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# Storage Quality and Oxidative Stability Attributes of Jackfruit (*Artocarpus heterophyllus* L.) Seed Powder fortified Ghee Residue Burfi

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**ABSTRACT**

Ghee residue is one of the important by-products of the dairy industry, the potential of which has not been commercialised and is otherwise discarded, which leads to loss of many nutrients, anti-oxidants and flavour compounds. Recognizing its vital importance, the present study was carried out to standardize the formulation and to evaluate the acceptability of the *burfi.* Initially, *burfi* was prepared by incorporating *ghee* residue in the proportion of 10%, 20%, 30%, 40% and 50% by replacing respective proportions of *khoa* from which 40% *ghee* residue and 60% *khoa* was optimised in the formulation. Further, different levels of gram flour (3%, 6% and 9%) were tried in the formulation of *ghee* residue *burfi*. Based on sensory parameters, optimum level of gram flour was found to be 3%. The addition of gram flour enhanced the textural attributes of the product. Further, jackfruit seed powder (JSP) was added at 1%, 2% and 3% and shelf-life studies were undertaken. The various levels of JSP non significantly decreased the pH, TBARS and FFA content of the *burfi* samples. An increase in the most of sensory parameters was seen at 3% of gram flour. The total phenol and total flavonoid content were found to be in the range of (1.71-3.34 mg/g GAE) and (0.46-6.12 mg/g Quercetin) respectively. The shelf-life of the products were reported to be 15 days without any marked loss of physico-chemical, microbial and sensory quality. Considering the nutritional content of the product, it shall prove to be beneficial in providing energy and protein content to the malnourished section of the society.

**Keywords:** *Ghee* residue, gram flour, sensory parameters, jackfruit seed powder, total phenol content, total flavonoid content

India is the largest and one of the most economical milk producers in the world, with an average production of 155.5 Million tonnes per annum (NDDB, 2015-16); Nearly 56 per cent of total milk produced in India is utilized for preparation of variety of traditional milk products *i.e., Ghee*, *Curd*, *Khoa*, *Butter*, *Milk powder*, *Paneer*, C*hhana* etc. Out of total milk produced, 6.5 per cent is utilized for *Khoa* making (Anonymous, 2016). Ghee residue is a by-product obtained during manufacture of *ghee*. About 30-35% of the milk produced in India is converted into ghee (Gandhi *et al.,* 2013). When cream is heated into *ghee*, a brownish residue/*ghee* residue settles down after molten *ghee* is strained out. It has high nutritional value and is a rich source of lipids, proteins, antioxidants and flavour compounds. Most of the times, it is considered as a waste and is used at the industry level for the production of lipase being a potential source of the lipids (35-70%) and in the baking industry as flavour enhancer. However, at commercial level it has not been utilized by food industries. At the domestic levels it is used for *samosa* filling or spreading over chappaties etc. Consumption of dairy sweets is closely related with our traditional rituals and festivals. Most dairy food delicacies are value added products generating high profits. *Burfi*, a *khoa* based sweet delicacy is popular in all parts of the country. The remarkable adaptability of *khoa* to amalgamate with different ingredients has craved out methodologies of large *burfi* varities. The market for traditional dairy products in

India is estimated to be US $ 10 billion, being the largest and fastest growing segment of the Indian dairy industry (Pal *et al*., 2006). Although manufacture of traditional products are gaining popularity yet the limitation of shorter shelf life due to microbial contamination is a matter of concern. Development of rancidity arising out of lipid degradation reduces the shelf-life of the product, which ultimately affects consumer acceptability (Nerin *et al.,* 2008). Advancement in the preservation of food items now inclines more towards the use of biopreservatives for shelf life extension which also provides additional health benefits of the natural antioxidants. *Artocarpus heterophyllus* (Jackfruit) trees belong to mulberry family Moraceae (Rahman *et al.,* 1999). Jackfruit seeds contains 6.6-7 % protein, 38% carbohydrate, 1-1.5% fiber and 0.4% fat. Converting seeds into flour overcomes the problem of shorter life span and also allows adjunction with wide arrays of flours to be used for value addition while providing extra advantage of nutrients and polyphenolic compounds. Antimicrobial effects of jackfruit seed powder has also been reported by several researchers in the recent times. Therefore, present study was carried out of evaluate physico-chemical attributes of *ghee* residue collected by direct cream method and its conversion into *burfi* type confection. Further, shelf-life studies were undertaken with the incorporation of jackfruit seed powder.

## MATERIALS AND METHODS

### Collection and processing of *ghee* residue

Cream collected over a span of time and kept under freezer condition was heated uniformly on a low heat with continous stirring to avoid scorching at the base of container. *Ghee* was filtered out and sediment (*ghee* residue) was hand pressed in sieve to obtain *ghee* residue. Further, the *ghee* residue was treated as recommended by Prahlad (1954) with slight modifications. *Ghee* residue was tied in a muslin cloth and then kept in warm soda bicarbonate solution (1%) for 15 minutes to neutralize the acidity.

### Preparation of *khoa*

The *khoa* was prepared from milk by continous stirring cum scrapping till it attained pasty consistency as described by De (2004).

### Preparation of control *burfi*

Freshly prepared *khoa* was spread over the karahi and crystal sugar @30g was added following which the mixture was worked upon with wooden ladle for 5-10 minutes. The mass was transferred to the greased trays, flattened and allowed to cool under room temperature. It was later cut into the desired rectangular shape.

### Preparation of experimental *burfi* and JSP added *burfi*

Experimental *burfi* was prepared with *khoa, ghee* residue and gram flour. Sugar @30g was added. Jackfruit seed powder was added at three different levels viz 1%, 2% and 3% for the preparation of JSP added *burfi*.

### Physico-chemical properties

The pH of *ghee* residue *burfi* was measured soon after its preparation by the method of Keller *et al*. (1974) by using a digital pH meter (Systronics Digital pH Meter 803). The proximate components viz., moisture, crude protein, crude fat, total ash contents and Titratable acidity and peroxide values were determined by using standard procedures prescribed by AOAC (1995). Water activity of the samples was determined using water activity meter (Aqua Lab-Series 3 TE). Lactose percent in the samples was done as per Lane–Eynon volumetric method (Adriano *et al*., 1934). Total cholesterol in the lipid extracts was determined by adopting the Tschugaeff reaction as modified by Hanel and Dam (1995).

### Storage studies

TBARS value of the samples was determined as per method described by Witte *et al.* (1970). Free Fatty Acid value of the samples was determined as per method of Koniecko 1979. The microbiological characteristics viz., total plate count, psychrophillic count, coliform count and yeast and mould count were determined by methods of APHA (1984).

### Antioxidant assays

Total Phenol content- Phenol content of the samples was determined as per method of Singleton *et al*. 1999. Total Flavonoid Content- The content of flavonoids

in the examined samples was determined using spectrophotometric method (Quettier *et al*., 2000).

### Sensory evaluation of *ghee* residue *burfi*

The *burfi* was evaluated for its sensory parameters at regular intervals by semi-trained experienced sensory panel consisting of 7 scientists of the Faculty of Veterinary Sciences and Animal Husbandry on a 9-point hedonic scale with slight modification (Pal and Gupta, 1985) wherein a score of 1 represented 'dislike extremely' and score of 9 represented 'like extremely'. Water was provided to the panellists for oral rinsing between two sample testing.

### Statistical analysis

The results were analysed statistically for analysis of variance and least significant difference tests using the software of statistical package for social sciences (SPSS 16.0) and as per Snedecor and Cochran (1980).

## RESULTS AND DISCUSSION

### Sensory evaluation of *ghee* residue *burfi* of different ratio

The basic formulation of *burfi* was optimized for the levels of *ghee* residue and levels of *khoa*. For this purpose, different proportions of *ghee* residue and *khoa* viz. 10:90, 20:80, 30:70, 40:60 and 50:50 were used in the preparation of *ghee* residue *burfi* keeping the fixed level of sugar i.e. 30g (as per standard texts) to optimize the levels of *ghee* residue and *khoa*. The 0:100 combination served as control. The products were judged for colour and appearance, body and texture, flavour and overall acceptability. The results of sensory evaluations are presented in table 1.

Results showed that with increase in the levels of *ghee* residue, no significant difference was observed upto 40:60 level thereafter, a significant ($P<0.05$) decrease was observed. This could be attributed to the brown colour of the *ghee* residue and so could be incorporated upto 40% level. This is in accordance with the study of Borawake and Bhosale (1996), where it was reported that increasing levels of replacement of fat with GR decreased the colour and appearance scores in *nankhatai* type cookies and sponge cakes. The scores for flavour increased non-significantly ($P>0.05$) with the increase in the inclusion of *ghee* residue. This is probably because of the high flavour potential of GR due to the presence of high FFA, carbonyls and lactones (Galhotra and Wadhwa, 1991a and 1991b). Similar findings were observed by Subbulakshmi *et al*. (1990), who concluded that *ghee* flavour in the residue improves the aroma of the products there by improving the overall acceptability. Overall acceptability of *burfi* containing 40:60 combination although low was comparable with the control. Based on above observations, 40% *ghee* residue and 60% *khoa* proportion was selected for further studies.

### Sensory evaluation of *ghee* residue *burfi* incorporated with different levels of gram flour

In this part of the study, different levels of gram flour (GF) i.e. (3, 6 and 9%) were utilized in the formulation of *burfi* by replacing the respective proportion of *khoa*. Product containing 0% gram flour served as control. The mean values for sensory parameters are presented in table 2. The mean sensory scores for *burfi* made with 9% gram flour

**Table 1:** Sensory evaluation of different *ghee* residue *burfi* of different ratio

| *Ghee* Residue (%) | *Khoa* (%) | Colour and Appearance | Body and Texture | Flavour | Mouth-feel | Overall Acceptability |
|---|---|---|---|---|---|---|
| — | 100 | $8.47\pm0.10^{B}$ | $8.54\pm0.12^{B}$ | 7.54±0.13 | $7.26\pm0.16^{B}$ | $8.16\pm0.18^{B}$ |
| 10 | 90 | $8.38\pm0.11^{B}$ | $8.50\pm0.12^{B}$ | 7.61±0.12 | $7.13\pm0.14^{B}$ | $8.09\pm0.13^{B}$ |
| 20 | 80 | $8.35\pm0.11^{B}$ | $8.42\pm0.13^{B}$ | 7.69±0.09 | $7.04\pm0.11^{B}$ | $7.98\pm0.12^{B}$ |
| 30 | 70 | $8.21\pm0.17^{B}$ | $8.11\pm0.19^{B}$ | 7.73±0.09 | $6.96\pm0.11^{B}$ | $7.92\pm0.12^{B}$ |
| 40 | 60 | $8.09\pm0.13^{B}$ | $8.09\pm0.13^{B}$ | 7.75±0.11 | $6.85\pm0.13^{AB}$ | $7.86\pm0.14^{B}$ |
| 50 | 50 | $7.70\pm0.12^{A}$ | $7.33\pm0.18^{A}$ | 7.74±0.13 | $6.47\pm0.15^{A}$ | $7.38\pm0.15^{A}$ |

*Mean± SE with different superscripts in a column wise (upper case alphabet) differ significantly ($P<0.05$). n=21 for each treatment.

**Table 2:** Effect of different levels of gram flour on the sensory attributes of *ghee* residue based *burfi*

| Attributes | Levels of Gram Flour (%) | | | |
|---|---|---|---|---|
| | 0 | 3 | 6 | 9 |
| Colour & Appearance | 7.11±0.16 | 7.28±0.17 | 7.26±0.17 | 7.07±0.18 |
| Body & Texture | 7.20±0.13$^{a}$ | 7.84±0.15$^{b}$ | 7.45±0.14$^{ab}$ | 7.01±0.19$^{a}$ |
| Flavour | 7.87±0.15 | 8.23±0.18 | 8.06±0.13 | 7.97±0.17 |
| Mouthfeel | 7.48±0.15 | 7.51±0.17 | 7.89±0.16 | 7.90±0.19 |
| Overall Acceptability | 7.36±0.15$^{ab}$ | 7.68±0.17$^{b}$ | 7.41±0.17$^{ab}$ | 7.05±0.18$^{a}$ |

*Mean± SE with different superscripts in a row wise (lower case alphabet) differ significantly (P<0.05). n=21 for each treatment.

were significantly (P<0.05) lower than the *burfi* prepared with 3% gram flour and control *burfi*, however the latter two were comparable with each other. The scores for colour and appearance decreased after 3% level because at higher amounts, it gave darker colour to the product and did not appeal the judges. The scores of flavour for *burfi* also decreased after 3% level because of the flour taste which replaced the original flavour and taste of *burfi* when used in greater amounts. Higher values of overall acceptability might be due to higher scores for other sensory attributes for the formulation containing 3% gram flour. Hence, 3% gram flour was found optimum in the development of gram flour incorporated *ghee* residue *burfi* (GFb).

### Proximate composition of designed *burfi*

The proximate composition of *burfi* designed with *ghee* residue, *khoa* and gram flour is presented in Table 3.

**Table 3:** Proximate composition of *ghee* residue *burfi* with 3%gram flour

| Parameters | % |
|---|---|
| Moisture | 19.45 |
| Protein | 23.68 |
| Fat | 27.96 |
| Total Ash | 4.06 |
| Lactose | 18.79 |
| Cholesterol (mg/100g) | 64.02 |
| Ca | 0.56 |
| P | 0.50 |

The average per cent moisture, protein, fat, ash, lactose, calcium and phosphorus were found out to be 19.45, 23.68, 27.96, 4.06, 18.79, 0.56 and 0.50 respectively. The values illustrate *ghee* residue *burfi* as a potential source of protein and energy.

### Physico-chemical and sensory evaluation of optimized *burfi* with different levels of Jackfruit Seed Powder (JSP)

Three different levels of Jackfruit seed powder (1%, 2% and 3%) were added into gram flour based *ghee* residue *burfi* and the product was analysed for storage parameters at weekly interval upto 21 days.

### Physico-chemical parameters

The mean values for various physico-chemical attributes of *ghee* residue *burfi* (containing 3% gram flour) and incorporated with different levels of Jackfruit seed powder are presented in Table 4. The mean values of pH in control (GFb) as well as *burfi* treated with different levels of JSP decreased significantly (P<0.05) with the progressive storage interval. The decline in the pH of gram flour *burfi* with jackfruit seed powder could be attributed to the acidic pH of Jackfruit seed powder (Swami *et al.,* 2012). TBARS followed a significant (P<0.05) increasing trend from day 0 to 21 in case of both control as well as *burfi* with added jackfruit seed powder. This is in accordance with findings of Kumar *et al.* (2010) who reported a significant increase in TBA values with increase in time in stored *khoa* samples containing antioxidants. The FFA content showed a non-significant increase throughout the storage period in control as well as treated *burfi* samples. Increase in FFA was within desirable limits when compared to BIS (1966) as per IS: 3508 rules maximum limit for FFA is 3.0 in *ghee* and all *ghee* residue products showed lower levels

**Table 4:** Effect of various levels of JSP on physico-chemical attributes of *ghee* residue *burfi* incorporated with optimized level of gram flour (3%) (Mean±SE)

| Treatments | Storage Period (Days) | | | |
|---|---|---|---|---|
| | 0 | 7 | 14 | 21 |
| **pH** | | | | |
| GFb | 6.28±0.02$^{d}$ | 6.11±0.04$^{c}$ | 5.80±0.04$^{b}$ | 5.68±0.03$^{Aa}$ |
| GFb+1%JSP | 6.27±0.03$^{c}$ | 6.15±0.05$^{c}$ | 5.84±0.02$^{b}$ | 5.81±0.05$^{ABa}$ |
| GFb+2%JSP | 6.24±0.04$^{c}$ | 6.13±0.03$^{c}$ | 5.91±0.06$^{b}$ | 5.83±0.04$^{Ba}$ |
| GFb+3%JSP | 6.21±0.05$^{c}$ | 6.13±0.03$^{c}$ | 5.95±0.05$^{b}$ | 5.86±0.06$^{Ba}$ |
| **TBARS** | | | | |
| GFb | 0.79±0.02$^{a}$ | 1.39±0.03$^{b}$ | 1.75±0.09$^{c}$ | 2.36±0.04$^{d}$ |
| GFb+1% JSP | 0.80±0.02$^{a}$ | 1.35±0.07$^{b}$ | 1.70±0.08$^{c}$ | 2.31±0.08$^{d}$ |
| GFb+2% JSP | 0.79±0.03$^{a}$ | 1.32±0.07$^{b}$ | 1.68±0.08$^{c}$ | 2.30±0.10$^{d}$ |
| GFb+3% JSP | 0.75±0.04$^{a}$ | 1.29±0.04$^{b}$ | 1.66±0.10$^{c}$ | 2.29±0.06$^{d}$ |
| **FFA(%oleic acid)** | | | | |
| GFb | 1.128±0.04 | 1.152±0.06 | 1.187±0.02 | 1.229±0.04 |
| GFb+1% JSP | 1.125±0.04 | 1.149±0.06 | 1.176±0.04 | 1.217±0.05 |
| GFb+2% JSP | 1.127±0.05 | 1.147±0.07 | 1.167±0.05 | 1.198±0.07 |
| GFb+3% JSP | 1.121±0.05 | 1.144±0.06 | 1.163±0.04 | 1.186±0.06 |
| **Titratable acidity** | | | | |
| GFb | 0.29±0.02$^{a}$ | 0.47±0.02$^{b}$ | 0.63±0.04$^{c}$ | 0.89±0.04$^{d}$ |
| GFb+1% JSP | 0.31±0.01$^{a}$ | 0.45±0.02$^{b}$ | 0.60±0.03$^{c}$ | 0.87±0.05$^{d}$ |
| GFb+2% JSP | 0.33±0.03$^{a}$ | 0.44±0.03$^{b}$ | 0.58±0.02$^{c}$ | 0.83±0.05$^{d}$ |
| GFb+3% JSP | 0.36±0.04$^{a}$ | 0.40±0.02$^{b}$ | 0.56±0.02$^{c}$ | 0.78±0.03$^{d}$ |
| **$a_w$** | | | | |
| GFb | 0.831±0.04 | 0.813±0.05 | 0.790±0.03 | 0.763±0.04 |
| GFb+1% JSP | 0.843±0.04 | 0.831±0.04 | 0.786±0.04 | 0.763±0.03 |
| GFb+2% JSP | 0.843±0.03 | 0.825±0.02 | 0.790±0.03 | 0.773±0.03 |
| GFb+3% JSP | 0.856±0.01 | 0.843±0.04 | 0.813±0.05 | 0.790±0.04 |
| **Peroxide Value (meq/kg)** | | | | |
| GFb | ND | ND | ND | 0.89±0.02 |
| GFb+1% JSP | ND | ND | ND | 0.87±0.04 |
| GFb+2% JSP | ND | ND | ND | 0.88±0.03 |
| GFb+3% JSP | ND | ND | ND | 0.86±0.04 |

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly ($P<0.05$. Gfb- *Ghee* residue *burfi* incorporated with gram flour (3%) JSP- Jackfruit Seed Powder). n=6 for each treatment.

in comparison to PFA recommendations. The results are also in agreement with Janghu *et al.* (2014) who studied the effect of storage on free fatty acid content of candy and chocolate made from *ghee* residue. Water activity ($a_w$) of the products decreased with the advancement in the storage interval; however the scores for GFb with 3% JSP were higher than the control on all days of storage. Peroxides were not detected till 14 days of refrigerated storage, however they were detected on day 21.

### Total Phenol content (mg/g GAE)

Total phenolic content of samples (with optimized levels of flours) treated with varying levels of JSP and stored at refrigeration temperature (7±1ºC) is presented in Fig.

1. The results showed that there was non-significant decrease (P<0.05) in phenolic content of control, GFb with 2% JSP and RWFb with 2% JSP upto day 14 and thereafter a significant (P<0.05) decrease was observed on day21 of refrigerated storage. Shanmugapriya *et al.* (2011) studied total phenolic contents of *Artocarpus heterophyllus* (Jackfruit) seeds and reported that it has effective antioxidant activity due to presence of phenolic compounds in the range of 2-4.2 mg/g extract. However, low content of phenols were detected in *burfi* which might be due to processing losses.

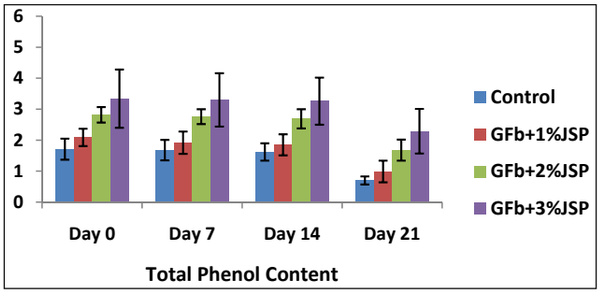


**Fig. 1:** Graphical representation of Total Phenol Content of *ghee* residue *burfi* incorporated with varying levels of Jackfruit Seed Powder

## Total Flavonoid Content (mg/g Quercetin)

Total flavonoid content of ten samples (with optimized levels of flours) treated with varying levels of JSP and stored at refrigeration temperature (7±1ºC) is presented in Fig. 2.

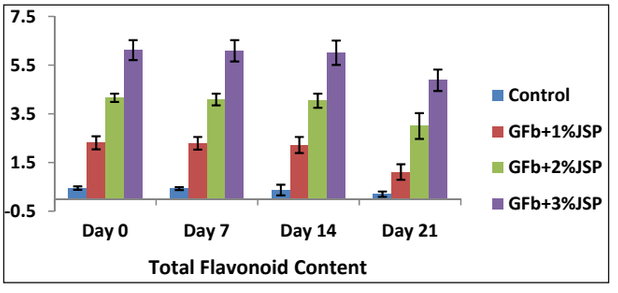


**Fig. 2:** Graphical representation of Total Flavonoid Content of *ghee* residue *burfi* incorporated with varying levels of Jackfruit Seed Powder

The results showed that there was non-significant (P>0.05) decrease in values for GFb with 2% JSP upto 14$^{th}$ day of storage after which a significant (P<0.05) decrease was observed on day 21 of refrigerated storage. For rest of the treatments, a non-significant difference (P>0.05) was observed. Shanmugapriya *et al.* (2011) studied total flavonoid contents of *Artocarpus heterophyllus* (Jackfruit) seeds and reported that it has high flavonoids content in the range of 1-4 mg/g extract. However, content of flavonoid detected were low in *burfi* which might be due to processing losses and destruction of flavonoids during preparation of product.

## Microbiological Parameters

The mean values expressed as cfu/g for various microbiological attributes of *ghee* residue *burfi* incorporated with optimized level of gram flour (3%) are presented in Table 5.

**Table 5:** Effect of various levels of JSP on microbiological quality of *ghee* residue *burfi* incorporated with optimized level of gram flour (3%) (Mean±SE)

| Treatments | Storage Period (Days) | | | |
|---|---|---|---|---|
| | 0 | 7 | 14 | 21 |
| | ***Total Plate Count(log cfu/g)*** | | | |
| GFb | 3.28±0.07$^{a}$ | 3.58±0.04$^{b}$ | 4.16±0.06$^{c}$ | 5.13±0.07$^{d}$ |
| GFb+1% JSP | 3.28±0.05$^{a}$ | 3.53±0.04$^{b}$ | 4.15±0.05$^{c}$ | 5.11±0.05$^{d}$ |
| GFb+2% JSP | 3.26±0.06$^{a}$ | 3.52±0.09$^{b}$ | 4.14±0.05$^{c}$ | 5.12±0.09$^{d}$ |
| GFb+3% JSP | 3.25±0.04$^{a}$ | 3.49±0.08$^{b}$ | 4.09±0.08$^{c}$ | 5.10±0.09$^{d}$ |
| | ***Psychrophillic count(log cfu/g)*** | | | |
| GFb | ND | ND | 1.91±0.02$^{a}$ | 2.41±0.11$^{b}$ |
| GFb+1% JSP | ND | ND | 1.90±0.04$^{a}$ | 2.40±0.09$^{b}$ |
| GFb+2% JSP | ND | ND | 1.88±0.06$^{a}$ | 2.38±0.07$^{b}$ |
| GFb+3% JSP | ND | ND | 1.87±0.07$^{a}$ | 2.39±0.07$^{b}$ |
| | ***Coliform Count(log cfu/g)*** | | | |
| GFb | ND | 0.74±0.08$^{a}$ | 1.52±0.03$^{b}$ | 1.98±0.04$^{c}$ |
| GFb+1% JSP | ND | 0.73±0.06$^{a}$ | 1.49±0.10$^{b}$ | 1.97±0.05$^{c}$ |
| GFb+2% JSP | ND | 0.71±0.07$^{a}$ | 1.50±0.04$^{b}$ | 1.97±0.06$^{c}$ |
| GFb+3% JSP | ND | 0.70±0.08$^{a}$ | 1.49±0.05$^{b}$ | 1.98±0.06$^{c}$ |
| | ***Yeast & Mould count (log cfu/g)*** | | | |
| GFb | 1.85±0.08$^{a}$ | 1.93±0.06$^{a}$ | 2.36±0.09$^{b}$ | 3.05±0.08$^{c}$ |
| GFb+1% JSP | 1.86±0.11$^{a}$ | 1.94±0.06$^{a}$ | 2.35±0.08$^{b}$ | 3.00±0.04$^{c}$ |
| GFb+2% JSP | 1.85±0.10$^{a}$ | 1.92±0.10$^{a}$ | 2.36±0.09$^{b}$ | 2.98±0.06$^{c}$ |
| GFb+3% JSP | 1.85±0.08$^{a}$ | 1.93±0.11$^{a}$ | 2.36±0.11$^{b}$ | 2.99±0.05$^{c}$ |

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly (P<0.05). Gfb- *Ghee* residue *burfi* incorporated with gram flour (3%) JSP- Jackfruit Seed Powder n=6 for each treatment.

Total plate count (TPC) followed a linear increasing trend from day 0 to 21 in control as well as JSP added *burfi* samples. The values were non-significantly ($P<0.05$) lower in case of GFb with added 3% JSP on all days. This might be because of the low concentration of the JSP. However, counts remained under acceptable range until 14 days of refrigerated storage. The increase in TPC with progressive storage may be attributed to the post process contamination during handling. Reddy (1985), also found that *burfi* made from concentrated milk and mixture of cane sugar and corn-syrup and stored at 5 °C had a total viable count of $2\times10^2$ and $6\times10^3$/g on the first day and after 190 days, respectively. The psychrophillic count was not detected at day 0 and 7 but appeared at 14 day of storage with significant ($P<0.05$) increase on day 21. The appearance of psychrophilles after such a long gap might be caused by sufficient heat treatment during processing, which drastically injured and killed the psychrophillic population reducing the number of surviving injured and resistant ones and hence donot form any colony. A detectable count on day 14 onwards while nil on preceding observations might be attributed the fact that bacteria generally need some lag phase before active multiplication is initiated (Jay, 1996). No anti-fungal effect could be seen in any sample incorporated with jackfruit seed powder on any day of storage.

### Sensory parameters

The mean values for various sensory attributes of *ghee* residue *burfi* incorporated with optimized level of gram flour (3%) are presented in Table 6. The values of colour and appearance and mouthfeel for control as well as JSP added *burfi* samples were comparable upto 14 day of storage. Decrease in colour scores with advancement of storage days might be attributed to oxidative fading, moisture loss and non-enzymatic browning from reaction between lipid oxidation products and amino acids (Chandralekha *et al.,* 2012). The scores for flavour in case of control GFb decreased non-significantly upto 7th day and thereafter a significant decline was observed. Decline in textural scores on 21st day of storage might be attributed to proteolytic and disulphide bond changes (Santamaria *et al*., 1992). Similar trend was observed by Reddy (1985) and Kamble (2010). There was dryness of the surface, reduced freshness, dull appearance and faded colour with advanced storage period. The observations present study indicated that both control and JSP added burfi samples retained acceptable physico-chemical characteristics, colour values, microbiological counts and good to very good sensory rating during storage under refrigerated temperature at 7±1ºC for 14 days. Hence, formulated burfi samples evolved in this study could be safely stored up to 14 days of storage at 7±1ºC without any marked loss of physico-chemical, colour, microbiological and sensory quality.

**Table 6:** Effect of various levels of JSP on sensory attributes of *ghee* residue *burfi* incorporated with optimized level of gram flour (3%) (Mean±SE)

| Treatments | Storage Period (Days) | | | |
|---|---|---|---|---|
| | 0 | 7 | 14 | 21 |
| | ***Colour & Appearance*** | | | |
| GFb | 7.22±0.18$^{b}$ | 7.00±0.19$^{b}$ | 6.76±0.16$^{b}$ | 6.10±0.15$^{a}$ |
| GFb+1% JSP | 7.25±0.18$^{b}$ | 7.05±0.19$^{b}$ | 6.79±0.15$^{b}$ | 6.12±0.16$^{a}$ |
| GFb+2% JSP | 7.24±0.15$^{b}$ | 7.10±0.20$^{b}$ | 6.80±0.17$^{b}$ | 6.15±0.16$^{a}$ |
| GFb+3% JSP | 7.20±0.16$^{b}$ | 6.97±0.21$^{b}$ | 6.74±0.17$^{b}$ | 6.17±0.14$^{a}$ |
| | ***Body & Texture*** | | | |
| GFb | 7.46±0.14$^{b}$ | 7.24±0.18$^{bc}$ | 6.96±0.15$^{b}$ | 5.90±0.13$^{a}$ |
| GFb+1% JSP | 7.49±0.13$^{c}$ | 7.29±0.18$^{bc}$ | 6.99±0.14$^{b}$ | 5.91±0.13$^{a}$ |
| GFb+2% JSP | 7.53±0.16$^{b}$ | 7.36±0.15$^{b}$ | 7.17±0.19$^{b}$ | 5.93±0.15$^{a}$ |
| GFb+3% JSP | 7.10±0.19$^{b}$ | 7.17±0.19$^{b}$ | 6.90±0.17$^{b}$ | 5.97±0.16$^{a}$ |
| | ***Flavour*** | | | |
| GFb | 8.06±0.13$^{c}$ | 7.76±0.18$^{bc}$ | 7.49±0.13$^{b}$ | 5.85±0.14$^{a}$ |
| GFb+1% JSP | 8.02±0.14$^{c}$ | 7.78±0.18$^{bc}$ | 7.46±0.13$^{b}$ | 5.82±0.14$^{a}$ |
| GFb+2% JSP | 8.00±0.17$^{b}$ | 7.80±0.16$^{b}$ | 7.53±0.16$^{b}$ | 5.86±0.13$^{a}$ |
| GFb+3% JSP | 8.10±0.16$^{b}$ | 7.85±0.16$^{b}$ | 7.56±0.17$^{b}$ | 5.89±0.15$^{a}$ |
| | ***Mouthfeel*** | | | |
| GFb | 7.88±0.15$^{b}$ | 7.63±0.21$^{b}$ | 7.47±0.14$^{b}$ | 5.90±0.12$^{a}$ |
| GFb+1% JSP | 7.85±0.16$^{b}$ | 7.66±0.21$^{b}$ | 7.49±0.17$^{b}$ | 5.91±0.13$^{a}$ |
| GFb+2% JSP | 7.90±0.17$^{b}$ | 7.68±0.17$^{b}$ | 7.51±0.17$^{b}$ | 5.93±0.13$^{a}$ |
| GFb+3% JSP | 7.80±0.19$^{b}$ | 7.70±0.18$^{b}$ | 7.54±0.17$^{b}$ | 5.95±0.14$^{a}$ |
| | ***Overall Acceptability*** | | | |
| GFb | 7.40±0.13$^{b}$ | 7.27±0.18$^{b}$ | 7.00±0.16$^{b}$ | 5.94±0.12$^{a}$ |
| GFb+1% JSP | 7.45±0.13$^{b}$ | 7.30±0.18$^{b}$ | 7.05±0.18$^{b}$ | 5.98±0.15$^{a}$ |
| GFb+2% JSP | 7.57±0.14$^{b}$ | 7.32±0.16$^{b}$ | 7.10±0.14$^{b}$ | 6.00±0.13$^{a}$ |
| GFb+3% JSP | 7.35±0.15$^{c}$ | 7.18±0.18$^{bc}$ | 6.76±0.16$^{b}$ | 6.03±0.12$^{a}$ |

*Mean± SE with different superscripts in a row wise (lower case alphabet) and column wise (upper case alphabet) differ significantly ($P<0.05$). Gfb- *Ghee* residue *burfi* incorporated with gram flour (3%) JSP- Jackfruit Seed Powder; n=21 for each treatment.

## CONCLUSION

On the basis of analysis of different parameters, it can be

concluded that *ghee* residue can be very well utilized for preparation of palatable and economical burfi by blending 40 per cent *ghee* residue and 60 per cent *khoa* on weight basis. The level of gram flour in the formulation of *ghee* residue *burfi* was standardized at 3%. The addition of flour improved the textural properties of the *burfi*. The storage quality of the developed products was further studied and both control and jackfruit seed powder enriched burfi maintained acceptable oxidative stability, microbial profile and sensory acceptability upto 14th day of refrigerated storage (7±1ºC).

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