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Study on textural analysis of camel and buffalo milk based khoa burfi blended with watermelon seeds

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Abstract
The present study was carried out to assess the textural analysis of camel and buffalo milk based khoa burfi blended with watermelon seeds. Formation of burfi was done by using different ratio of camel and buffalo milk (50% of camel milk and 50% of buffalo milk) and then the incorporation of watermelon seeds powder was done, whereas the control burfi was obtained without incorporation of watermelon seeds powder. Burfi was subjected to the textural analysis on TA-XT*plus* texture analyzer. Various textural characteristics like hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness were determined. The overall textural profile of Burfi showed a wide difference in value of texture parameters like Hardness, Adhesiveness, Springiness, Cohesiveness, Gumminess and Chewiness in control as well as all treatment groups of developed Burfi. The incorporation of 50% of camel milk and 50% of buffalo milk without watermelon seeds incorporation forms a good textural structure of the khoa Burfi.

Keywords: Khoa, Burfi, Texture, Camel milk, Buffalo milk

Introduction

In India 46 per cent of total milk production consumed as liquid milk and 54 per cent is converted into milk products (www.nddb.org/statistics/milkproduction). Amongst the traditional milk products, khoa is an important indigenous heat coagulated, partially dehydrated milk product, popular in large section of population throughout the country. The chemical composition of khoa include 20-25% humidity, 25-37% fat, 17-20% protein, 22-25% lactose, 3.6-3.8% ash and 100-103 ppm iron depending on whether it is made from cow, buffalo or mixed milk (Moulick and Ghatak, 1997) [15]. It contains relatively large amounts of building proteins, bone forming minerals and energy giving fat and lactose. Most fat-soluble vitamins A, D, E and K are also expected to be retained. Above all, milk conversion to Khoa is the best milk preservation method for a relatively longer period of time without the use of any natural or chemical preservatives.

In India, burfi is most popular khoa based milk sweet, white to light cream in colour with firm body and smooth to granular texture. Burfi was prepared by many research workers using various fruits like ber (Kathalkar, 1995) [9], papaya and sapota (Khedkar *et al.* 2007) [11], mango (Kadam *et al.* 2009) [7], orange (Thaware *et al.* 2009) [24], fig (Matkar & Deshmukh, 2007) [14] etc. These fruits enhance the acceptability of burfi to the masses as well as choosy classes. Other ingredients are also incorporated in different proportions to meet the special needs of flavor, body and texture.

Watermelon (*Citrullus lanatus*) being a very famous fruit in Rajasthan, refreshing and diuretic properties of its red flesh present inside, together with its pleasant taste, make it a popular choice for producing juices and salads or for vegetable and raita making. The watermelon contains important carotenoids such as β-carotene, carotene and Lycopene which are important in neutralizing free radicals in the body (Oseni & Okoye, 2013) [16], high in proteins and fats and can find applications as a protein source in various food formulations and preparation (El-Adway & Taha, 2001) [3]. Watermelon seeds are a good source of low-molecular-weight polypeptides i.e. globulin, glutenin and albumin. Seeds are also rich in aspartic acid, glutamic

acid and serine (Tabiri *et al.* 2016) [23].

In the western world, camel milk is experiencing a novel awareness in these days and even the FAO has stepped in promoting camel milk (Ramet, 2001) [18]. Camel milk is considered to have anti-cancer (Magjeed, 2005) [13], hypo-allergic (Shabo *et al.* 2005) [21] and anti-diabetic properties (Agrawal *et al.* 2003). High content of unsaturated fatty acids contributes to its overall dietary quality (Karray *et al.* 2005; Konuspayeva *et al.* 2008) [8, 12]. Camel milk is rich in chloride. Chlorides contents ranged between 0.20 and 0.28 g per 100 g, respectively and the mean value (g per 100 g) was 0.26± 0.01 for chlorides (Khaskheli *et al.* 2005) [10].

Buffalo milk has a high fat content and can be preserved naturally for longer periods due to high peroxidase activity. Buffalo milk contains more calcium, better calcium**:** phosphorous ratio and less sodium and potassium compared to cow milk, making it a better nutritional supplement for infants. Buffalo milk is preferred for the preparation of western and traditional (indigenous) milk and dairy products and is superior in nutritional terms.

Texture is an important fundamental sensory property of foods which can be regarded as a manifestation of the rheological properties of foods. Texture is an important quality of attribute as it affects processing, handling and influence shelf life as well as consumer acceptance as their food habits. The present investigation was carried out to study the effect of different levels of watermelon seeds powder incorporation on textural quality profile of khoa Burfi.

Material methods

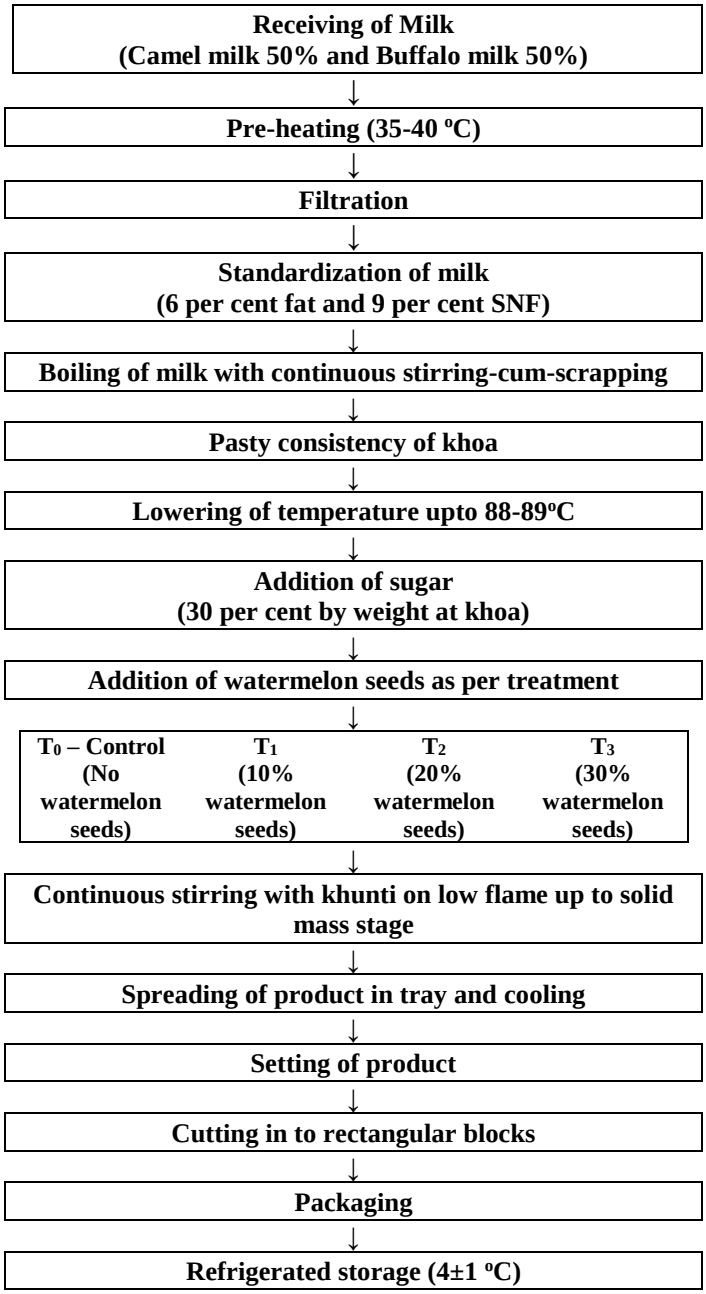
TA-XT*plus* Texture Analyzer equipped with an Acoustic Envelop Detector (AED) device (Stable Micro System Ltd., Godalming, UK) used to perform a more comprehensive analysis of the khoa burfi texture. Textural profile analysis was conducted for khoa burfi samples for all experiments to obtain textural responses viz- hardness, springiness, adhesiveness, cohesiveness, gumminess, chewiness.

Formation and accessibility of camel and buffalo milk based khoa burfi blended with or without watermelon seeds

Formation of khoa was done by using different ratio of camel and buffalo milk. Best result was obtained on the basis of high yield, consistency of khoa and low cost of production by combination of 50% camel milk and 50% buffalo milk. On the basis of evaluation for quality parameters like yield, consistency of khoa, cost of production, sensory evaluation and physico-chemical characteristics, optimum ratio of admixture of camel and buffalo milk was determined.

Burfi was prepared as per the method described by Reddy (1985). Received milk was preheated at 35-40 ºC before filtration. Then milk was filtered in order to remove the visible dust and dirt particle. The process involved standardization of camel and buffalo mixed milk to 6 per cent fat and 9 per cent SNF, taken in an iron karahi and heated on gentle fire. At the time of boiling, milk was stirred with the help of a khunti in a circular manner. The stirring-cum-scrapping process was continued till a pasty consistency was reached. Then temperature was lowered upto 77-79 ºC. At this stage, watermelon seeds as per treatment and sugar @ 30 per cent of khoa were added. Finally this mixture was heated on a low fire with stirring till the desired texture was obtained. It was then spread in a tray and allowed to cool. After setting, camel and buffalo milk khoa based watermelon seeds burfi was cut into rectangular blocks and stored at refrigeration (4±1 °C) followed by packaging.

Flow diagram for preparation of camel and buffalo milk based khoa burfi blended with or without watermelon seeds



Product development

Various levels of watermelon seeds powder incorporated camel and buffalo milk based khoa burfi by inclusion of 10% watermelon seeds powder, 20% watermelon seeds powder and 30% watermelon seeds powder were used for preparation of treatment burfi under investigation.

T_0 – 100 parts of buffalo and camel milk khoa by weight + 0 Parts of Watermelon seeds powder,

T_1 – 90 parts of buffalo and camel milk khoa by weight + 10 Parts of Watermelon seeds powder,

T_2 – 80 parts of buffalo and camel milk khoa by weight + 20 Parts of Watermelon seeds powder,

T_3 – 70 parts of buffalo and camel milk khoa by weight + 30 Parts of Watermelon seeds powder.

Textural properties of camel and buffalo milk based khoa burfi blended with watermelon seeds

The textural properties were evaluated using the TA.XT *plus* Texture analyzer of Stable Micro System equipped with 25 kg load cell. The analyzer is linked to a computer that recorded the data via a software programme. Burfi samples of length 1cm^3 were cut from the central portion with a stainless-steel cutter. A stainless-steel probe of 5 mm diameter with a flat end was used to determine the textural properties.

The textural properties of camel and buffalo milk based khoa burfi blended with watermelon seeds has been summarized in table 1 and depicted in figures 1, 2, 3, 4, 5 and 6 for hardness, adhesiveness, springiness cohesiveness, gumminess and chewiness respectively.

Table 1: Texture analysis (mean ± SE) camel and buffalo milk based khoa burfi blended with watermelon seeds

Parameter	T_0	T_1	T_2	T_3
Hardness (g)	3202.93^a ± 32.06	6880.50^b ± 64.62	9887.55^{bc} ± 83.17	12838.30^c ± 68.01
Adhesiveness (g.sec)	-60.61^a ± 24.047	-134.79^b ± 11.207	-205.09^c ± 31.964	-280.14^d ± 10.590
Springiness	0.35 ± 0.107	0.31 ± 0.009	0.27 ± 0.034	0.19 ± 0.014
Cohesiveness	0.18^a ± 0.026	0.22^a ± 0.011	0.28^b ± 0.012	0.36^c ± 0.013
Gumminess	553.11^a ± 77.973	1461.01^a ± 84.352	2702.39^b ± 263.832	4500.24^c ± 578.854
Chewiness	199.02^a ± 63.152	441.06^{ab} ± 24.014	694.84^{bc} ± 71.907	841.79^c ± 148.347

Note: Means bearing different superscript in a row (small letter) differ significantly. T_0 – camel and buffalo milk khoa without any seed powder incorporation, T_1 – camel and buffalo milk khoa with watermelon seed powder (10%), T_2 – camel and buffalo milk khoa with watermelon seed powder (20%), T_3 – camel and buffalo milk khoa with watermelon seed powder (30%)

Hardness

For the analysis of khoa burfi texture, hardness is the most commonly evaluated characteristic. It may be described as the force necessary to attain a given deformation. The hardness value is the peak force of first compression of the product during textural determination. Factors such as moisture and fat content, type of protein, processing treatments etc. affect the hardness of the khoa. A higher value is indicative of greater hardness. The hardness value is expressed in terms of grams (g).

Hardness: Value of the peak force of the first compression of the product.

Hardness, g = Maximum force of first compression.

The hardness values obtained for the camel and buffalo milk based khoa burfi blended with watermelon seeds were in the range from 3202.93±32.06 to 12838.30±68.01 g. The values of hardness for different treatments of camel and buffalo milk based khoa burfi blended with watermelon seeds (T_0, T_1, T_2 and T_3) were 3202.93±32.06, 6880.50±64.62, 9887.55±83.17 and 12838.30±68.01 respectively. Lowest and highest hardness values were 3202.93±32.06 and 12838.30±68.01 for treatment T_0 and T_3 respectively.

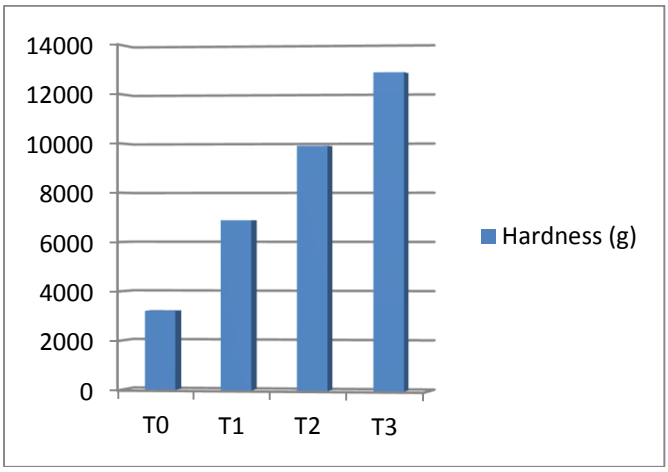


Fig 1: Hardness of camel and buffalo milk based khoa burfi blended with watermelon seeds

Addition of watermelon seeds powder increases the hardness of Burfi. Hardness of Burfi depends upon various factors including moisture content and mineral content. Significant difference (p<0.05) was observed in the hardness of burfi prepared from watermelon seeds powder incorporation as per different treatments (T_0, T_1, T_2 and T_3). This might be due to the higher amount of total solids mainly contributed by low moisture content in samples. Adhikari *et al.* (1994) [1] also reported negative correlation between moisture and instron hardness of khoa. The present findings were in accordance with the reports of Gupta *et al.* (1990) [5] and Suresh and Jha (1994a) [22] who reported that the increased hardness of khoa correlated highly with the total solids and by increasing the total solids, hardness also increased.

Adhesiveness

Adhesiveness is sometimes referred as stickiness. The negative forces area of the first bite is defined as adhesiveness**.** It gives the force that is required to remove the sample from adhering to the probe while compression. It is expressed in terms of gram second (g.s).

Adhesiveness: Force necessary to remove the material that adheres to the mouth during eating food.

Adhesiveness, g/sec = Negative area in the graph.

The adhesiveness values obtained for the camel and buffalo milk based khoa burfi blended with watermelon seeds were in the range from -280.14±10.590 to -60.61±24.047g. The minimum value of adhesiveness was found for 30 per cent watermelon seeds blended with camel and buffalo milk based khoa burfi (T_3) -280.14±10.590. The value of adhesiveness for T_0 was -60.61±24.047 whereas the value of treatments T_1 and T_2 were -134.79±11.207 and -205.09±31.964 respectively**.**

Significant difference (p<0.05) was observed in the adhesiveness of burfi prepared from watermelon seeds powder incorporation as per different treatments (T_0, T_1, T_2 and T_3). Rasane *et al.* (2012) [19] also reported that variation in adhesiveness of market samples of Burfi may be due to variation in sugar content but Gupta *et al.* (1990) [5] reported no significant effect of compositional factors on adhesiveness of khoa.

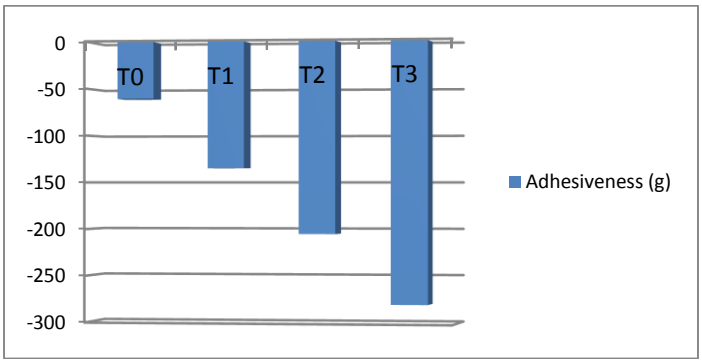


Fig 2: Adhesiveness of camel and buffalo milk based khoa burfi blended with watermelon seeds

Springiness

Extent to which a product physically springs back after it has deformed during the first compression. Springiness is the distance between the end of 1st bite and beginning of 2nd bite. Its unit is in millimeter, it denotes how well a product springs back physically after deformation during the first bite. The spring back is measured at the lower stroke of the second bite, so the wait time between two strokes can be relatively important. In some cases, an excessively long waiting time will allow a product to spring back more than it could under the conditions being investigated (for example, one would not wait 60 seconds between the chews).

$$\text{Springiness} = \frac{\text{Length 1}}{\text{Length 2}}$$

The springiness values for different treatments were in the range from 0.35±0.107 to 0.19±0.014. The value of control (T_0) was 0.35±0.107. The values of springiness for 10 per cent watermelon seeds(T_1), 20 per cent watermelon seeds(T_2) and 30 per cent watermelon seeds(T_3) incorporated camel and buffalo milk khoa burfi were 0.31±0.009, 0.27±0.034 and 0.19 ± 0.014 respectively.

Non significant difference was observed in springiness values of burfi prepared from watermelon seeds powder incorporation as per different treatments (T_0, T_1, T_2 and T_3). Springiness decreased with increasing Watermelon seeds powder. Jha *et al.* (2014) [6] reported that lower springiness value in lalpeda was due to the porous texture of lalpeda. Results were in accordance with Rajorhia *et al.* (1990) [5] who reported higher springiness value in khoa from acidic buffalo milk followed by khoa from fresh and neutralized milk.

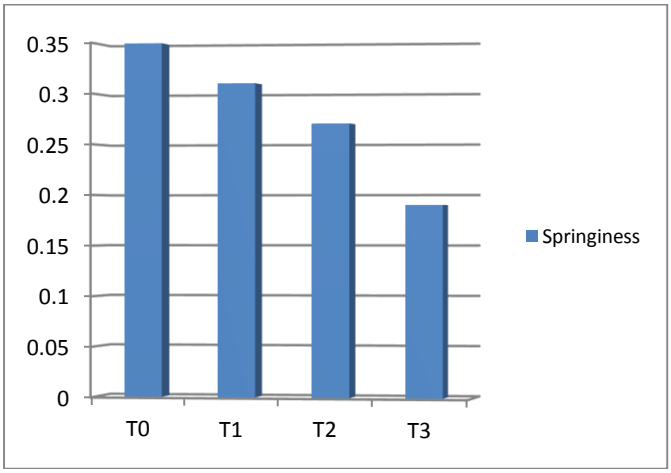


Fig 3: Springiness of camel and buffalo milk based khoa burfi blended with watermelon seeds

Cohesiveness

Extent to which a material can be deformed before it ruptures and it depends upon the strength of internal bonds. Cohesiveness is the ratio of areas under the first and second bite. It is defined as the extent to which a material can be deformed before its rupture and it mainly depends upon the strength of internal bonds. In other words, it refers to how a product stays together after deformation and it is unit less.

$$\text{Cohesiveness} = \frac{\text{Area under 1}^{st}\text{ compression}}{\text{Area under 2}^{nd}\text{ compression}}$$

The maximum value of cohesiveness was found for T_3 i.e. 0.36±0.013 and the minimum value for T_0 i.e. 0.18±0.026. Whereas the value of 10 per cent watermelon seeds (T_1) and 20 per cent watermelon seeds (T_2) incorporated camel and buffalo milk khoa burfi were 0.22±0.011 and 0.28±0.012 respectively.

In terms of cohesiveness, T_0 sample of Burfi showed superior results with highest cohesiveness among the Burfi samples. Adhikari *et al.* (1994) [1] and Garg *et al.* (1989) [4] also reported negative correlation between cohesiveness and moisture content in khoa. Gupta *et al.* (1990) [5] reported that cohesiveness of khoa tended to decline with increasing total solids.

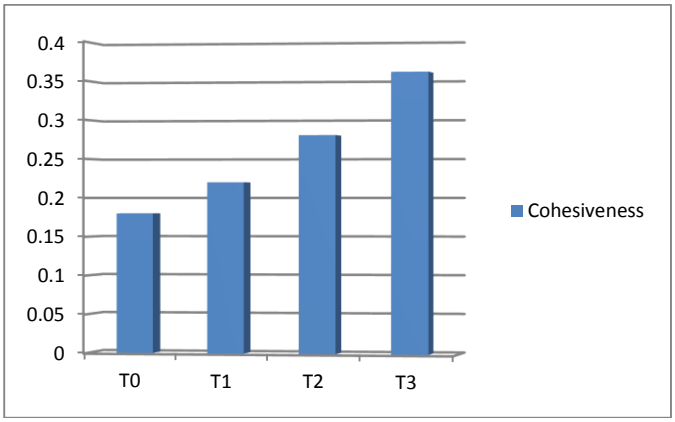


Fig 4: Cohesiveness of camel and buffalo milk based khoa burfi blended with watermelon seeds

Gumminess

The energy required to disintegrate a semi-solid food to a state ready for swallowing. Gumminess is the energy required to disintegrate a semi-solid food to a state ready for swallowing. Gumminess is related to primary parameters of hardness and cohesiveness and is obtained by multiplication of these two parameters. The gumminess value is expressed in terms of grams (g). The influence of the watermelon seeds powder incorporation on gumminess of experimental khoa burfi was depicted in table 1.

Gumminess, (g) = Hardness × Cohesiveness

Among all samples, T_3 sample contained highest (4500.24±578.854) gumminess, while lowest (553.11±77.973) values were observed in case of control i.e. T_0 (camel and buffalo milk khoa burfi without incorporation of any seeds). Whereas the value of 10 per cent watermelon seeds (T_1) and 20 per cent watermelon seeds (T_2) incorporated camel and buffalo milk khoa burfi were 1461.01±84.352 and 2702.39±263.832 respectively.

Gumminess of all the burfi samples was significantly different (p<0.05) from each other. Since gumminess is a secondary parameter derived from hardness and cohesiveness, hence a

slight change in these two textural parameters also affected it. Gupta *et al.* (1990) [5] also reported an increase in total solids, which resulted in increase in instron gumminess in khoa. Adhikari *et al.* (1994) [1] also reported negative correlation between moisture and instron gumminess of khoa. Similar results were also reported by Rajorhia *et al.* (1990) [5] that the gumminess of khoa from acidic buffalo milk was higher than khoa from fresh and neutralized buffalo milk.

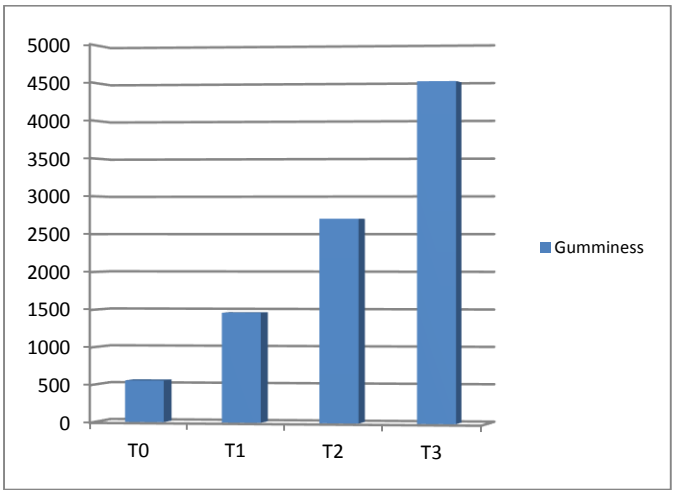


Fig 5: Gumminess of camel and buffalo milk based khoa burfi blended with watermelon seeds

Chewiness

The energy required to masticate food into a state ready for swallowing and is a product of hardness, cohesiveness and springines.

Chewiness, (g.mm) = Hardness × Cohesiveness × Springiness

The value obtained for chewiness were depicted in Table-1, which revealed that value for chewiness of experimental camel and buffalo milk based khoa burfi blended with watermelon seeds was in the ranged of 199.02±63.152 (T_0) to 841.79±148.347 (T_3). Whereas the value of other treatments T_1 and T_2 of camel and buffalo milk based khoa burfi blended with watermelon seeds were 441.06±24.014 and 694.84±71.907 respectively.

The addition of watermelon seeds powder significantly affected the chewiness of Burfi. Among all samples, T_0 (199.02±63.152) Burfi showed lowest chewiness while highest value was observed in case of sample T_3 (841.79±148.347) of Burfi. Wasnik *et al.* (2015) [25] reported positive correlation between chewiness and protein content of santraburfi. Since chewiness is a secondary parameter derived from hardness, cohesiveness and springiness, hence a slight change in these textural parameters also affected it. Gupta *et al.* (1990) [5] also reported that the increase in total solids resulted in increase of instron chewiness in khoa. Adhikari *et al.* (1994) [1] also reported negative correlation between moisture and instron chewiness of khoa.

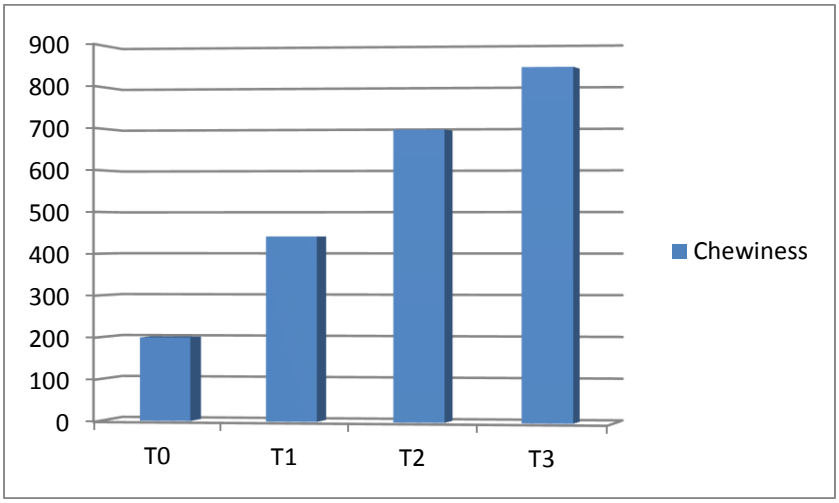


Fig 6: Chewiness of camel and buffalo milk based khoa burfi blended with watermelon seeds

Conclusion

From the present study it may be concluded that the overall textural profile of khoa burfi showed a wide difference in value of texture parameters like hardness, adhesiveness, springiness cohesiveness, gumminess and chewiness in control as well as all treatment group of developed burfi.

The incorporation of 50% camel milk and 50% buffalo milk without incorporation of watermelon seeds powder forms a good textural structure of the khoa burfi.

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