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Storage related changes in basundi added with jaggery

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Abstract
Basundi is one of the heat desiccated indigenous dairy product, Now-a-days, the popularity and demand of *basundi* is increasing due to its delicacy also important nutritional properties of jaggery along with available in local area, attempts were made for replacement of sugar with jaggery in preparation of *basundi*. The *basundi* prepared by addition of jaggery (T_2) was subjected to storage stability and compare with *basundi* added with sugar (T_1). The product was stored at 5±1 ºC in laminate pouches and observed changes in sensory, physico-chemical and microbial attributes were evaluated periodically at 4 days interval. As the storage period increases there was decreases the sensorial qualities of *Basundi* such as colour, flavour, body and texture and consistency also physico chemical attributes as the moisture decreased other parameters such as fat, protein, lactose, sucrose, total ash, and acidity were slightly increased. Also the standard plate count and yeast and mould count increased in both sample during storage period.

Keywords: *basundi*, jaggery, sensory evaluation, physico-chemical properties, microbial qualities

Introduction
Among traditional dairy indigenous products *Basundi* is one of the heat desiccated indigenous dairy product, The market value of product depends upon a relative creamy consistency, white to light brown colour, sweetish caramel aroma and soft textured flakes uniformly distributed throughout the product mass (Patange *et al*. 2006) [26]. Traditionally *basundi* is prepared from buffalo milk which is concentrated, along with the scrapping and agitating, to about two fold by slow boiling in open kettle. Sugar at the rate of 6 to 7 per cent of milk added at the last stage of concentration followed by optional addition of flavours and nuts. The product is cooled and served chilled (Pal and Raju 2007) [27].
Basundi can be classified in the condensed milk group along with rabri, khoa, mithai and kheer and the dehydration of milk is done in iron karahi directly on fire. The original volume of milk is reduced to 40 to 50 per cent. (Chougule *et al*. 2014) [8].
Now-a-days, the popularity and demand of *basundi* is increasing due to its delicacy. Several basundi pockets are established in the country. The known pockets are Ujani (Gaikwad and Hembade 2015) [13] Kunthalgiri Satara, Bholwadi etc. Hence its production and marketing is increasing in a few big cities of the country. The small-scale producers find it difficult to cope up with the increasing demand. Therefore, in recent times, attention is being focused either to scale up the operation or to modify the technology so as to make it amenable to mechanization and continuous operation (Bhutkar *et al*. 2015) [6].
The micronutrients present in the jaggery possess antitoxic and anti-carcinogenic properties. It has moderate amount of calcium, phosphorous and zinc. Gur is high calorie sweetener and as it contains minerals, protein, glucose and fructose, it is known to be healthier in comparison to white sugar (Shrivastav *et al*. 2016) [29].
In India, sugarcane is being processed for making jaggery (gur), rab (concentrated sugarcane juice), sugar and khandsari. These jaggery is considered as a food material and is consumed directly as sweetener and also in different preparations including animal feed mixtures (Singh *et al*.2011) [30]. It is used in Ayurvedic medicines and is considered to be the best of all sugarcane preparations.
Considering demand of *basundi* and important nutritional properties of jaggery along with available in local area, attempts were made for replacement of sugar with jaggery in manufacturing of *basundi* Therefore, the present investigation was undertaken to study the effect of storage on changes in jaggary added *basundi* in relation to basundi prepared by addition of jaggery (T_2) was subjected to storage stability and compare with *basundi* added with sugar (T_1). The product was stored at 5±1 ºC in laminate pouches.

Materials and Method

Fresh buffalo milk was obtained from Dairy farm, RCSM College of Agriculture, Kolhapur and it was standardized to 6.0 per cent fat and 9% SNF. Good quality jaggery was procured from local market of Kolhapur city. Sugar Clean crystalline cane sugar was procured from local market of Kolhapur city. An iron karahi was used for preparation of basundi. Long handled stirrer with flattened end made up of mild steel was used for stirring-cum scrapping the milk during preparation of basundi. L.P.G. gas was used as heating media. madhur khoa Pvt. Ltd., Kolhapur make cream separator was u sed for separation of cream and skim milk for standardizati on. All glasswares used were of Borosil make for analytical work. Anamed Electronic balance model M-3000, capacity 3000g was used for weighing during the course of investigation. All the chemicals required for analytical work was used of Analytical Reagent (AR) and Guaranteed Reagent (GR) grade manufactured by Merk, India Ltd/Glaxo India Ltd.

Storage Stability of *Jaggery Basundi*

The basundi prepared by addition of jaggery (T_2) was subjected to storage stability and compare with basundi added with sugar (T_1). The product was stored at 5±1 ºC in laminate pouches. The changes in sensory, physico-chemical and microbial attributes were evaluated periodically at 4 days interval. The changes in sensory attributes examined were colour and appearance, flavour, body and texture, consistency and overall acceptability. Physico-chemical properties included moisture, fat, protein, lactose, sucrose, TSS, ash, acidity, pH. In microbial analysis included standard plate count, yeast and mould count and coliform count.

The treatments were as follows

T_1 (control) - Basundi prepared by addition of sugar
T_2 (sample) - Basundi prepared by addition of jaggery

Analytical Methods

Sensory Evaluation

The product was evaluated for sensory quality using 9 points Hedonic scale as per Amerine *et al.*, (1965) [1]. For colour, flavour, body and texture and consistency etc. Sensory attributes was evaluated by semi trained panel of judges from staff of Division of Animal Husbandary and Dairy Science, College of Agriculture, Kolhapur.

Physico-chemical Analysis of *Jaggery Basundi*

Total solids was determined as per method given in: IS 1479(Part- II), 1961. The fat content of the *basundi* was determined By Mojonnier method by Chaudhury (1959) [7]. For determination of protein the formal titration method described by Mathur *et al*. (2002) [2]. The lactose of *basundi* was estimated by Lane-Eynon's method given in IS: 1479 (Part-II) 1961. Total sugar of *basundi* was determined as per Lane-Eynons method given in IS: 1479 (Part-II) 1961. The total ash content was determined as per the method described in AOAC (1998). pH was measured by (A.O.A.C. 2000). The titratable acidity of *basundi* sample was determined as per procedure stated in IS: 1479 (Part-I) 1960.

Microbial analysis

Standard plate count (SPC) was determined by (IS 5402: 1969). Yeast and mould was determined by (IS 5403:1999: Reaffirmed 2005). The coli form count of the samples of *basundi* was determined as per the Procedure described in IS: 5404, (1984)

Statistical Analysis

To generate meaningful inferences, the data of storage samples were analyzed using Completely Randomized Design (CRD) and Factorial Completely Randomized Design (FCRD) as per Snedecor and Cochran (1994) [31].

Result and Discussion

Storage related changes in sensory scores of jaggery *basundi*

Changes in flavour

The changes in flavour score of *basundi* during storage period are shown in fig 1.0 The data showed that flavour score were found to be decreased from 7.50±0.04 to 6.45±0.03 and 7.82±0.04 to 6.35±0.04 in T_1 and T_2 respectively. The flavour deteriorated with length of storage. During storage a slight rancid flavour was observed in control sample and it may due to hydrolysis of the fat due to lipase enzyme secreted by bacteria. The defect seemed not to be objectionable at storage condition. On 1st day both T_1 and T_2 secured nearly equal score. But when the storage increased the flavour score also decreased. The flavour score of both treatments was significantly reduced (P<0.05). Same findings also reported by Gaikwad and Hembade (2013) [14, 15] for Ujani basundi stored under refrigerated temperature at 5±1 ºC.

Changes in colour and appearance

The scores remained around like moderately to like slightly range throughout the storage period of 16 days. Indicating thereby the products were sensorial acceptable when stored at 5±1 ºC for 16 days. Similar findings were observed by Gaikwad and Hembade(2013) [14, 15] and also by Bhaiyye (2017) [5] reported decreasing trend of score related to colour and appearance in the case of basundi stored under refrigerated temperature. Shrivastav *et al*. (2016) [29] reported that, the first difference in sugar and jaggery is the difference in colour. Sugar is bright white in colour, whereas the colour of jaggery can range from golden yellow to golden brown or dark brown, hence *jaggery basundi* was have highest score for colour and appearance as compared to sugar basundi.

Changes in body and texture

The data pertaining to body and texture of *basundi* during storage have been presented in fig.2.0 the body and texture scores of *basundi* were decreased during storage. The significant (P<0.05) reduced in body and texture score was observed from 12th day onwards. Data showed at body and texture score were found to be decreased from 7.30±0.04 to 6. 40±0.02 and 7.50±0.02 to 6.45±0.04 in T_1 and T_2 respectively statistically, the effect of period was significant (P<0.05). Declined body and texture score of *basundi* during storage also reported by Gaikwad and Hembade (2013) [14, 15].At the time of storage period there was loss of moisture in product. Due to loss of moisture the product became slightly thicker however body and texture scores were not much influenced with increase in storage period. The scores remained liked very much to liked slightly range throughout the storage period. Indicating thereby the products were sensorial acceptable when stored at 5±1 ºC for 16 days. Declined score for body and texture during storage period also reported by Raghavendra (2005) [28] in the retort processed *basundi.*
While sugar crystals are solid and hard, jaggery is semi-solid,

softer than sugar and also amorphous. This is because the molasses and other impurities are not removed from it, as is the case with sugars, as reported by Shrivastav *et al.* (2016) [29].

Changes in consistency

Consistency property of fluid dairy product is most important for enhancing the richness of product. The data in relation to consistency of *basundi* during storage are presented in fig 2.0 the data showed that consistency score were found to be decreased from 7.85±0.02 to 6.40±0.04 and 7.97±0.04 to 6.50±0.02 in T_1 and T_2 respectively. There was significant (P<0.05) decrease in consistency of product during storage. Commonly the consistency score reduces due to increase in the consistency of the product and this was because of hydrolysis of protein. Similar findings were reported by Gaikwad and Hembade (2013) [14, 15] for Ujani *basundi* stored under refrigeration temperature 5±1 ºC.

Overall acceptability

The overall acceptability score for *basundi* presented in fig 3.0 it was observed that, the mean score of overall acceptability was 7.43±0.04 to 6.41±0.04 and 7.60±0.04 to 6.43±0.04 in T_1 and T_2 respectively. During storage period there was significant (P<0.05) reduction in overall acceptability of product. The decreased score for overall acceptability with advancement of storage period might be attributed to the declining colour and appearance, body and texture and flavour of the product. This was might be due to occurrence of microbial growth in the product as a result sample was discarded from study. All deteriorative changes like textural changes were collectively reflected in sensory quality and thus led to unacceptability of the stored product after a definite period. Similar finding was observed by Gaikwad and Hembade (2013) [14, 15]. Raghavendra (2005) [28] reported decreased score for overall acceptability with respect to increased storage period in the study of shelf life of retrot processed *basundi*.

Storage related changes in physico-chemical attributes of jaggery *basundi*

Changes in moisture (%)

The product coded with T_1 and T_2 showed moisture content of 38.24 and 38.59 on first day of storage and it was reduced to 38.14, 38.09, 37.94 and 38.12, 38.15, 37.65, 37.48 per cent on 4,8,12 and 16th day of storage respectively. Moisture plays an important role during storage for bacterial activity, yeast and mould growth. During storage period, there was significant (P<0.05) decrease in moisture level of stored product. The reduction in moisture content from 38.31 to 34.44 per cent in Ujani *basundi* during storage was also reported by Gaikwad and Hembade (2013) [14, 15].

Changes in total soluble solid (TSS ºBrix)

It was observed that, the TSS of stored *basundi* gradually increases in both T_1 and T_2. As the storage period prolonged there was increase in TSS in T_1 and T_2 from 36 to 39ºBrix and 35 to 37 ºBrix respectively. During storage period there was significant (P<0.05) increase in TSS of *basundi*. Increase in TSS during storage might be due to refrigeration temperature. As increase in TSS, the product becomes thicker. During storage period there was increase in TSS might be due to moisture loss.

Changes in fat (%)

The fat content was slightly increased during storage period in T_1 and T_2. Effect of storage period was found, statistically sig nificant (P<0.05). Fat of T_1 and T_2 increases from 11.10 to11. 97percent and 11.08 to 12.10 per cent on storage days 0, 4, 8, 12 and 16 days. The similar finding of present investigation was also reported by Gaikwad and Hembade (2013) [14, 15]. Sample which shows the higher loss of moisture therefore it showed higher percentage of fat content in16th day of storage. Similar observation was also recorded by Desale (2017) [11] in that basundi samples were analyzed for fat with a view to know the lipolytic changes during storage, there was increase in fat per cent ranged from 10.32 to10.90 per cent.

Changes in protein (%)

Variations in the protein content of *basundi* stored for 16 days were observed at refrigerated temperature (5±1 ºC). T_1 at first day shows protein content 8.73±0.06 per cent and T_2 shows 8.82±0.10 per cent. As the storage length increases, there was slight increase in protein content of *basundi*. There was slight increase in protein content of *basundi* during storage *i.e.*8.73±0.06 to 9.22±0.05 per cent and 8.82±0.10 to 9.26±0.05 per cent, in T_1 and T_2 respectively. In the present study it was indicates that, there was significant (P<0.05) increase in protein content of *basundi* during storage period. Similar effect was observed by Gaikwad and Hembade (2013) [14, 15] they reported, there was increase in protein content of basundi during storage at refrigeration temperature *i.e* 5±1 ºC.

Changes in lactose (%)

Lactose is the principal sugar of milk. Initially the lactose content in T_1 and T_2 was 11.25 and 11.12 per cent, which was again decreased to 11.12, 11.06, 11.00, 10.94 and 11.07, 11.00, 10.92, 10.87 per cent in the T_1 and T_2 respectively. These values are statistically significant (P<0.05). During storage period there was steady decrease in lactose content, this might be due to growth of microbes. Hence as the storage period prolonged there was steady decrease in lactose content of *basundi*. Similar finding was found by Aneja *et al.* (2002) [2]. By Desale (2015) [10] reported that in herbal treated *basundi* lactose content was reduced from 11.28 to 10.08 per cent.

Changes in sucrose (%)

Sucrose is non-reducing sugar which extensively used as sweeteners in various Indian dairy products. It imparts number of properties, bulking agent, preservative, texturizer, humicant, flavour carrier browning agent and decorative agent. Initially the sucrose content in T_1 and T_2 is 18.22 per cent and 18.27 per cent which was increased as storage period increases. It was increased in T_1 and T_2 from 18.39, 18.42, 18.55, 18.62 and 18.45, 18.51, 18.69, 18.72 per cent on 4,8,12 and 16th day of storage. Statistically there was significant (P<0.05) increase in sucrose content during storage period.

Changes in pH

It was observed that, the pH showed a decreasing trend on storage for both T_1 and T_2. With increase in storage period, there was observed that decrease in pH of stored *basundi*. The pH decreased significantly during storage in T_1 and T_2 from 6. 48 to 6.32 and 6.56 to 6.42,within 16 days of storage. There was significant (P<0.05) decrease of pH in stored product. The decrease in pH could be attributed to the maillard reaction taking place during storage leading to the production of organic acids.

Changes in Ash (%)

The *basundi* stored under refrigeration showed the marginal increase in ash in T_1 and T_2 from 1.95 to 2.07 per cent and 1.94 to 2.08 per cent respectively. Statistically there was significant (P<0.05) increase in ash content of stored *basundi*. The increased in ash content might be due to increase in minerals by enzymatic and microbial activities, observations of present study agreed with those reported by Gaikwad and Hembade (2013) [14, 15] carried an experiment in which they stored Ujani *basundi* for 20 days at refrigerated temperature they observed there was increase in ash content upto 2.10 per cent. Desale (2015) [10] reported that total ash content in herbal treated *basundi* was increased during storage period.

Changes in acidity (% LA)

There was increase in titratable acidity of *basundi* with increase in storage length. The initial titratable acidity 0.33 and 0.37 per cent in the T_1 and T_2 gradually increased and approached to 0.40 and 0.51 per cent. There was increase in titratable acidity in T_1 and T_2 from 0.33, 0.34, 0.38, 0.40 and 0.37, 0.44, 0.46, 0.47 per cent on 4, 8, 12 and 16th day of storage respectively. In the stored product there was significant (P<0.05) increase in acidity. The increase in acidity could also be due to the action of microorganisms as well as production of organic acids during processing and storage. Increase in acidity is an indication of spoilage in dairy products. De (1980) [9] also reported similar terms of increase in acidity of stored dairy products. Similar finding were reported by Gaikwad and Hembade (2013) [14, 15] they showed that, acidity of Ujani *basundi* increased from 0.50 to 0.58 per cent with increase in storage period.

Storage related Changes in Microbial Quality of Jaggery *Basundi*

Standard Plate Count (cfu/g)

The standard plate count is also called as Aerobic Plate Count. The initial count of the sample was 66×10^3 and increased steadily during the early storage from an initial value of 66×10^3 to 161×10^3 and 76×10^3 to 192×10^3cfu/g T_1 and T_2 respectively. The growth rate of bacteria was higher in *jaggery basundi* (T_2) than sugar *basundi* (T_2). The increase in SPC with progressive storage might be attributed to the post process contamination during handling. Gaikwad and Hembade (2012) [16] reported increase in SPC during storage of Ujani *basundi* at 30±1 ºC and 5±1 ºC

Yeast and Mould Count (cfu/g)

Yeast and Mould growth in dairy products tends to be a major problem and often most important single factor limiting their shelf life. There was increase in yeast and mould count in T_1 and T_2 from 17×10^3 to 187×10^3 and 22×10^3 to 192×10^3cfu/g respectively. There was significant (P<0.05) increase in Yeast and mould count during storage period. Gaikwad and Hembade (2012) [16] reported increase in YMC during storage of Ujani *basundi* at 30±1 ºC and 5±1 ºC. Gaikwad and Hembade (2011) [12] reported in microbiological analysis of traditionally manufactured Ujani *basundi* and neighboring villages by traditional manufacturers, they observed that there was increase in Standard plate count, Yeast and mould count and Coliform count which might be due to not maintaining hygienic conditions during manufacturing the product.

Coliform Count

In the present study, coliform were absent in the samples of T_1 and T_2 during storage. Gaikwad and Hembade (2011) [12] also support the present finding *i.e.* absence of coliform in *Ujani basundi* during storage at 30±1 ºC and 5±1 ºC.

Conclusion

From the present study it was concluded that as the storage period increases then decreases the sensorial qualities of *Basundi* such as colour, flavor, body and texture and consistency also loss of moisture occurred, as the moisture decreased other parametersuch as fat, protein, lactose, sucrose, total ash and acidity were slightly increased. Also the standard plate count and yeast and mould count increased in both sample during storage period.

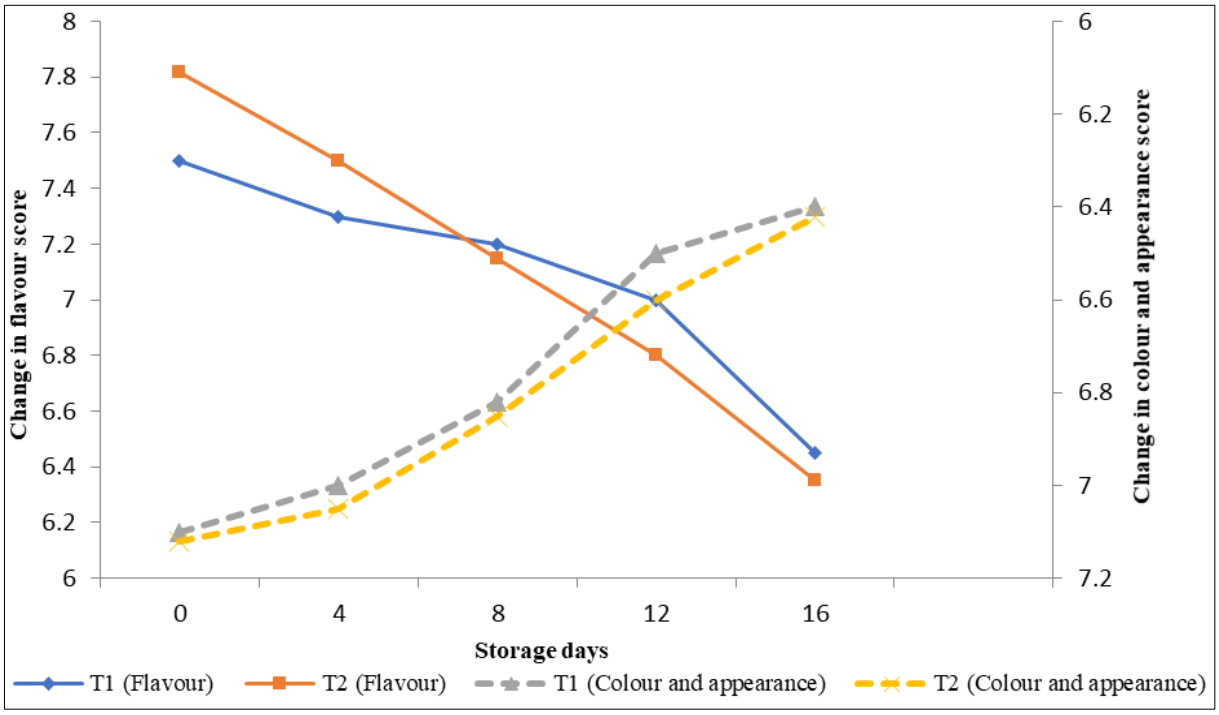

Fig 1: Storage related changes in flavour and colour and appearance score of jaggery *basundi*

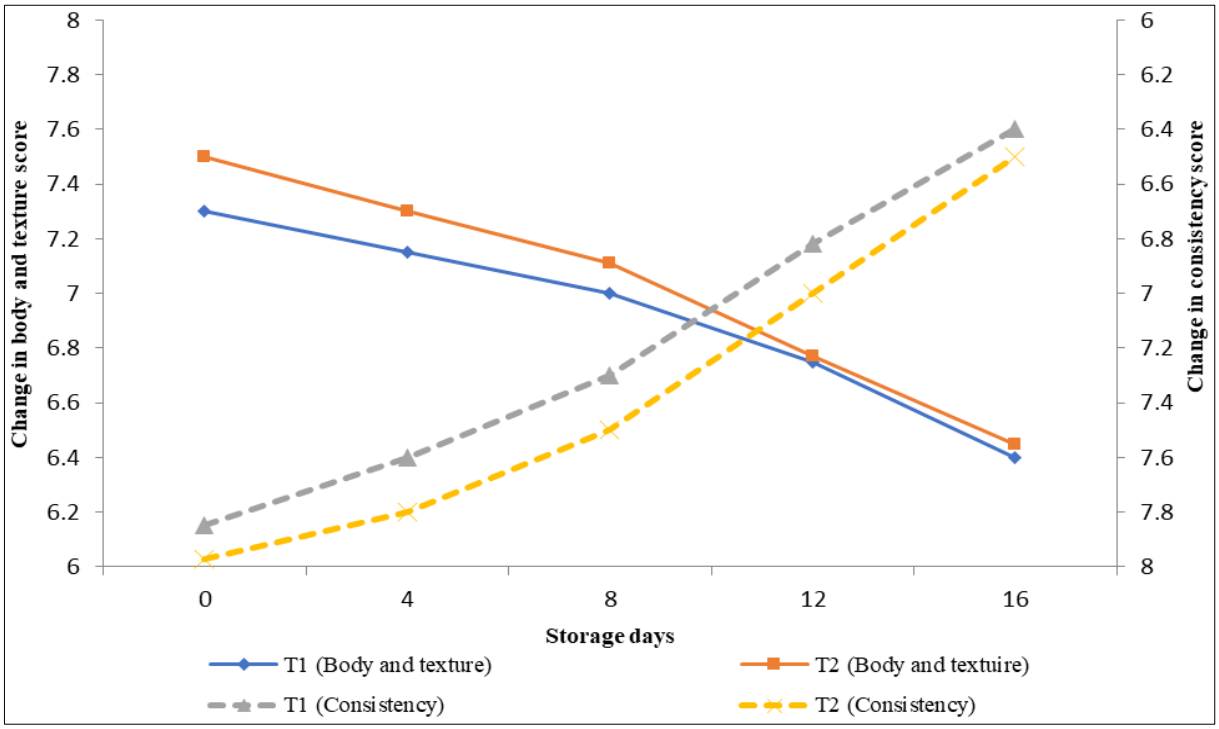

Fig 2: Storage related changes in body and texture and consistency score of jaggery *basundi*

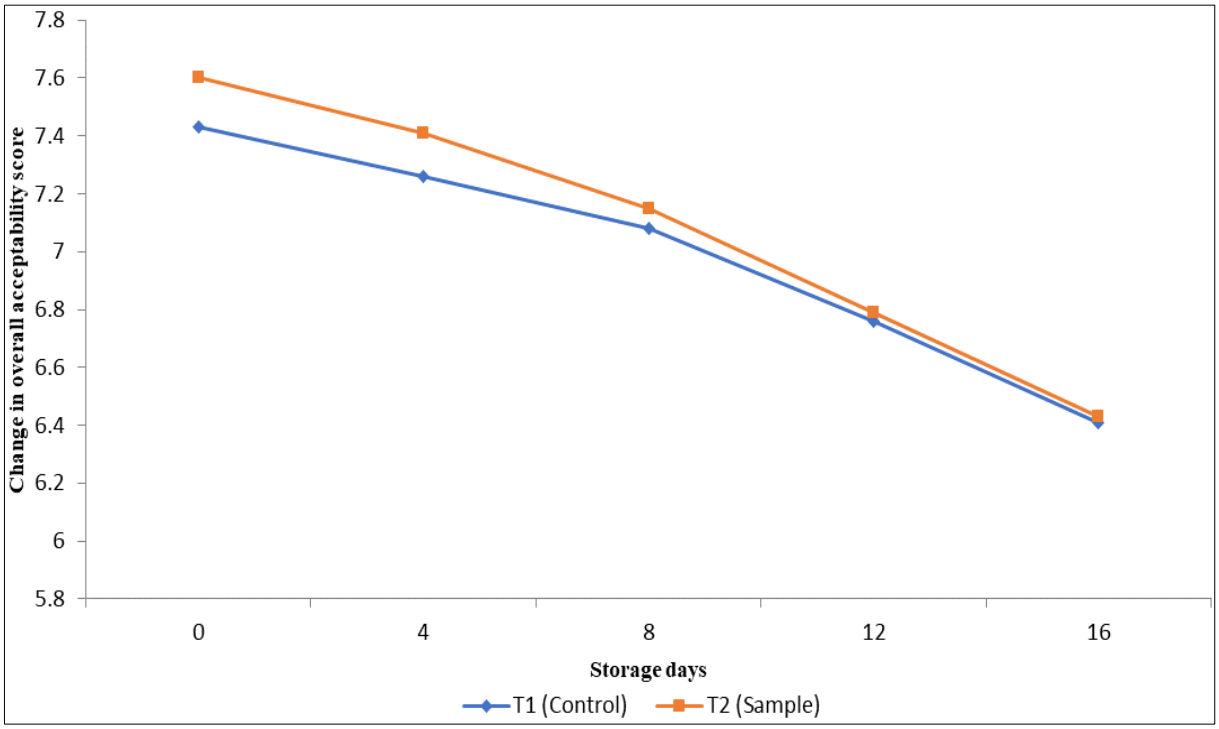

Fig 3: Storage related changes in overall acceptability score of jaggery *basundi*

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