

RESEARCH ARTICLE

Evaluation of selected characteristics of market *Dhap Khoa*

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Abstract: *Dhap khoa* is heat desiccated traditional Indian milk product. It has higher moisture content than other two *khoa* types (*pindi* and *danedar*). In this paper, some important characteristics (chemical, colour and textural) of six market *dhap khoa* samples were evaluated. Moisture of *dhap khoa* was statistically highly significant ($p < 0.001$) whereas its fat content was found statically non-significant ($p > 0.05$). Its moisture content ranges from $40.77 \pm 0.33\%$ to $43.77 \pm 0.15\%$. Colour characteristics (L^* , a^* , b^*) of market *dhap khoa* samples were found statistically highly significant from each other i.e., between market sample group ($p < 0.001$). L^* , a^* and b^* values varied from 81.39 ± 0.03 to 84.84 ± 0.55 , -5.43 ± 0.03 to -4.29 ± 0.10 and 15.24 ± 0.12 to 15.96 ± 0.02 , respectively. The textural characteristics (hardness, adhesiveness, cohesiveness, springiness, gumminess and resilience) of market *dhap khoa* were found statistically highly significant ($p < 0.001$). Their chewiness was found statistically significant ($p < 0.01$). The hardness, adhesiveness, cohesiveness, springiness, gumminess, chewiness and resilience, ranged from 4.58 ± 0.87 N to 11.37 ± 0.15 N, -198.90 ± 4.31 to -139.56 ± 3.69 g.s, 0.087 ± 0.001 to 0.140 ± 0.002 , 0.05 ± 0.002 to 0.12 ± 0.003 m, 1.04 ± 0.12 to 1.58 ± 0.10 N, 0.04 ± 0.0095 to 0.13 ± 0.0034 Nm and 0.019 ± 0.0093 to 0.028 ± 0.0010 , respectively. The characteristics showed the variation in *dhap khoa* quality in the market and it may be useful for improvisation in process equipment and process parameter selection for *dhap khoa* preparation.

Keywords : *Dhap khoa*, market sample, characteristics, texture, colour, moisture

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Introduction

India is the largest milk-producing nation in the world contributing over 23% of the world's total milk production. India's total milk output is about 221.06 million tonnes (MT) in 2021-22 (DAH & D, 2022-23). About half of the milk produced is consumed in liquid form, and the other half is used to make various milk products, including ice cream, milk powders, ghee, curd, butter, *khoa* and *khoa*-based products, *paneer*, cheese, and *chhana* and *chhana*-based products. The dairy products that are native to India and certain Asian nations, including Nepal, Bangladesh, and Pakistan, are referred to as traditional Indian dairy products i.e. TIDPs (Aneja et al. 2002). In different parts of the country, various sweets are made and categorized on the basis of production process, taste and names. Numerous efforts have been made during their production process, including heat desiccation, heat coagulation, fermentation, and the use of diverse ingredients and therefore there are several TIDPs, their variants, and brands available in the market.

Typically, *khoa* and *channa* are the two important base materials to make variety of sweets. *Khoa* is used in preparation of several sweets such as *peda*, *burfi*, *kalakand*, and milk cakes whereas the sweets made with *channa* are *rasogolla*, *rasomalai*, and *sandesh*, *kala-jamun*, *pantooa* etc. There are some other sweets which are made with the combination of both *channa* and *khoa*. It is estimated that *khoa* is produced annually in India which utilize 7% of total milk production (Prasad et al. 2015).

Khoa is a heat desiccated milk product produced by continuous heating of milk until desired total solids (55-65%) obtained with a semi solid consistency. A good quality *khoa* has uniform white colour with tinge of brown colour with sweet taste so buffalo milk is preferred over cow milk for production of *khoa* to get high quality superior and acceptable *khoa* (Aneja et al. 2002). It is classified into three major types viz. *pindi*, *danedar* and *dhap* (IS 4883, 1980). This classification is based on their chemical composition and end uses. *Pindi* is dry kind of *khoa* which is used to manufacture of *burfi* and *peda* kind products. *Danedar khoa* have granular texture and it is used for production of milk cake and granular heat desiccated products. *Dhap khoa* is a kind of heat desiccated milk product.

Dhap khoa have solid content (55% minimum) with fat content (about 37% minimum) on the basis of dry matter content. It is characterized by a loose, sticky body and a smooth texture. It has higher moisture content than *pindi* and *danedar* types of *khoa*. *Dhap khoa* is preferred for making *gulabjamun* because after frying and soaking in sugar syrup, it creates homogenous balls with the appropriate rheological qualities (IS 4883, 1980). *Dhap khoa* is also preferred for preparation of *kalajamun*, *pantooa*, *carrot halwa* etc. (Aneja et al. 2002). It is also utilized for making different kind of products like *jalebi* and *bottle gourd halwa* etc.

The production of *dhap khoa* is mostly in hands of non-organized milk handling system such as local vendors etc. There are very few market suppliers for *dhap khoa*. The shelf-life of *dhap khoa* is very less due to higher moisture content and few products may be made up of this kind of *khoa*.

In published literature, the characteristics of some market TIDPs are available such as *brown peda* (Londhe and Pal, 2008), *khoajalebi* (Pagote and Rao, 2012), *kheer mohan* (Meena et al. 2014), and *khoa-peda* (Singh et al. 2018) and *gulabjamun* (Sukre et al. 2021). However, systematic study on determination of various characteristics of *dhap khoa*, available in market, is rarely found and mentioned in published literature. These characteristics may be useful to better comprehend the consumer perspectives about *dhap khoa* and improvisation in process equipment for *dhap khoa* manufacturing. Therefore, the aim of present study was to characterize the selected chemical, colour, and textural attributes of the six market *dhap khoa* samples, collected from different places.

Materials and Methods

Collection of *Dhap khoa* Samples

The different places of India especially North India is famous for production of *khoa* and *khoa* based different sweets. For this study, the market *dhap khoa* samples were collected from six different places of India like Jaipur (Rajasthan), Mathura (Uttar Pradesh), Ludhiana (Punjab), Ambala (Haryana), Karnal (Haryana), and Delhi. Collected samples were randomly designated as M1, M2, M3, M4, M5 and M6 for study. *Dhap khoa* samples were procured carefully and hygienically for determination of its characteristics.

Fat

Fat content of the samples was estimated using acid digestion method (Werner Schmidt Method) (FSSAI, 2015). Fat (%) in the samples was calculated by following equation:

$$\text{Fat, \% w/w} = \left(\frac{W_1 - W_2}{W_3} \right) \times 100$$

Where W_1 = weight of contents in the flask or metal dish or glass bowl before removal of fat (g); W_2 = weight of contents in the flask or metal dish or glass bowl after removal of fat (g) and W_3 = weight of material taken for the test (g)

Moisture

Moisture content of the samples was estimated using gravimetric method (FSSAI, 2015).

Moisture (%) in the samples was calculated by following equation:

$$\text{Moisture, \% by mass} = \left(\frac{M_1 - M_2}{M_1 - M} \right) \times 100$$

Where M = mass of the empty dish (g); M_1 = initial mass of the dish, along with the material taken for analysis (g) and M_2 = final mass in g of the dish, along with the material after drying (g)

Colour Characteristics

The International Commission on Illumination created the CIE $L^* a^* b^*$ system in 1976. This technique depicts colour in accordance with how the human eye perceives it. It is a device-independent method that is widely regarded as a standard in the dairy and food industries. The system is made up of a three-dimensional colour space with the letters L^* , a^* , and b^* , which stand for the degrees of lightness, redness-greenness, and yellowness-blueness, respectively where L^* ((lightness: 0 (black) to 100 (white)), a^* ((redness: +60 (red) to -60 (green)) and b^* ((yellowness: +60 (yellow) to -60 (blue)). The colour properties of market *dhap khoa* (L^* , a^* , and b^*) were assessed using the reflectance spectroscopic technique utilizing the reflectance meter, Colour flex (Hunter lab, Reston, Virginia, USA). Prior to colour measurement, the instrument was calibrated with a standard black glass and white glass tiles as specified by the manufactures (Barnwal et al. 2014; Srinivasa et al. 2017). To ensure there are no air bubbles in the *dhap khoa* sample, it is blended before being transferred to a sample beaker to measure the colour. The readings for L^* , a^* , and b^* were noted.

Textural Characteristic

Textural characteristics of market *dhap khoa* were determined using a texture analyzer (TA-XT2i, Stable Micro Systems Ltd., Surrey, England) equipped with a 25 kg load cell and calibrated with 5 kg standard dead weight (Sukre, 2021). Before testing, sample was cut into cylindrical form (1 cm dia. × 1 cm height) by cutting tool provided with equipment. Compression probe (P-75)

was used to compress the *dhap khoa* samples up to 80 per cent of its original height (80 per cent of its strain), using a double compression test. The constant probe speeds (5 mm/s pre-test speed, 2.5 mm/s speed during test and 5 mm/s post-test speed) were used throughout the study and temperature of the samples were maintained at 25±1°C. Force distance compression curve was obtained and analyzed to estimate the hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness, resilience of the samples.

Statistical Analysis

The Analysis of Variance (ANOVA) for all various characteristics of market *dhap khoa* samples were analyzed by using IBM SPSS Statistics 27.0.1 software and 2D-graphs of various characteristics were prepared by using Microsoft Excel 2016 MSO (Version 2303).

Results and Discussion

Chemical characteristics

Table 1 represents the ANOVA for moisture, fat and colour characteristics of market *dhap khoa*.

The moisture content of market *dhap khoa* samples were statistically significantly different (p<0.001). Moisture content of market *dhap khoa* (Fig.1) ranged from 40.77 ± 0.33 (M3) to 43.77 ± 0.15 (M5). Mehta (2015) reported that *khoa* had moisture between 18 and 42%. *Dhap khoa* has solid content (55% minimum) in accordance with Bureau of Indian Standards. So, the moisture content should be lower than 45%.

The fat content of the six market samples (M1, M2, M3, M4, M5, and M6) were statistically non-significant (Table 1). The variation between the various *dhap khoa* samples is minimal (Fig.1) and

varies from 21.93 ± 0.52 (M5) to 23.10 ± 0.13 (M3). Fat content of *dhap khoa* was reported between 20 to 23% (Prasad et al. 2015).

Colour Characteristics

The *L**, *a**, and *b** colour features of the *Dhap khoa* samples were found to be statistically highly significant (p≤0.001) with respect to sample type (Table 1). The values of *L** (Fig. 2) ranged from 81.39 ± 0.03 (M5) to 84.84 ± 0.55 (M6). The *a**-value ranged from (-5.43) ± 0.03 (M1) to (-4.29) ± 0.10 (M4) whereas *b**-value ranged from 15.24 ± 0.12 (M6) to 15.96 ± 0.02 (M3). Kumar et al. (2006) observed that *gulabjamun* balls' lightness value (*L**) ranged from 23.48 to 79.86 when deep-fried. Arora et al. (2022) studied heat desiccated *chhana-murki* and found that it's *L**, *a** and *b** values ranged from 62.39 and 79.27, -2.06 and -1.74, and 14.66, to 14.82, respectively. So, *L** values of *dhap khoa* was on higher side of lightness than desiccated *channa-murki*. The *a** value of *dhap khoa* was more towards greenish side than the *channa murki*. The *b** of *dhap khoa* had more yellowness than desiccated *channa murki*.

Textural characteristics

ANOVA for textural characteristics of market *dhap khoa* are depicted in Table 2. It showed that hardness, adhesiveness, cohesiveness, gumminess and resilience were statistically highly significantly different (p<0.001) whereas chewiness and springiness were statistically significantly different (p<0.01). Figure 3 shows the variation of springiness, cohesiveness, chewiness and resilience of *dhap khoa* among different market samples. The values for springiness, cohesiveness, chewiness and resilience ranged between, 0.05 ± 0.002 (M3) to 0.12 ± 0.003 m (M4), 0.087 ± 0.001 (M5) to 0.140 ± 0.002 (M4), 0.04 ± 0.0095 N (M2) to 0.13 ± 0.0034 Nm (M1), and 0.019 ± 0.0093 (M3) to 0.028 ±

Table 1 ANOVA for moisture, fat and colour characteristics of market *dhap khoa*

Market <i>dhap khoa</i>	Moisture, %	Fat, %	<i>L*</i>	<i>a*</i>	<i>b*</i>
DF	5	5	5	5	5
SS	18.49	2.814	26.024	4.039	1.473
MS	3.698	0.563	5.205	0.808	0.295
F-Value	12.703	1.46	2081.917	276.991	146.921
Prob	<0.001***	0.273 ^{NS}	<0.001***	<0.001***	<0.001***

^{NS} Non-significant; *** p≤0.001, n=3

Table 2 ANOVA for textural characteristics of market *dhap khoa*

Market <i>dhap khoa</i>	Hardness (N)	Adhesiveness (g.s)	Cohesiveness	Gumminess (N)	Chewiness (N)	Resilience	Springiness
DF	5	5	5	5	5	5	5
SS	324.145	8576.802	0.011	0.007	0.571	0.021	0.011
MS	64.829	1715.36	0.002	0.001	0.114	0.004	0.002
F-Value	156.958	129.822	144.426	278.375	6.253	97.68	144.426
Prob	<0.001***	<0.001***	<0.001***	<0.001***	0.004**	<0.001***	<0.01**

p≤0.01; *p≤0.001, n=3

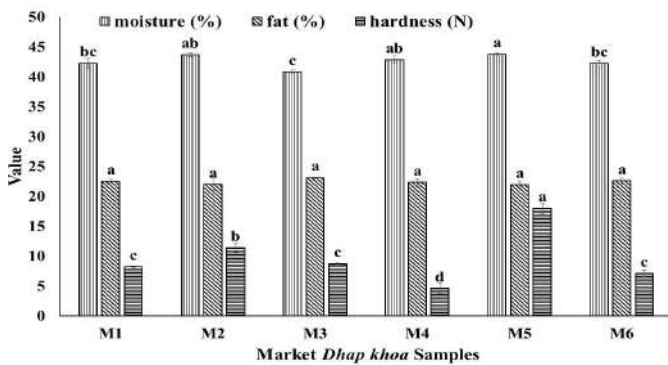


Fig. 1 Moisture, fat and hardness of market dhap khoa

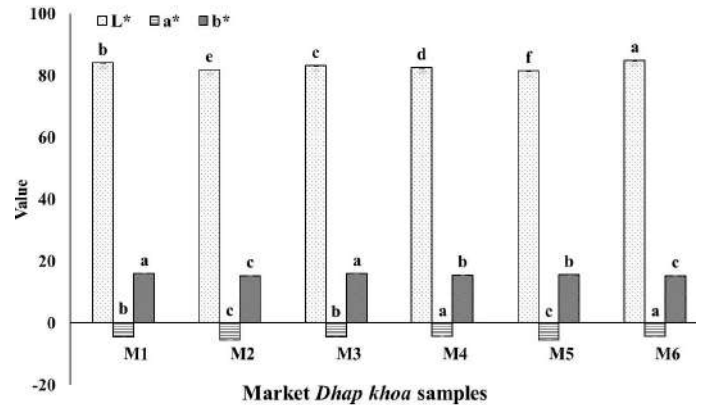


Fig. 2 Colour characteristics (L*, a*, and b*) of market dhap khoa

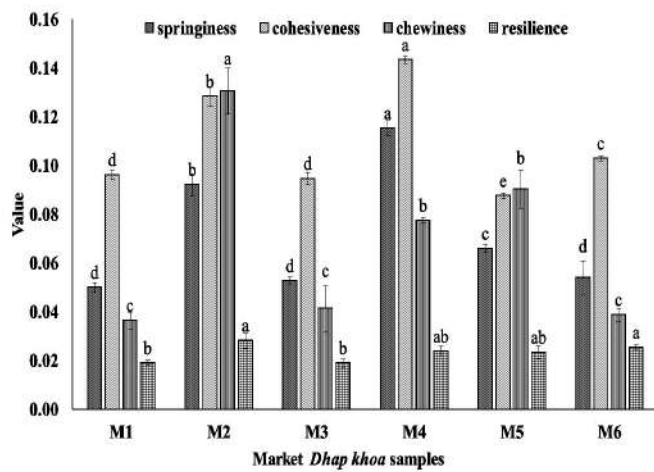


Fig. 3 Springiness, cohesiveness, chewiness and resilience of market dhap khoa

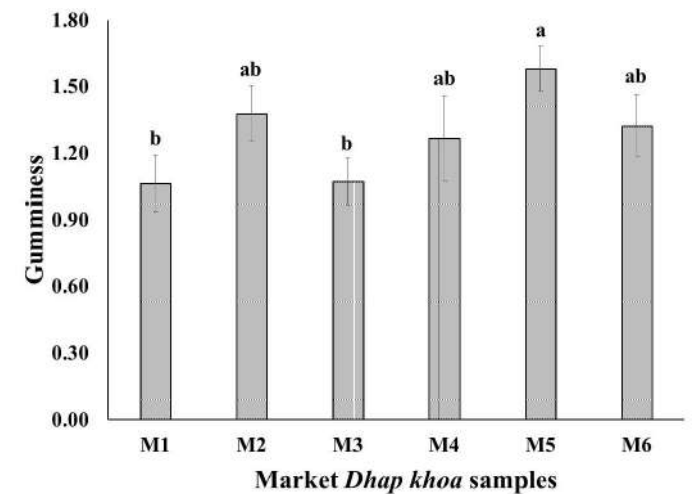


Fig. 4 Gumminess of market dhap khoa

0.0010 (M1), respectively. Springiness is unaffected by the characteristics of the composition (Gupta et al. 1990). As the amount of total solids increased, khoa's cohesiveness tended to decrease. About 50% of the cohesiveness is contributed by total solids (Gupta et al. 1990). Additionally, cohesiveness and moisture content in khoa were found to be negatively correlated (Adhikari et al. 1994). Gupta et al. (1990) noted that the increase in total solids caused the instron chewiness in khoa to increase.

Adhikari et al. (1994) observed a negative correlation between the moisture content and internal chewiness of khoa. Hardness (Fig. 1) ranged from 4.58 ± 0.87 N (M4) to 11.37 ± 0.15 N (M1). Gupta et al. (1990) reported that total solids (TS) have an impact on khoa's hardness and with increase in its total solids, the hardness increases. Total solids alone accounts for around 78% of the khoa's hardness. A negative association between moisture and the instron hardness of khoa was also reported by Adhikari et al. (1994). When cow milk khoa was converted into gulabjamun, there was about 50 per cent decrease in its hardness (Adhikari, 1993).

Gumminess (Fig. 4) ranged between 1.04 ± 0.12 N (M2) to 1.58 ± 0.10 N (M5). Compositional characteristics of khoa have a significant impact on gumminess and chewiness as well. Gupta et al. (1990) found with an increase in total solids, there was an increase in the instron gumminess in khoa. Moisture and instron gumminess have a negative connection (Adhikari et al. 1994).

The values for adhesiveness (Fig. 5) ranged between -198.90 ± 4.31 (M5) to -139.56 ± 3.69 (M6) g.s. Londhe et al. (2008) reported that the decrease in free moisture during storage may be the cause of the decreased adhesion in brown peda. Adhesiveness of brown peda market samples were reported in the range of -460 to -1522.65 g.s. Higher adhesiveness values might be linked to higher moisture content in the peda (Londhe et al. 2008).

Conclusions

Six market dhap khoa samples were studied to determine their some important characteristics (chemical, colour and textural). The moisture content was statistically highly significantly different between market samples. Moisture content ranged from

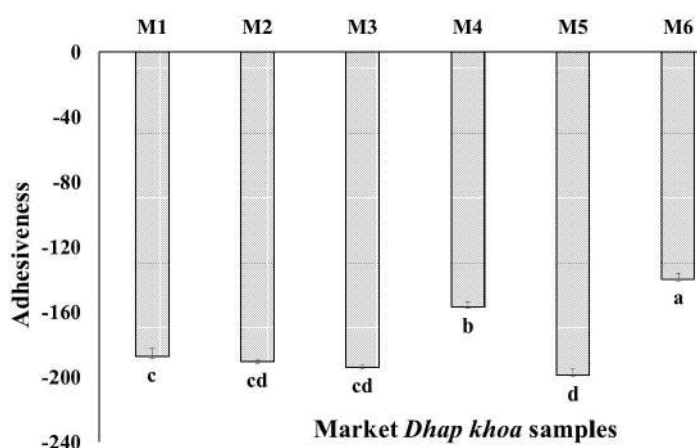


Fig. 5 Adhesiveness of market *dhap khoa*

21.93 ± 0.52 % (M5) to 23.10 ± 0.13 % (M3). Their fat content was statically non-significantly different from each other. Colour characteristics (L^* , a^* , b^*) was statistically highly significantly different from each other. The L^* value ranged between 81.39 ± 0.03 to 84.84 ± 0.55. Texture characteristics such as hardness, cohesiveness, gumminess, chewiness, springiness and resilience were statistically highly significant. Hardness and cohesiveness ranged from 4.58 ± 0.87 N to 11.37 ± 0.15 N and 0.087 ± 0.001 N to 0.140 ± 0.002 N, respectively. These characteristics may be useful for improvisation in process equipment design, process parameter selection and to get consumer prospective about *dhap khoa*.

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