Quality assessment of market sample of *khoa* based *ramdana lai*

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Abstract: *Khoa based Ramdana Lai (KBRL)* is a popular traditional *khoa* based sweets of Bihar. It is prepared by *khoa* blending with *ramdana*, sugar and other additives. The present investigation was planned to assess the quality of *KBRL* samples from different location of Bihar. A total of 36 *KBRL* samples were collected from various locations of Bihar and were analyzed for their sensory, physico-chemical, microbial, textural and colour characteristics. The sensory scores of *KBRL* in terms of flavour, body and texture, colour and appearance and overall acceptability; the colour characteristics in terms of L^* , a^* , b^* values; the textural characteristics in terms of hardness, springiness, cohesiveness, chewiness and gumminess and microbial quality measured in terms of TPC, yeast and molds and coliform count were found significantly ($p \leq 0.05$) different among samples. The moisture, fat, protein, total carbohydrate and ash content of samples varied from 16.83 to 20.83%, 9.30 to 12.0%, 10.63 to 16.22%, 51.62 to 61.3% and 0.7 to 0.75%, respectively.

Keywords: *Khoa*, Physico-chemical, *Ramdana*, *Ramdana Lai*, Sensory, Textural characteristics

Introduction

Milk based ethnic sweets have lot of market potential as their demand is increasing not only Indian market, but also in overseas market. Apart from *khoa* based confectionary like *burfi*, *peda*, *kalakand*, *gulabjamun* are quite popular in India and abroad. Among them one of the *khoa* based confectionary *Khoa based Ramdana Lai (KBRL)* is one of the most popular product of Bihar. It is mostly prepared by *halwais* generally at Barh, Dhanarua, Biharsharif, and Patna location of Bihar. It is articulasly prepared by blending of *khoa* with *ramdana* and certain proportion of sugar to make homogenous consistency with round shape and square shape.

In absence of technical know-how, the large scale production of these region specific milk products in organized sector is a challenging task (Singh and Kumar, 2006), which requires scientific investigations in terms of their characterization, standardization of technological parameters and strategic interventions for ensuring the safety and enhancing the shelf-life (Chawla et al. 2014). Due to the differences in the manufacture procedure adopted by the manufactures, the organoleptic and physico-chemical quality of *KBRL* vary greatly. Keeping this in view, the present study was undertaken to evaluate the quality of market sample of *KBRL* collected from various location of Bihar.

Material and Methods

Sample collection

The market samples of *KBRL* were procured from four different places of Bihar like Barh, Dhanarua, Biharsharif, and Patna. Nine sweet shops were selected in each city thus a total of 36 samples were procured for this survey work.

Sensory evaluation

The sensory analysis was carried out by serving market samples of *KBRL* among a panel of seven judges of faculty members of university. The samples were examined for colour and appearance, body and texture, flavour, sweetness and overall acceptability

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on 9-point hedonic scale. The scores given by panel of judges were then statistically analysed.

Physico-chemical analysis

The fat content of *KBRL* market samples were determined by mojonner fat extraction apparatus as specified in BIS (1961). The protein content was determined by micro kjeldahl method (Menefee and Overman, 1940). The moisture content by gravimetric method and ash content of samples were determined as method suggested in BIS (1981). The total carbohydrate content of *KBRL* samples was calculated by difference to achieve 100% of total contents. The method prescribed by Deeth et al. (1975) was used to estimate the FFA content of market samples of *KBRL*.

Colour measurement

Colour measurements were carried out using *Color Flex* (Hunter Associates Laboratory, Inc., Reston VA, USA) colour measurement system equipped with dual beam xenon flash lamp and universal software. The results were represented by the L^* , a^* , b^* notation. It is a 3D colour presentation method in which L^* is the lightness index of colour and equals 0 for black and 100 for white, a^* value is redness and greenness index the amount of red (0 to 60) or green (0 to -60) and b^* value is the yellowness (0 to 60) or blueness (0 to -60) index.

Textural characteristics

Various textural characteristics such as hardness (N), cohesiveness, springiness (mm), gumminess (N) and chewiness (N mm) were measured of *KBRL*, using *Stable Micro Systems Texture Analyzer* (Model TA.XT2i Stable Micro systems, double cycle compression, fitted with 25 kg load cell, combined with Texture Expert Exceed Software). A cylindrical shape of market samples with 1.0 cm diameter and 1.0 cm height was used for determining the textural characteristics. A data acquisition rate 200 pps with probe P75 was used and samples were compressed twice to 80 % of its height. The probe speed of 2.5 mm/sec during test and 2.5 mm/sec for pre-test and 5.0 mm/sec post-test were used throughout the study. All measurements were carried out at 25°C.

Microbiological analysis

All the market samples of *KBRL* were analyzed for total plate count (TPC), yeast and mould count and coliform count by standard method cited in BIS (1980). The results were expressed as cfu/g of sample.

Statistical analysis

The data were recorded and analyzed as per the standard procedures (Snedecor and Cochran, 1994) using SPSS version 22.0 statistical software employing one-way and two-ways

ANOVA test. The data are presented as mean $\pm$ standard error (SE) of three replicates.

Results and Discussion

Physico-chemical properties

Moisture content

It has been observed (Table 1) that the moisture content of market samples were found in the range of 16.83 ± 0.99 to 20.83 ± 0.38 . However, the results of present findings are in accordance with Keerthi et al. (2018) and Dastur and Lakhani (1971). Similar observations were also reported by Sharma et al. (2012), who observed that the moisture content of milk cake was slightly higher in control samples than market samples. The variation in the moisture content might be mainly due to the difference in method of manufacture, extent of desiccation, amount of sugar added, difference in chemical composition of base material used. The present findings are also in accordance with Banjare et al. (2015). Further, our study reported similar finding with Chawla et al. (2014) and Patel et al. (2006), who observed significant differences in moisture content in *dooda burfi*.

Fat

The fat content of market *KBRL* samples were significant ($p \leq 0.05$) as presented in Table 1. The difference in the fat content of *KBRL* samples might be attributed to the variation in the type of milk used (buffalo/cow) and their fat content, amount of sugar added and duration of desiccation. The present study was in alignment with Banjare et al. (2015). Keerthi et al. (2018) and Chawla et al. (2014) also reported that fat content of market sample *doda burfi* was in the range of 4.70 to 41.05%. Further, Puri et al. (2015) reported that the fat content of market sample of *cham-cham* was in the range of 2.39 to 9.4%.

Protein

The protein content was also found significant ($p \leq 0.05$) also even among the samples (Table 1). Our finding correlates with Keerthi et al. (2018) and Chawla et al. (2014) who reported the protein content variation of market samples of *doda burfi*. Further, Ghodeker et al. (1974) also reported that the protein content of market samples *burfi* and *peda* varied between 12.1 to 20.3 and 6.3 to 11.8%, respectively

Ash content

The ash content of market samples of *KBRL* were also found significant ($p \leq 0.05$) among samples (Table 1). Our findings correlate with the reports of Rajorhia and Srinivasan (1979), who studied that the ash content in *khoa* samples also showed fairly wide variations due to the type of milk used, extent of desiccation and addition of adulterants.

Total carbohydrate

The total carbohydrates of market samples of *KBRL* were found significant ($p \leq 0.05$) difference among the samples (Table 1). Sharma et al. (2012) was observed similar observation for milk cake. Further, Ghodeker et al. (1974) reported that variation in sugar content of market samples of *burfi* and *peda*.

Free fatty acids (FFA)

The FFA values of *KBRL* samples were in ranged from 0.11 ± 0.03 to $0.21 \pm 0.05\%$ oleic acid (Table 1). There was significant ($p \leq 0.05$) difference found among samples even from same market. Further, Ray et al. (2002) found that *peda* samples from Kolkata market having FFA in the range of 0.056 to 0.65% oleic acid. Similarly, Hemavathy and Prabhakar (1973) also reported that *burfi* comprised of FFA of 3.41 g oleic acid/kg fat, whereas Suresh and Jha (1994) reported FFA ranging from 0.2 to 0.6% oleic acid in *kalakand* samples.

Microbial analysis

It is evident (Table 2) that there was significant ($p \leq 0.05$) difference between market samples even in same market. The difference in the TPC of *KBRL* samples might be mainly due to unhygienic conditions prevailing during manufacture and quality of raw material used during preparation. Spoilage of dairy products by molds is a frequent occurrence in India mainly due to the prevailing tropical climate and high humidity. Since the mold spores are transmitted through air, they are ubiquitous in nature. Similar observation also reported by Karthikeyan and Pandiyan (2013). The difference in the coliform count of *KBRL* samples could be

due to uncleaned hands of workers, poor quality of milk, unhygienic conditions of manufacturing unit, inferior quality of material used, water supplied for washing the utensils and post processing contamination. The results obtained in present study are in agreement with the results reported by Keerthi et al. (2018), Kumar and Sinha (1989) and Grewal and Tiwari (1990) for *peda*, Indigenous milk product and *rasmalai*, respectively.

Sensory characteristics

Flavour

It is evident (Table 3) that the flavour scores of various market samples of *KBRL* were found in the range from 7.05 ± 0.39 to 8.33 ± 0.25 . All the values obtained from the samples collected from different region showed significant ($p \leq 0.05$) difference among them. The wide range in values of flavour score of samples collected from each region clearly revealed shop to shop variation. The samples of Barh and Dhanarua were found significantly higher ($p \leq 0.05$) than the samples from Biharsharif and Patna. The highest flavor score were obtained for Barh sample which might be due to the higher fat content and special skill of preparation of this product. These finding are supported by Reddy and Rajorhia (1990), who reported that an increase in flavour score of plain *peda* with the increase in fat content.

Colour and Appearance

All the values of the samples collected from different cities showed significant ($p \leq 0.05$) difference among them (Table 3). The difference in the colour and appearance score might be due to wide variation in raw material, amount of sugar added (during

Table 1 Proximate composition* of market samples of *KBRL*

Component (%)	Cities			
	Barh	Biharsharif	Dhanarua	Patna
Moisture	20.41 ± 1.11^a	17.93 ± 0.01^{cd}	18.50 ± 1.41^b	17.97 ± 1.50^c
Fat	11.83 ± 0.38^a	9.30 ± 0.57^d	11.37 ± 0.37^b	10.35 ± 0.92^c
Protein	15.97 ± 0.37^a	10.8 ± 0.54^d	12.79 ± 0.87^b	11.23 ± 0.50^c
Ash	0.72 ± 0.04^a	0.70 ± 0.01^d	0.72 ± 0.03^a	0.71 ± 0.03^b
Total Carbohydrate	51.05 ± 1.37^d	61.26 ± 0.01^a	56.55 ± 2.27^c	59.73 ± 1.43^b
FFA	0.11 ± 0.01^d	0.21 ± 0.05^a	0.12 ± 0.01^c	0.16 ± 0.03^b

Values in a row with different superscripts are significantly different markets (cities) at $p \leq 0.05$, *mean values $\pm$ SE, n=3

Table 2 Microbial count* of market *KBRL* samples

Cities	Microbial count (cfu/g)		
	Total plate counts	Yeast and mould count	Coliform count
Barh	3.860 ± 2.51^d	3.777 ± 1.23^d	1.930 ± 0.72^d
Biharsharif	4.187 ± 3.67^a	4.070 ± 2.07^b	2.020 ± 0.51^{bc}
Dhanarua	4.163 ± 3.31^{ab}	4.127 ± 1.61^a	2.053 ± 0.47^b
Patna	4.107 ± 3.21^c	4.030 ± 1.18^{bc}	2.110 ± 0.32^a

Values in a column with different superscripts are significantly different markets (cities) at $p \leq 0.05$, *mean values $\pm$ SE, n=3

heat treatment reaction between sugar and amino acid produce maillard browning) and method (direct or indirect). Sharma et al. (2001), recorded that increase in fat percentage in *khoa* resulted in improvement in its colour.

Body and Texture

The results obtained from different cities showed significant ($p \leq 0.05$) difference (Table 3). It is also observed that there was a wide range in values of body and texture score of samples collected from each region. It might be due to wide variation in chemical composition particularly moisture, fat and sugar levels. Our findings is in agreed with the result of Londhe and Pal (2007) who reported that significant effect on the body and texture score of brown *peda* with increase in the level of fat in milk and sugar, but to a certain extent and Banjare et al. (2015), who also concluded that there was significant difference among all the samples of *peda*

Overall acceptability

The highest mean score as 8.33 ± 0.25 while the lowest mean score as 7.11 ± 0.22 were obtained for the samples from Barh and Biharsharif, respectively which were significantly ($p \leq 0.05$) different from Patna and Dhanarua (Table 3). Among samples from different shops from same cities, all the values obtained from different shops showed significant ($p \leq 0.05$) variation. Difference in the overall acceptability might be due to wide variation in colour and appearance, body and texture, flavour, and also variation in chemical composition of market these samples. Our results are in accordance with Chawla et al. (2014) who characterized *Doda burfi*.

Rheological characteristics

Hardness

It is evident (Table 4) that wide ranges of variation in hardness were observed in all samples of *KBRL*. The samples of Barh had least hardness with mean value of 4.64 ± 0.56 N with range between 3.44 to 5.35 N. It could be observed that hardness of *ramdana Lai* significantly ($p \leq 0.05$) differed between cities and shops. Similar findings were reported by Londhe et al. (2012) in *peda* samples. The increase in hardness of all brown *peda* samples during storage could be attributed to the difference in moisture content. Our observation is also in conformity with the findings of Banjare et al. (2015).

Springiness

The springiness was found significantly ($p \leq 0.05$) differed between samples of *KBRL* from different market areas and shops (Table 4). The samples of Barh, Dhanarua and Biharsharif had significantly ($p \leq 0.05$) lower springiness than samples of Patna. Similar findings were reported by Banjare et al. (2015) in case of *peda*. Further, our findings was in close agreement with Londhe et al. (2012) who observed that the springiness value of brown *peda* sample showed rapid increase from initial value of 0.16 to 0.23 mm.

Cohesiveness

KBRL samples from region Patna and Biharsharif had significantly ($p \leq 0.05$) lower cohesiveness than samples from Barh and Dhanarua region. After first bite of TPA, *KBRL* lost its original shape and texture and became little bit floury, which shows

Table 3 Sensory score* of market samples of *KBRL*

Cities	Sensory Characteristics			
	Flavour	Body & Texture	Colour & Appearance	Overall Acceptability
Barh	8.33 ± 0.25^a	7.94 ± 0.03^a	8.27 ± 0.35^a	8.33 ± 0.25^a
Biharsharif	7.05 ± 0.39^{cd}	7.05 ± 0.16^d	7.11 ± 0.48^{cd}	7.11 ± 0.22^d
Dhanarua	8.05 ± 0.30^b	7.77 ± 0.26^b	7.94 ± 0.16^b	8.00 ± 0.25^b
Patna	7.33 ± 0.35^c	7.27 ± 0.26^c	7.27 ± 0.36^c	7.33 ± 0.25^c

Values in a column with different superscripts are significantly different markets (cities) at $p \leq 0.05$, *mean values $\pm$ SE, $n=3$

Table 4 Textural attributes* of market samples of *KBRL*

Textural property	Cities			
	Barh	Biharsharif	Dhanarua	Patna
Hardness (N)	4.64 ± 0.56^d	14.63 ± 3.49^a	9.17 ± 1.25^c	10.40 ± 1.84^b
Cohesiveness (N)	0.132 ± 0.02^b	0.077 ± 0.08^c	0.140 ± 0.02^a	0.071 ± 0.04^d
Springiness (mm)	0.203 ± 0.02^b	0.197 ± 0.03^d	0.200 ± 0.01^c	0.225 ± 0.05^a
Gumminess (N)	0.610 ± 0.09^d	1.127 ± 0.31^a	1.274 ± 0.18^{ab}	0.720 ± 0.15^c
Chewiness (N mm)	0.123 ± 0.02^{cd}	0.215 ± 0.04^b	0.256 ± 0.04^a	0.161 ± 0.02^c

Values in a row with different superscripts are significantly different markets (cities) at $p \leq 0.05$, *mean values $\pm$ SE, $n=3$

Table 5 Colour attributes* of market samples of *KBRL*

Cities	Colour attributes		
	<i>L</i> *	<i>a</i> *	<i>b</i> *
Barh	53.65±1.19 ^c	8.45±0.37 ^b	26.29±0.06 ^c
Biharsharif	54.50±0.14 ^b	7.65±0.92 ^c	27.75±1.58 ^a
Dhanarua	56.34±0.44 ^a	5.78±0.15 ^d	22.93±0.26 ^d
Patna	52.72±0.21 ^d	9.03±0.08 ^a	27.06±0.86 ^b

Values in a column with different superscripts are significantly different markets (cities) at $p \leq 0.05$, *mean values±SE, $n=3$

brittleness of product and lower cohesiveness were found in the samples from Patna and Biharsharif samples. Similar findings were recorded by Londhe et al. (2012) in *peda* sample and Palit and Pal (2005) in *burfi* sample during storage. Further similar findings were observed by Banjare et al. (2015) in case of *peda*.

Chewiness

The chewiness of *KBRL* differed significantly among market areas and shops ($p \leq 0.05$). Similar findings were observed by Banjare et al. (2015) in case of *peda*.

Gumminess

KBRL samples of Barh and Patna had significantly ($p \leq 0.05$) lower gumminess values than the samples of Dhanarua and Biharsharif. Similar findings were reported by Banjare et al. (2015) in case of *peda*. Further, similar findings were also observed by Londhe et al. (2012) who reported that the initial gumminess of laboratory made brown *peda* was 1343.8g but during storage in 20 days at 30°C *peda* packed in cardboard box lined with butter paper was increased to 5335.71g

Colour attributes

*L** value

The quantitative measurement of *L** value can be considered to indicate the severity of heat treatment (Rufian–henares et al. 2005). Statistical analysis revealed that there was significant ($p \leq 0.05$) differences in *L** value among all four groups studied. The lower *L** value of *ramdana Lai* could be due to intense heat treatment given, heat interactions between sugar (both milk sugar and added cane sugar) and milk constituents, leading to well-known Maillard reaction. Similar finding was reported by Singh et al. (2018) for *pinni* where *L** value of market samples was varied from 30.10 to 59.63.

*a** value

It is evident (Table 5) that highest *a** (9.03±0.08) value was observed with the Patna's samples and lowest (5.78±0.15) value was for samples of Dhanarua. Statistical analysis revealed that there was significant ($p \leq 0.05$) differences in *a** value of *KBRL* among all four groups studied. It was well established that the colour of milk and milk products undergoes maillard browning

which is characterized by two primary hues viz., brown and yellow. Kumar et al. (2006) estimated the colour value of *gulabjamun* and found that brownness of *gulabjamun* crust was comprised of brownness and yellowness. Similar finding was reported by Singh et al. (2018) for *pinni* in which reported that *a** value varied from 6.03 and 18.56.

*b** value

It is observed (Table 5) that the market samples from Biharsharif (27.75±1.58) was yellower than Barh, Patna, Dhanarua as their *b** value were 26.29±0.06, 27.06±0.86, and 22.93±0.26, respectively. Statistical analysis revealed that there was significant difference ($p < 0.05$) in *b** value of *ramdana lai* among four group. Our finding was contradictory with the report by Kumar et al. (2006) who reported *b** value as 57.34 for *Gulabjamun* samples. This variation is mainly due to quite difference in the method of manufacture of *KBRL* and *Gulabjamun*. However, Singh et al. (2018) reported variation of *b** value from 19.75 to 39.92 in market samples of *pinni*

Conclusions

KBRL is an indigenous milk product of Bihar origin with considerable nutritional importance. The market samples procured from different shops from various cities of Bihar showed wide variation in their proximate composition, sensory attributes, textural profile, colour attributes and microbial qualities among the various cities and even within the different samples collected from same shop. The reason for variability could be attributed to the use of variable amount of *khoa*, type of *khoa* and addition of *khoa* and *ramdana* at intermittent stages of preparation. Further, the microbial quality of market samples also indicated a wide variation among the samples of various places of Bihar even also in same sweet maker shop. This might be because of poor attention followed for maintaining hygiene and sanitary condition of manufacturing, post contamination through packaging materials or other handling practices.

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