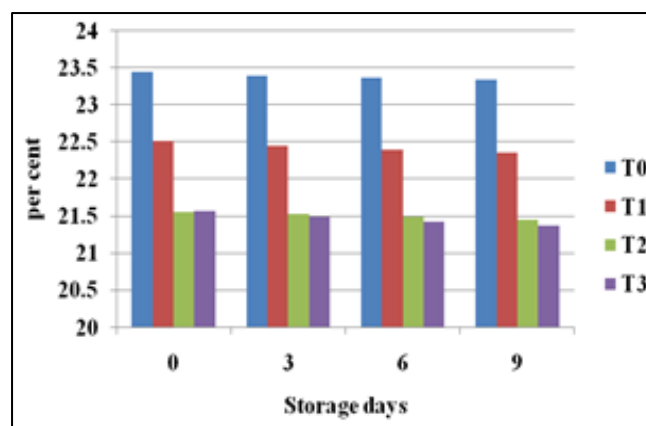


Fig 10: Changes in fat content (%) of date *peda* during storage

Protein

The mean protein content of fresh and stored samples of date *peda* samples is presented in Table 6.

Table 6: Changes in protein content of date *peda* during storage

Treatment	Protein (%)			
	Day 0	Day 3	Day 6	Day 9
T_0	15.21 ^b	15.20 ^b	15.16 ^b	15.13 ^b
T_1	15.45 ^a	15.44 ^a	15.41 ^a	15.40 ^a
T_2	15.52 ^a	15.45 ^a	15.40 ^a	15.38 ^a
T_3	15.58 ^a	15.50 ^a	15.45 ^a	15.41 ^a
SE ±	0.065	0.043	0.056	0.043
CD at 5%	0.197	0.131	0.168	0.131

The mean protein content of *date peda* sample varied from 15.21 (T_0) to 15.58 (T_3) per cent, 15.20 (T_0) to 15.50 (T_3) per cent, 15.16 (T_0) to 15.45 (T_3) per cent and 15.13 (T_0) to 15.41 (T_3) per cent, on day 0, 3, 6 and 9th of storage. The protein content in the product decreased as storage period enhanced.

It may be due to proteolytic changes in the *date peda* samples during storage.

More (2019) [28] reported the mean protein content in red pumpkin *burfi* samples decreased as the storage period enhanced at 30±1 °C.

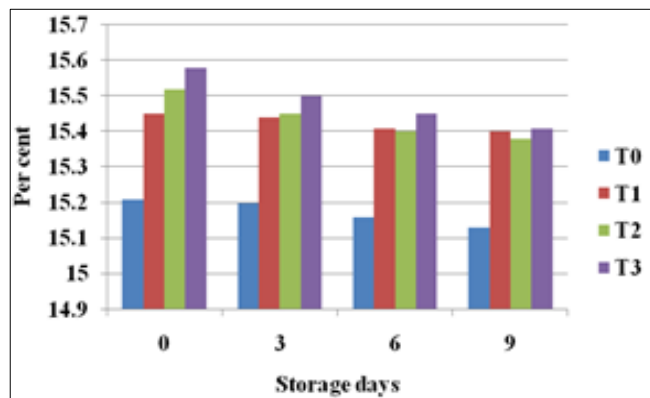


Fig 11: Changes in protein content (%) of date *peda* during storage

Total Solids

The mean total solids content of fresh and stored samples of date *peda* is presented in Table 7. The mean total solids content of date *peda* samples varied from 83.57% (T₃) to 84.08% (T₀), 84.20% (T₃) to 85.02% (T₀), 85.30% (T₃) to 86.10% (T₀) and 86.38% (T₃) to 87.12% (T₀) on day 0, 3, 6 and 9 of storage. The total solids content of *peda* samples significantly ($p < 0.05$) differed during storage of 9 days at 30 °C. All the *peda* samples significantly differed among themselves during storage. The total solids content increased as storage period advanced. It might be due to the loss of moisture from *peda* samples during storage period. A significant increase in the total solids content was observed at all the stages of storage.

Table 7: Changes in total solids content of date *peda* during storage

Treatment	Total solids (%)			
	0 Day	3 Day	6 Day	9 Day
T ₀	84.08 ^a	85.02 ^a	86.10 ^a	87.12 ^a
T ₁	83.66 ^b	84.11 ^b	85.13 ^c	86.19 ^b
T ₂	83.62 ^b	84.15 ^b	85.60 ^b	86.26 ^b
T ₃	83.57 ^b	84.20 ^b	85.30 ^{bc}	86.38 ^b
SE ±	0.099	0.165	0.116	0.122
CD at 5%	0.298	0.494	0.349	0.366

The results of present study are very well comparable with the observation recorded by Hemavathy and Prabhakar (1973)^[16], Bhatele (1983)^[3] and Kamble (2010)^[21]. Bhingardive (2012)^[4] observed that the average total solids percentage in the samples of wood apple *burfi* increased as the storage period extended. More (2019)^[28] reported that the mean total solids content in red pumpkin *burfi* samples increased as the storage period enhanced at 30±1 °C.

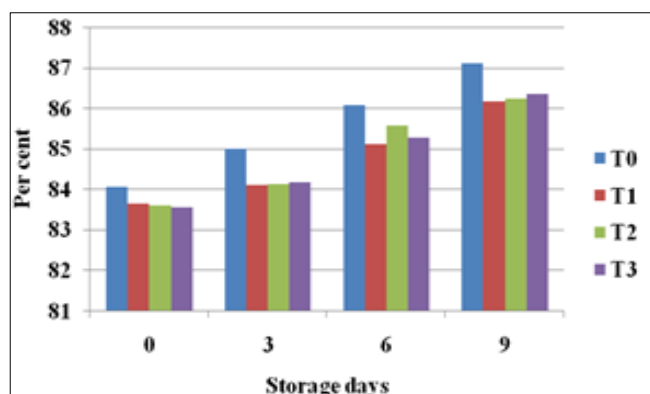


Fig 12: Changes in total solids content (%) of date *peda* during storage

Reducing Sugar

The data regarding the reducing sugar content of fresh as well as stored date *peda* samples is presented in Table 8. The mean reducing sugar content of date *peda* samples varied from 14.68 (T₀) to 16.62 (T₃) per cent, 14.40 (T₀) to 16.55 (T₃) per cent, 13.79 (T₀) to 16.00 (T₂) per cent and 13.23 (T₀) to 15.90 (T₂) per cent on day 0, 3, 6 and 9th of storage. The reducing sugar content of date *peda* samples significantly ($p < 0.05$) influenced during all the stages of storage 9 days at 30 °C. All *peda* samples significantly differed among themselves at all the stages of storage.

It was revealed that, reducing sugar content decreased significantly ($p < 0.05$) during storage. The mean reducing sugar content of date *peda* samples were decreased from 14.68 to 13.23, 15.17 to 14.40, 16.22 to 15.90 and 16.62 to 15.23 for treatments T₀, T₁, T₂ and T₃, respectively from day 0 to 9th day of storage.

Table 8: Changes in reducing sugar content of date *peda* during storage

Treatment	Reducing sugar (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	14.68 ^d	14.40 ^d	13.79 ^c	13.23 ^d
T ₁	15.17 ^c	15.10 ^c	14.79 ^b	14.40 ^c
T ₂	16.22 ^b	16.19 ^b	16.00 ^a	15.90 ^a
T ₃	16.62 ^a	16.55 ^a	15.79 ^a	15.23 ^b
SE ±	0.081	0.076	0.218	0.137
CD at 5%	0.243	0.228	0.656	0.412

Bhingardive (2012)^[4] observed decrease in reducing sugar percentage in the samples of wood apple *burfi* as the storage period extended. More (2019)^[28] reported that the mean reducing sugar content in red pumpkin *burfi* samples decreased as the storage period enhanced at 30±1 °C.

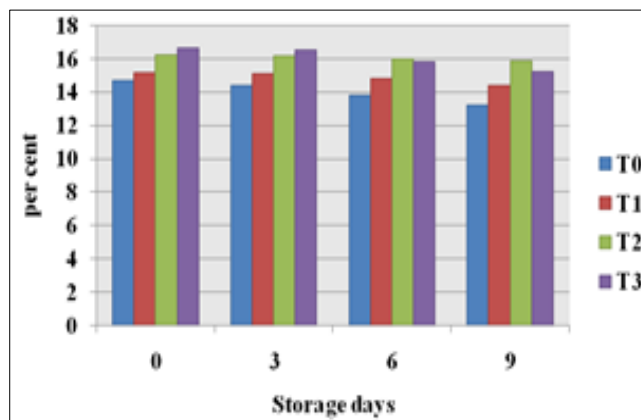


Fig 13: Changes in reducing sugar content (%) of date *peda* during storage

Total Sugar

The results of the total sugar content of fresh date *peda* samples as well as stored is presented in Table 9.

The mean total sugar content of *peda* samples varied from 42.59 (T₀) to 43.19 (T₃), 42.78 (T₀) to 43.27 (T₃), 42.93 (T₀) to 43.56 (T₃) and 43.10 (T₀) to 43.76 (T₃) per cent on day 0, 3, 6 and 9th day of storage. The total sugar content of *peda* samples significantly ($p < 0.05$) influenced during storage. All the *peda* samples significantly differed among themselves at all the stages of storage at 30 °C. From the table 4.21, it is revealed that, the mean total sugar content in the date *peda*

samples goes on increasing as the storage period inances at 30 °C. It may be due to gradual inversion of non-reducing sugars to reducing sugars by hydrolysis.

Table 9: Changes in total sugar content of date *peda* during storage

Treatment	Total sugar (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	42.59 ^b	42.78 ^b	42.93 ^b	43.10 ^b
T ₁	42.57 ^b	42.79 ^b	42.98 ^b	43.18 ^b
T ₂	43.39 ^a	43.70 ^a	43.93 ^a	44.15 ^a
T ₃	43.19 ^a	43.27 ^a	43.56 ^a	43.76 ^a
SE ±	0.085	0.145	0.137	0.151
CD at 5%	0.256	0.434	0.411	0.453

More (2019) [28] reported the mean total sugar content in red pumpkin *burfi* samples increased as the storage period enhanced at 30±1 °C. Bhingardive (2012) [4] observed increase in total sugar percentage in the samples of wood apple *burfi* as the storage period extended.

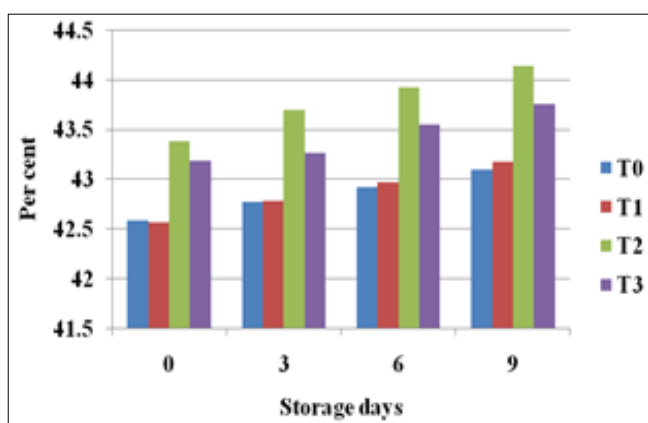


Fig 14: Changes in total sugar content (%) of date *peda* during storage

Titratable Acidity (% LA)

The mean titratble acidity content of fresh and stored samples of date *peda* samples is presented in Table 10. The development of acidity (% LA) is an important degradative chemical change, which occur in *peda*. The level of acidity may also serve as indicator to know the extent of microbial spoilage in many food products. The high acidity even influences the consumer’s acceptability of the product.

Table 10: Changes in Titratable acidity (% LA.) of date *peda* during storage

Treatment	Titratable acidity (% L.A.)			
	Day 0	Day 3	Day 6	Day 9
T ₀	0.33 ^b	0.35 ^c	0.37 ^d	0.41 ^c
T ₁	0.35 ^a	0.37 ^c	0.40 ^c	0.42 ^c
T ₂	0.36 ^a	0.39 ^b	0.42 ^b	0.44 ^b
T ₃	0.37 ^a	0.41 ^a	0.44 ^a	0.48 ^a
SE ±	0.006	0.006	0.004	0.006
CD at 5%	0.020	0.020	0.012	0.018

The mean titratable acidity of date *peda* samples varied from 0.33 (T₀) to 0.37 (T₃), 0.35(T₀) to 0.41(T₃), 0.37(T₀) to 0.44 (T₃) and 0.41(T₀) to 0.48 (T₃)% LA on a day 0, 3, 6 and 9th day of storage.

The titratable acidity of all the date *peda* samples were significant ($p < 0.05$) during all the stages of storage at 30 °C. The titratable acidity of *peda* samples increased significantly ($p < 0.05$) as storage period increased up to 9 days at 30 °C. It might be due to increase in microbial activity in the *peda* samples. The titratable acidity of *peda* samples increased from 0.33 to 0.41% LA, 0.35 to 0.42% LA, 0.36 to 0.44% LA and 0.37 to 0.48% LA for *peda* samples T₀, T₁, T₂ and T₃, respectively.

From the data, it is revealed, that the titratable acidity of *peda* increased as the storage period enhanced. Similar trend was observed by Ray *et al.* (2000) [30].

Londhe *et al.* (2012) [24] reported that increase in acidity of *lal peda* during storage for 20 days at 30 °C.

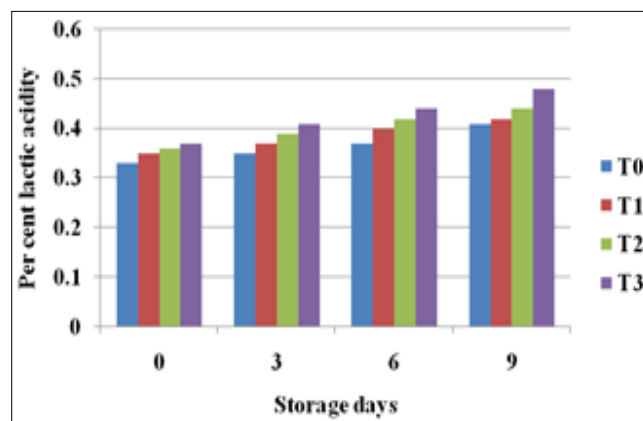


Fig 15: Changes in titratable acidity (% LA.) of date *peda* during storage

pH

The mean pH of fresh and stored samples of date *peda* is presented in Table 11. The pH of date *peda* samples ranged from 6.28 (T₃) to 6.35 (T₀), 6.24 (T₃) to 6.31 (T₀), 6.20 (T₃) to 6.28 (T₀) and 6.18 (T₃) to 6.24 (T₀) during 0, 3, 6 and 9th days storage at 30 °C. During storage there was gradual but significant ($p < 0.05$) decreased trend in pH values was observed in all *peda* samples. As the titratable acidity of the product increased, the pH values of the *peda* samples decreased. The decrease in pH might be due to increase lactic acid production by the spoilage organisms in the product during storage. The pH and titratble acidity are the indicators of microbial activity in dairy products. It affects sensory quality of product during storage.

Table 11: Changes in pH of date *peda* during storage

Treatment	pH			
	Day 0	Day 3	Day 6	Day 9
T ₀	6.35 ^a	6.31 ^a	6.28 ^a	6.24 ^a
T ₁	6.33 ^b	6.28 ^b	6.26 ^b	6.23 ^a
T ₂	6.30 ^c	6.27 ^b	6.24 ^c	6.18 ^b
T ₃	6.28 ^d	6.24 ^c	6.20 ^d	6.18 ^b
SE±	0.006	0.006	0.005	0.006
CD at 5%	0.019	0.019	0.017	0.020

Londhe *et al.* (2012) [24] reported similar observations in brown *peda* and thabdi *peda*.

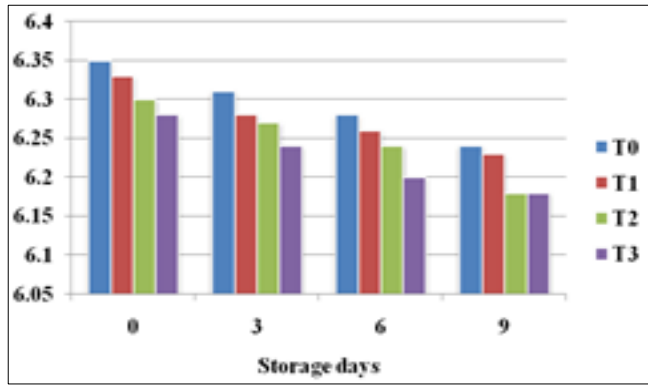


Fig 16: Changes in pH of date *peda* during storage

Total Fiber

Dietary fibers can provide a multitude of functional properties when they are incorporated in food systems. Thus, fibres addition contributes to the modification and improvement of the texture, sensory characteristics and shelf-life of foods due to their water binding capacity, gel-forming ability, fat mimetic, antisticking, anticlumping, texturising and thickening effects.

The mean total fibre content of fresh and stored *peda* samples is presented in the Table 12. The mean total fiber varied from 2.01 (T₁) to 2.49 (T₃), 2.01 (T₁) to 2.49 (T₃), 2.01 (T₁) to 2.49 (T₃) and 1.99 (T₁) to 2.48 (T₃) per cent on day 0, 3, 6 and 9th days of storage. The total fiber content in the *peda* samples significantly ($p < 0.05$) differed during storage of 9 days period. All *peda* samples during storage significantly differed among themselves during storage.

Table 12: Changes in Total fiber of date *peda* during storage

Treatment	Fiber (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	0.00 ^d	0.00 ^d	0.00 ^d	0.00 ^d
T ₁	2.01 ^c	2.01 ^c	2.01 ^c	1.99 ^c
T ₂	2.29 ^b	2.29 ^b	2.29 ^b	2.27 ^b
T ₃	2.49 ^a	2.49 ^a	2.49 ^a	2.48 ^a
SE±	0.006	0.006	0.006	0.005
CD at 5%	0.019	0.020	0.018	0.015

The fiber content of *peda* samples on a 9th day of storage declined significantly. More (2019) [28] observed decrease in fiber content of red pumpkin *burfi* during storage of 16 days at 30±1 °C.

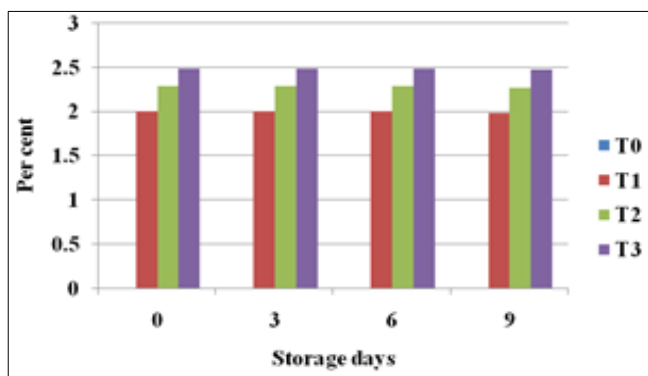


Fig 17: Changes in total fiber (%) of date *peda* during storage

Ash

The mean ash content of fresh and stored *peda* samples is presented in the Table 13.

Table 13: Changes in ash content of date *peda* during storage

Treatment	Ash (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	2.83 ^b	2.83 ^b	2.82 ^b	2.82 ^b
T ₁	3.12 ^a	3.12 ^a	3.13 ^a	3.14 ^a
T ₂	3.15 ^a	3.15 ^a	3.14 ^a	3.14 ^a
T ₃	3.22 ^a	3.22 ^a	3.21 ^a	3.21 ^a
SE±	0.037	0.039	0.041	0.039
CD at 5%	0.113	0.118	0.123	0.117

The mean ash varied from 2.83 (T₀) to 3.22 (T₃), 2.83 (T₀) to 3.22 (T₃), 2.82 (T₀) to 3.21 (T₃) and 2.82 (T₀) to 3.21 (T₃) on day 0, 3, 6 and 9th days of storage. The ash content in the *peda* samples significantly ($p < 0.05$) differed during storage period.

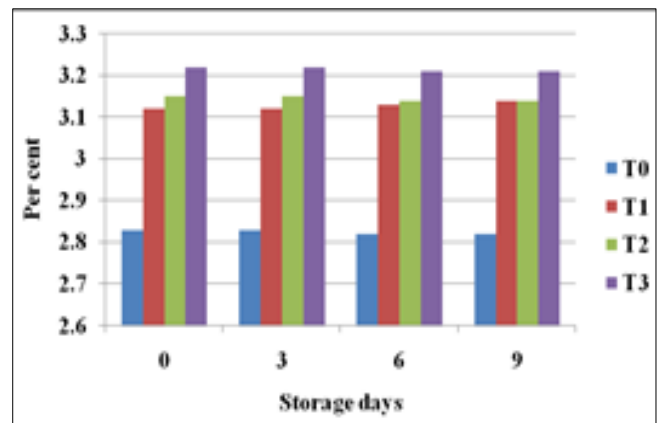


Fig 18: Changes in ash content (%) of date *peda* during storage

Moisture

The mean moisture content of fresh and stored *peda* samples is presented in the Table 14.

Table 14: Changes in moisture content of date *peda* during storage

Treatment	Moisture (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	15.92 ^b	15.38 ^b	15.22 ^b	14.92 ^b
T ₁	16.34 ^a	16.15 ^a	15.96 ^a	15.68 ^a
T ₂	16.38 ^a	16.25 ^a	16.13 ^a	15.89 ^a
T ₃	16.43 ^a	16.29 ^a	16.19 ^a	16.10 ^a
SE±	0.095	0.111	0.099	0.202
CD at 5%	0.287	0.333	0.297	0.608

The mean moisture content *peda* samples varied from 15.92 (T₀) to 16.43 (T₃), 15.38 (T₀) to 16.29 (T₃), 15.22 (T₀) to 16.19 (T₃) and 14.92 (T₀) to 16.10 (T₃) per cent on day 0, 3, 6 and 9th days of storage. The moisture content in the *peda* samples significantly ($p < 0.05$) differed during storage.

The moisture in the *peda* samples significantly ($p < 0.05$) declined during storage of 9 days at 30 °C. The moisture loss during storage is a common observation for *peda*. Level of moisture in the product plays a significant role on quality of product during storage. The moisture decreased during storage period upto 9th days and there after the product was unacceptable due to visible mould growth.

Different research coworkers had reported similar trend in moisture content of *peda* during storage.

Londhe *et al.* (2012) [24] reported that decrease in moisture content of brown *peda* during storage at 30 °C.

Similar type of observations was noticed by Narwade (2003) [29]. Bhatele (1983) [3] reported that the rate of moisture

evaporation from *burfi* samples was found different from samples packaged in different packaging materials.

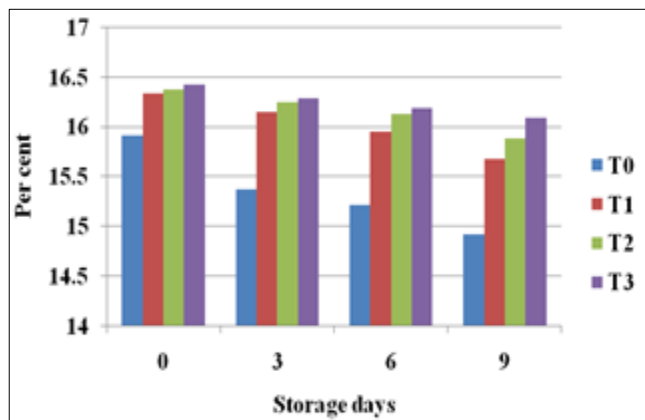


Fig 19: Changes in moisture content (%) of date *peda* during storage

Free Fatty Acids (% oleic acids)

The mean free fatty acids content of fresh and stored *peda* samples is presented in the Table 15.

Table 15: Changes in free fatty acids content of date *peda* during storage

Treatment	Free Fatty Acids (%)			
	Day 0	Day 3	Day 6	Day 9
T ₀	0.09 ^d	0.11 ^c	0.14 ^c	0.15 ^c
T ₁	0.14 ^c	0.18 ^b	0.20 ^b	0.23 ^b
T ₂	0.16 ^b	0.19 ^{ab}	0.21 ^{ab}	0.24 ^b
T ₃	0.18 ^a	0.21 ^a	0.23 ^a	0.26 ^a
SE±	0.004	0.007	0.006	0.006
CD at 5%	0.012	0.022	0.019	0.019

The mean free fatty acids content *peda* samples varied from 0.09 (T₀) to 0.18 (T₃), 0.11 (T₀) to 0.21 (T₃), 0.14 (T₀) to 0.23 (T₃) and 0.15 (T₀) to 0.26 (T₃) per cent oleic acids on day 0, 3, 6 and 9th days of storage.

Khader and Patel (19830) and Londhe *et al.* (2012) [24] reported similar trend and changes in free fatty acids in *peda* during storage.

Kamble (2010) [21] and Bhingardive (2012) [4] observed similar trend for changing in free fatty acids during storage.

Biradar (1981) [6] reported that free fatty acids increased consistently with storage time.

Jha *et al.* (1977) [20] also reported that free fatty acids in *khoa* increased significantly with the progression of storage period.

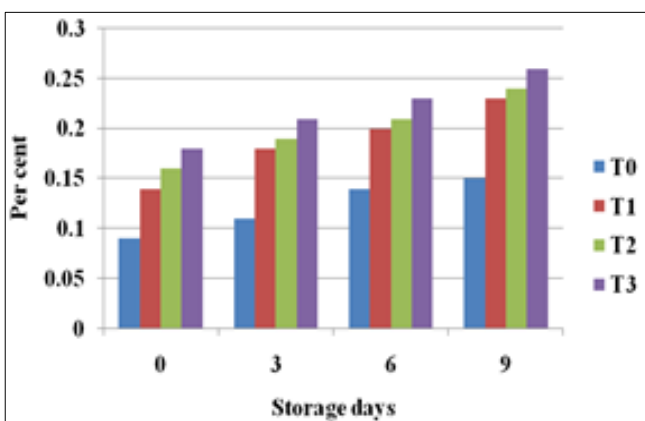


Fig 20: Changes in free fatty acids (% oleic acids) content of date *peda* during storage

Vitamin A

The mean vitamin A of fresh and stored date *peda* samples is presented in the Table 16.

Table 16: Changes in vitamin A of date *peda* during storage

Treatment	Vit. A (IU)			
	Day 0	Day 3	Day 6	Day 9
T ₀	108.03 ^d	95.66 ^d	78.72 ^d	61.73 ^d
T ₁	180.55 ^c	162.06 ^c	143.53 ^c	125.14 ^c
T ₂	199.04 ^b	185.15 ^b	169.75 ^a	148.14 ^a
T ₃	206.76 ^a	188.27 ^a	158.93 ^b	138.83 ^b
SE±	0.024	0.015	0.016	0.011
CD at 5%	0.074	0.045	0.049	0.034

The mean vitamin A of *peda* samples varied from 108.03 (IU) (T₀) to 206.76 (IU) (T₃), 95.66 (IU) (T₀) to 188.27 (IU) (T₃), 78.72 (IU) (T₀) to 158.93 (IU) (T₃) and 61.73 (IU) (T₀) to 138.83 (IU) (T₃) on day 0, 3, 6 and 9th days of storage. The vitamin A content in the *peda* samples significantly ($p < 0.05$) differed during storage. It is seen that the Vit. A content of date *peda* samples significantly decreased as the storage period progressed.

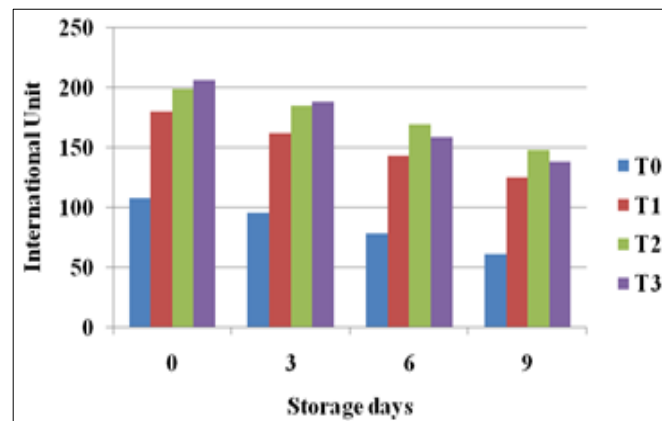


Fig 21: Changes in vitamin A (IU) of date *peda* during storage

Changes in microbiological quality of date *peda* during storage

Standard Plate Counts (SPC)

Table 17: Changes in standard plate count of date *peda* during storage

Treatment	Standard Plate Count (SPC)			
	Day 0 (10 ² x cfu/g)	Day 3 (10 ³ x cfu/g)	Day 6 (10 ³ x cfu/g)	Day 9 (10 ³ x cfu/g)
T ₀	2.40 ^c	2.80 ^b	3.00 ^c	3.40 ^b
T ₁	3.20 ^{bc}	3.60 ^b	3.80 ^{bc}	4.20 ^b
T ₂	3.40 ^{ab}	3.80 ^{ab}	4.00 ^b	4.40 ^b
T ₃	4.20 ^a	4.80 ^a	5.00 ^a	5.80 ^a
SE ±	0.316	0.346	0.331	0.387
CD at 5%	0.948	1.038	0.994	0.161

Standard plate count (SPC) is a collective enumeration of the overall microbiological quality of the product, after production and during its storage period. Standard plate count gives the idea about the status of the product in terms of its microbiological quality during storage. The SPC of fresh and stored samples of date *peda* is presented in the Table 17.

The mean SPC of *peda* samples ranged from 2.40 to 4.20 x 10² cfu/g, 2.80 to 4.80 x 10³ cfu/g, 3.00 to 5.00 x 10³ cfu/g and 3.40 to 5.80 x 10³ cfu/g on day 0, 3, 6 and 9th day of storage at 30 °C. The mean counts of SPC of *peda* samples significantly ($p < 0.05$) differed during storage. From Table 16 it was observed that SPC of date *peda* increased as storage period enhanced.

Londhe *et al.* (2012) [24], Makhecha (2012) [26], Ray *et al.*

(2000) [30] reported similar observations in laboratory made *peda*.

Yeast and Mould Count (YMC)

Yeast and molds are undesirable and their presence in sufficient numbers to reduces the keeping quality of product. The YMC of fresh and stored samples of date *peda* is presented in the Table 18.

Table 18: Changes in yeast and mould count of date *peda* during storage

Treatment	Yeast and Mould Count (YMC)			
	Day 0 (10 x cfu/g)	Day 3 (10 ² x cfu/g)	Day 6 (10 ³ x cfu/g)	Day 9 (10 ³ x cfu/g)
T ₀	0.00	1.40 ^b	1.80 ^c	2.20 ^b
T ₁	0.00	1.80 ^b	2.00 ^{bc}	2.40 ^b
T ₂	0.00	2.60 ^a	2.80 ^{ab}	3.00 ^b
T ₃	0.00	3.00 ^a	3.60 ^a	4.00 ^a
SE±	--	0.254	0.331	0.316
CD at 5%	--	0.764	0.994	0.948

From the Table 18, it was observed that YMC count of date *peda* increased as storage period increased. The highest YMC for *peda* sample prepared with 25% date syrup (T₃) (4.00 x 10³ cfu/g). The lowest YMC for *peda* sample prepared without date syrup (T₀) (1.40 x 10² cfu/g).

From the Table 18, it is seen that there was no yeast and mould growth detected on day 0. The significant difference was observed in yeast and mould count of all date *peda* samples on 3, 6 and 9 days of storage at 30 °C. The yeast and mould count ranged from 1.40 x 10² cfu/g to 3.00 x 10² cfu/g on 3rd day, 1.80 x 10³ cfu/g to 3.60 x 10³ cfu/g on 6th day and 2.20 x 10³ cfu/g to 4.00 x 10³ cfu/g on a 9th day. The increase in yeast and mould count from day 3rd to 9th day storage might be attributed due to post production contamination in the product. The rate of increase in YMC during storage period under different storage temperatures was quite variable.

Similar observations were reported by Londhe *et al.* (2012) [24] and Ray *et al.* (2000) [30] and found an increased count in brown and plain *peda*, respectively.

Coliform Count

The coliform count of fresh and stored samples of date *peda* is presented in the Table 19. The presence of coliforms in milk and milk products is suggestive of insanitary conditions or practices followed during production, processing, handling and storage. There was no growth of coliform count observed in the product during 9 days period.

Table 19: Coliform count of date *peda* during storage

Treatment	Coliform count Count (10 x cfu/g)			
	Day 0	Day 3	Day 6	Day 9
T ₀	ND	ND	ND	ND
T ₁	ND	ND	ND	ND
T ₂	ND	ND	ND	ND
T ₃	ND	ND	ND	ND
SE±	--	--	--	--
CD at 5%	--	--	--	--

Conclusions

The results of this investigation would lead to conclusions as under:

During storage, the sensory score of the *peda* samples *viz.*, colour and appearance, body and texture, flavour and overall acceptability gradually decreased. The mean colour and appearance score for date *peda* samples varied from 7.31 (T₃)

to 8.40 (T₀), 7.30 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.28 (T₂) and 7.18 (T₃) to 7.40 (T₁), on day 0, 3, 6 and 9th day of storage. The body and texture score varied from 7.29 (T₃) to 8.40 (T₀), 7.25 (T₃) to 8.40 (T₀), 7.22 (T₃) to 8.18 (T₂) and 7.18 (T₃) to 8.00 (T₂), on day 0, 3, 6 and 9th day of storage. The flavour score of *peda* samples varied from 7.31 (T₃) to 8.41 (T₂), 7.25 (T₃) to 8.40 (T₂), 7.22 (T₃) to 8.20 (T₂) and 7.16 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage at 30 °C. The overall acceptability score varied from 7.27 (T₃) to 8.39 (T₂), 7.25 (T₃) to 8.36 (T₂), 7.22 (T₃) to 8.31 (T₂) and 7.20 (T₃) to 8.00 (T₂) on a day 0, 3, 6 and 9th of storage at 30 °C. The fat, protein, total solids, reducing sugar, total sugar, titratable acidity, pH, total fibre, ash, moisture, free fatty acids and vitamin A of date *peda* samples ranged from 21.38 to 23.45 per cent, 15.13 to 15.58 per cent, 83.57 to 87.12 per cent, 13.23 to 16.62 per cent, 42.57 to 44.15 per cent, 0.33 to 0.48% LA, 6.18 to 6.35, 0.0 to 2.49%, 2.82 to 3.22%, 14.92 to 16.43%, 0.09 to 0.26% oleic acids and 61.73 to 206.76 IU, respectively upto 9 days of storage period.

The SPC of date *peda* samples increased from 3.40 x 10² cfu/g to 4.40 x 10³ cfu/g during the storage period of 9 days. The YMC of date *peda* samples varied from 2.60 x 10² cfu/g to 3.00 x 10³ cfu/g. There was no growth of coliform counts observed in the product during storage of 9 days period. The *peda* samples prepared with 20 per cent date syrup and 25 per cent sugar had shelf life upto 9 days at 30 °C.

Acknowledgements

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