Physico - Chemical, Sensory, Textural, and Microbiological Quality of Paneer (Indian Cottage Cheese) Marketed in Bengaluru City

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Abstract

Paneer has great value in diet because it is a rich source of high quality proteins, fat, and minerals. Paneer has a short life span of 5-7 days at refrigeration storage, but freshness of the product is lost after 3 days. So, the present study was carried out to know the quality of different brands of paneer sold in Bengaluru city. A total of 80 packets of eight different brands were analyzed for their quality. Wide variation in chemical composition like moisture (49% to 64 %), fat (13.5% to 24%), protein (18% to 23 %), and lactose (1.75% to 4.23 %) existed in the samples. Total bacterial count was observed between 25.40 and 41.10 × 10^4 /gm, yeast and mold count was observed to be 13.75 and 20.90 × 10^1/gm, coli-form count was 3.95 to 7.65 × 10^1 /gm, and *Staphylococcus aureus* count was 1.10 to 2.20 ×10^1/gm. Instrumental hardness value varied between 27.56 and 62.22 N. About 75% of the brands did not conform to Food Safety and Standards Authority of India Act (FSSAI) labeling requirements. It is said that India is the largest producer of milk in the world, but improvisations like more awareness about FSSAI Act with respect to packaging, labeling, chemical, microbial requirements, etc. have to be brought about. Further, more hygienic environment during the production of paneer by establishing pre-requisite programs like good manufacturing techniques, good hygienic practices, and Hazard Analysis Critical Control Programme have to be created by manufacturers to bring out utmost quality products in the Indian market.

Keywords : **Paneer, sensory characteristics, chemical quality, marketing, FSSAI, microbiological quality**

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Paneer is an important indigenous dairy product prepared by the heat and acid coagulation of milk. According to Food Safety & Standard Authority of India (2006), paneer means the product obtained from cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid, or citric acid. It shall not contain more than 70% moisture and milk fat content shall not be less than 50.0 % of the dry matter.

Paneer has great value in diet because it is a rich source of high quality proteins, fat, minerals, and vitamins. It is used widely as a base raw material for the preparation of various culinary dishes and snacks. Paneer is made up of protein and fat, insoluble salts and colloidal materials, as well as part of the moisture of the original milk, which contains lactose, whey proteins, soluble salts, vitamins, and other milk components (Kanawjia, Roy, & Singh,

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1990). It has been found that about 4-5% of the total milk produced in India is converted into paneer. Paneer has a short life span of about 5-7 days at refrigeration storage without much deterioration in the quality, but freshness of the product is lost after 3 days (Dhankhar, 2014). Hence, cold chain is a must for paneer marketing and at the retailer's end, it has to be foolproof. The problem of quality maintenance of food products sold in the market has been persisting for a long time. Unscrupulous entrepreneurs try to manipulate the paneer production and quality with a sole intention of profit generation, disregarding consumer concerns.

Gullible consumers are exploited because of their ignorance or their blind faith in the law enforcing agencies. However, for the controlling agencies like Ministry of Health and Family Welfare under whose administration Food Safety and Standards Authority of India (FSSAI) comes, inspecting and monitoring the huge quantity of products sold in the market is by any means a daunting task. Ensuring quality foods in the market should actually be a consumer movement and needs to be monitored by active and pragmatic consumer courts. Though food inspectors strive to continuously monitor the food quality in the market, it is indeed an unenviable task keeping in view the number of brands, number of retailers, and the vulnerability of our laws. Hence, it is the duty of all those concerned with food production, marketing, and consumers to keep a tab on the quality of food products sold in the market. Academic and research institutions too have to share this responsibility. This is more so in case of perishable food items like milk, paneer, etc. Survey works have been conducted from time to time on the quality of food products in the market, for example, on paneer (Desale, Dhole, Deshmukh, & Nimase, 2009 ; Godbole, 2013 ; Ingavale & Thakar, 2012 ; Vaishnavi, Singh, Grover, & Singh, 2001), khoa (Karthikeyan & Pandiyan, 2013), khoa sweets (Tarnbekar & Bhutda, 2006) etc.

Solanki and Sheth (2015) undertook a study to analyze the influence of nutritional information provided on the packages of ready-to-eat food products on the product evaluation and buying behavior of consumers in Rajkot. Sadia, Jabbar, Deng, Hussain, Riffat, Naveed, and Arif (2012) conducted a survey on occurrence of aflatoxins in sweets in Punjab. Similar work was reported by Iqbal and Asi (2013). Such works help in knowing the present status of the quality of food products that consumers get to buy and eat in different regions. The present study was carried out to know the quality of paneer being sold in Bengaluru city.

In Bengaluru, which is fast acquiring a cosmopolitan nature and in which social demography is changing like it is in other metro cities in India, the paneer market is growing. However, problem of substandard paneer being sold is always felt because paneer production is not considered as a profit generating venture.

Materials and Methods

The present study was carried out to know the quality of different brands of paneer being sold in Bengaluru city for the following quality parameters : sensory quality of all paneer samples (color, body & texture, and flavor), chemical quality (moisture , fat , protein , lactose, mineral , acidity %, and pH), microbial analysis (total bacterial count, yeast & mold count, coli-form count, *Staphylococcus aureus* count, and *E. coli* as well as Salmonella detection), and textural quality (instrumentally measured hardness, adhesiveness, cohesiveness, springiness, chewiness and resilience). The study was carried out during August 2015 - June 2016.

(1) Collection of Paneer Samples from Bengaluru Market : Sampling of different brands of paneer was done randomly in the market of Bengaluru city. Since Bengaluru is a metropolitan city with a good distribution network, the sampling area was divided into North and South Bengaluru. From North Bengaluru, four outlets and from south Bengaluru, four shops were chosen based upon the availability of brands. Paneer samples were collected from different outlets in Bengaluru city (South and North Bengaluru). The refrigerated packages were put in ice box and brought to the laboratory for analysis. In all, eight brands of paneer were purchased totaling to 80 samples. As soon as the samples were brought to the laboratory, the following details on the packages were recorded : weight, cost, nutritional labeling, FSSAI license logo, manufacturer's address, etc. The packets were cut open and the

appearance and colour were noted. The paneer blocks were cut into 1 cm cubes and tempered to room temperature and evaluated for sensory acceptance. The cut paneer cubes were also used for textural and chemical analysis. For microbial analysis, the packets were cut open under sterile laminar flow conditions and sample drawn for microbiological dilution preparations. These dilutions were used for plating purposes. No differentiation was made between fresh or stored samples, however, all the packets were collected before use by date.

(2) Sampling Plan : The sampling plan is depicted below :

Brand	Retail outlet -1	Retail outlet -2	Retail outlet -3	Retail outlet -4	Retail outlet -5	Retail outlet -6	Total
A	10	0	0	0	0	0	10
B	0	3	1	3	0	3	10
C	0	2	3	1	3	1	10
D	0	1	3	3	2	1	10
E	0	4	1	1	2	2	10
F	0	3	4	1	2	0	10
G	0	3	3	1	1	2	10
H	0	0	2	2	3	3	10
Total	**10**	**16**	**17**	**12**	**13**	**12**	**80**

(3) Sensory Evaluation : Each block of paneer was cut into about 1 cm small cubes. The paneer samples were tempered to room temperature before judging. Samples were served to judges in Petri dishes which were coded to conceal the identity of source. The orders of presentation of samples were randomized across subjects. Subjects judged a maximum of four samples in one session. The judges consisted of Institute staff and interested and motivated students - all of whom were well aware of desirable qualities of paneer. The quality of paneer samples were evaluated on a 9 - point hedonic scale (Lawless & Heymann, 2010) for colour and appearance, flavour, and body & texture.

(4) Chemical Analysis : Moisture was determined by gravimetric method (BIS, 1983), fat by Gerber method (BIS, 1977), and protein was determined by Kjeldahl method (AOAC, 2005). Lactose was derived by difference of sum total of the major constituents like moisture, protein, fat, and ash from 100 as described by AOAC (1990). The Ash content of paneer was estimated by the method of BIS (1981). Acidity was determined by the method described by BIS (1983).

(5) Microbial Analysis : The samples for microbiological analyses were prepared under aseptic conditions. A sanitized set of pestle and mortar was taken for macerating the sample. Approximately 11 gm of the paneer sample was weighed aseptically in a sterile 100 ml glass beaker and it was transferred aseptically to the sanitized mortar with the help of a sterile stainless steel spatula. The sample was then macerated thoroughly by making a paste using small quantity of previously warmed (45°C) 99 ml of 2% sterile diluent and the contents were transferred to the same conical flask to obtain first dilution (1:10).

Further dilutions were prepared using 9 ml quantity of citrate buffer from the first dilution as per the requirements. The dilutions were used immediately for plating purpose. Total viable count, yeast and mold count, and coli-form counts of paneer were determined according to BIS (1981) with modification except that the diluent used was 2% sodium citrate. *Staphylococcus aureus* count, *E. coli* count of paneer, and Salmonella detection was carried out as per the method described in AOAC (2012) with modification except that the diluent used was 2% sodium citrate.

(6) Texture Profile Analysis (Bourne, 1978) : Texture analyzer (Stable Microsystems, UK) was used for measuring the hardness, cohesiveness, adhesiveness, springiness, gumminess, chewiness, and resilience of paneer at $30^{O}C$ with size of 2 cm^3 cubes. The test conditions maintained were: load cell capacity 5 kg, platen probe (P/75) with 7.5 mm diameter, pre-test speed 1 mm/sec, test speed 5 mm/sec, post - test speed 5 mm/sec, target mode - distance, distance - 5mm, time - 30 sec, trigger type - auto force - 2gm, break made - off, and tare mode -auto.

Results and Discussion

The various physio - chemical and microbial parameters of paneer samples were tabulated and analyzed.

(1) Sensory Characteristics of Paneer Samples : It was observed that sensory score of samples varied from brand to brand (Table 1). The visual colour of paneer samples varied from whitish to slightly yellowish white. Fresh paneer usually has a spongy compact body and smooth texture. Some paneer brands seemed to be very hard while some paneer brands seemed very soft, but some brands had very acceptable body & texture. However, there were wide variations in body and texture from brand to brand. Fresh paneer had pleasant odor and characteristic mild acidic flavor. Paneer brands showed normal, sweet, acidic flavor, but some samples showed distinctly acidic flavor.

Table 1. Sensory Acceptance Scores* (± SD) of Paneer Samples Collected from Bengaluru City

Brand	Appearance	Flavor	Body &Texture	Overall Acceptability
A	7.4 ± 0.3^{BC}	7.5 ± 0.1^{B}	7.5 ± 0.1^{B}	7.5 ± 0.1^{B}
B	7.7 ± 0.1^{BCD}	7.4 ± 0.1^{B}	7.5 ± 0.1^{B}	7.4 ± 0.1^{B}
C	7.8 ± 0.1^{D}	7.3 ± 0.3^{B}	7.4 ± 0.1^{B}	7.5 ± 0.2^{B}
D	7.6 ± 0.4^{CD}	7.6 ± 0.1^{B}	7.6 ± 0.2^{B}	7.6 ± 0.2^{B}
E	7.4 ± 0.1^{B}	7.7 ± 0.1^{B}	7.6 ± 0.1^{B}	7.6 ± 0.1^{B}
F	7.4 ± 0.3^{D}	7.6 ± 0.2^{B}	7.6 ± 0.2^{B}	7.5 ± 0.1^{B}
G	7.7 ± 0.0^{BCD}	7.6 ± 0.1^{B}	7.6 ± 0.0^{B}	7.6 ± 0.0^{B}
H	6.9 ± 0.1^{A}	5.7 ± 0.1^{A}	6.2 ± 0.2^{A}	6.3 ± 0.1^{A}

Note: Values with different superscripts in a row are significantly different from each other ($p < 0.05$) ; * Mean of 10 samples

(2) Chemical Quality of Paneer Samples : It was observed that brand "H" showed the highest moisture content as compared to other brands whereas brand "G" showed lowest moisture content among all samples (Table 2). Rest of the brands showed moisture content within the limits of FSSAI standards (Table 3). The average moisture of paneer was 53- 55% as reported by Kanawjia and Singh (1996). With regard to fat content , brand "C" showed highest fat content as compared to other brands ; whereas, brand "H" showed lowest fat content as compared to all other brands. From analyzed observations, brand "A", "G," and "H" did not conform to FSSAI standards (Table 3). For protein content, brand "A" showed highest protein content as compared to other brands ; whereas, brand "B" showed lowest protein content as compared to other brands. Rest of the brands showed near about same protein content with minimum variation (Table 2). Brand "A" showed highest lactose content among all brands ; whereas, brand "B" showed lowest lactose content among all brands. Rest of the brands showed near about same lactose content with minimum variation (Table 2).

The lactose content depends upon the time for which coagulum is kept in chilled water before packaging. During soaking in chilled water, some of the lactose gets drained into the soaking water. For acidity, brand "H" showed unacceptably higher acidity among all brands ; whereas brand "B" showed lowest acidity, which was

Table 2. Chemical Composition* (± SD) of Paneer Samples Collected from Bengaluru City

Brand	Fat%	Moisture%	Protein %	Ash%	Lactose %	Acidity %	pH
A	23.05	52.29	23.81	1.62	1.43	0.48	6.05
	±1.11^{BC}	±1.00^{ABC}	±1.39^{E}	±0.16^{AB}	±1.12	±0.12^{A}	±0.13^{F}
B	22.64	56.53	17.14	1.74	2.02	0.47	5.50
	±1.28^{B}	±2.21^{D}	±1.27^{A}	±0.05^{B}	±0.56	±0.12^{A}	±0.25^{BC}
C	24.90	51.91	17.88	1.65	3.64	0.61	5.85
	±1.79^{C}	±1.79^{ABC}	±1.25^{AB}	±0.05^{AB}	±1.60	±0.18^{AB}	±0.08^{DE}
D	23.30	53.54	18.68	1.59	2.94	0.54	5.37
	±0.87^{BC}	±1.69^{BCD}	±1.0^{BC}	±0.5^{AB}	±2.25	±0.34^{AB}	±0.20^{AB}
E	23.45	54.84	17.96	1.65	2.09	0.69	5.76
	±1.89^{BC}	±2.42^{CD}	±0.44^{AB}	±0.05^{AB}	±0.71	±0.13^{BC}	±0.09^{D}
F	24.35	51.37	19.51	1.48	3.78	0.57	5.78
	±2.42^{BC}	±1.98^{AB}	±1.18^{C}	±0.11^{A}	±2.61	±0.14^{AB}	±0.13^{D}
G	23.55	49.92	22.17	1.62	3.33	0.55	5.65
	±0.93^{BC}	±3.17^{A}	±1.24^{D}	±0.13^{AB}	±2.94	±0.13^{AB}	±0.18^{CD}
H	13.65	64.29	17.76	1.68	3.2	0.83	5.15
	±0.74^{A}	±2.27^{F}	±1.06^{AB}	±0.09^{AB}	±2.29	±0.32^{C}	±0.07^{A}

Note: Values with different superscripts in a column are significantly different from each other ($p < 0.05$) ; *Mean of 10 samples

Table 3. Moisture and Fat Percentages (± SD) of Paneer Samples Collected from Bengaluru City vis a vis FSSAI Standards

Brand	According to FSSAI	Analyzed Moisture	Conform to FSSAI	According to FSSAI	Analyzed Fat	Conform to FSSAI
A	NOT > 70	52.29±1.00	✓	NOT > 50	43.91±3.85	×
B	NOT > 70	56.53±2.21	✓	NOT > 50	51.91±2.03	✓
C	NOT > 70	51.91±1.79	✓	NOT > 50	51.82±2.50	✓
D	NOT > 70	53.54±1.69	✓	NOT > 50	50.19±2.01	✓
E	NOT > 70	54.84±2.42	✓	NOT > 50	50.00±4.51	✓
F	NOT > 70	51.37±1.98	✓	NOT > 50	51.35±6.81	✓
G	NOT > 70	49.92±3.17	✓	NOT > 50	46.78±4.18	×
H	NOT > 70	64.29±2.27	✓	NOT > 50	38.56±3.67	×

most acceptable as compared to other brands (Table 3). Desale et al. (2009) also reported wide variation in chemical quality of paneer from different brands sold in Ahmednagar city. Rajorhia, Pal, and Arora (1984) also reported wide variations in chemical quality of different brands of paneer collected from Karnal and Delhi as compared to NDRI made paneer.

Ghodekar (1989) concluded that quality of paneer depended upon factors such as type of milk, fat percentage, moisture content, heat treatment of milk, type of coagulant, and microbial contamination. It was also concluded that shelf life and yield of paneer could be increased by lowering moisture content to 50 - 55%, reducing fat content to 42% (DM basis), and using sour whey, HCI, H_3PO_4, or acidophilus whey as coagulant. Boghra and Mathur (1991) reported wide variations in fat, moisture, and ash contents.

Table 4. Microbial Counts* (± SD) of Paneer Samples Collected from Bengaluru City

Brand	TBC(10^4)	Y&M(10^1)	Coliform(10^1)	*S. aureus* (10^1)
A	39.95±3.71	18.70±6.72	7.65±2.99	1.85±1.61
B	28.55±8.13	18.55±5.14	5.85±2.74	1.85±1.36
C	27.70±8.13	17.75±4.24	4.15±2.93	1.60±1.41
D	27.40±3.64	18.85±4.94	6.85±3.07	1.65±1.55
E	30.75±9.75	13.75±3.68	3.95±2.71	1.80±1.96
F	28.25±4.59	15.50±4.41	5.25±2.29	1.14±1.56
G	35.87±6.60	16.70±4.08	3.65±2.30	1.85±.10
H	43.10±4.20	20.90±2.49	5.25±2.05	2.20±.121

* Mean of 10 samples

Table 5. Microbial Counts of Paneer Samples Collected from Bengaluru City vis a vis FSSAI Standards

Brand	TBC	Y&M	Coliform	S. aureus	E. coli	Salmonella
A	×	✓	✓	✓	✓	✓
B	✓	✓	✓	✓	✓	✓
C	✓	✓	✓	✓	✓	✓
D	✓	✓	✓	✓	✓	✓
E	✓	✓	✓	✓	✓	✓
F	✓	✓	✓	✓	✓	✓
G	✓	✓	✓	✓	✓	✓
H	×	✓	✓	✓	✓	✓

(3) Microbiological Quality : TBC counts of paneer samples were in the range of 25.40 41.10 $\times 10^4$ colony forming units (CFU)/gm, yeast and mould count 13.75 - 20.90 $\times 10^1$ CFU/gm, coli-form count 3.95 - 7.65 $\times 10^1$ CFU/gm and *Staphylococcus aureus* count 1.10 - 2.20 $\times 10^1$ CFU/gm (Table 4). The presence of coli form and *Staph. aureus* has to be noted because these reflect the hygienic nature of paneer handling. Godbole (2013) found that 32 samples had bacteriological count ranging from 1×106 to 8.2×106 CFU/gm ; fungal count ranged from 1×105 - 6.6× 105 cfu/gm, and 97% samples got Staphylococcus spp. *E. coli* in 72% and Salmonella spp. were found in 34 % of the samples. They suggested that there was a need for more strict preventive control measures to avoid pre and post process contamination. Desale et al. (2009) reported wide variation in microbial quality of paneer from different brands sold in Ahmednagar city. Vaishnavi et al. (2001) reported that paneer samples sold in Chandigarh city were highly contaminated with microorganisms. In the present study, brand "A" and "H" did not conform to FSSA standards for TBC (Table 5). For other microbial analysis like yeast and mold, coli form, *Staphylococcus aureus* and Salmonella, all brands conformed to FSSAI standards (Table 5).

(4) Instrumentally Measured Textural Attributes : Hardness value of brand "G" was highest among all brands ; whereas brand "H" showed lowest hardness value, meaning that brand "H" was the softest paneer among all brands (Table 6). This variation could be attributed to several factors like quality of milk used for paneer manufacture, processing factors, etc. Even during storage, the textural characteristics may undergo changes because of conformational changes as reported by Kanawjia and Singh (1996).

Bargale and Jha (1992) concluded that as the storage period increased, hardness, chewiness, and gumminess increased significantly, while springiness and cohesiveness remained almost unchanged. In this study, for cohesiveness, brand "F" showed highest value except brand "H" and brand "G" showed lowest cohesiveness

Table 6. Instrumentally Measured Textural Characteristics* (± SD) of Paneer Samples Collected from Bengaluru City

Brand	H	Adh	Co	Spr	Gum	Chew	Res
A	50.1	0.63	0.59	0.79	29.98	23.41	4.26
	± 8.50^{bc}	±0.68^{a}	±0.11^{ab}	±0.16^{a}	±7.70^{c}	±7.70^{bc}	±1.42^{ab}
B	39.63	0.59	0.55	0.88	21.78	19.31	3.74
	± 9.71^{ab}	±1.04^{a}	±0.11^{ab}	±0.05^{a}	±6.04^{abc}	±5.40^{abc}	±0.82^{a}
C	30.40	1.74	0.53	0.81	16.52	14.22	3.27
	±12.22^{a}	±4.24^{a}	±0.19^{ab}	±0.17^{a}	±8.16^{ab}	±6.76^{ab}	±0.79^{a}
D	31.18	0.47	0.54	0.78	16.85	13.25	4.87
	± 4.91^{a}	±0.37^{a}	±0.07^{ab}	±0.04^{a}	±2.87^{ab}	±2.76^{ab}	±0.82^{ab}
E	58.95	0.28	0.51	0.82	30.96	25.63	4.54
	±11.15^{c}	±0.30^{a}	±0.07^{ab}	±0.04^{a}	±9.68^{c}	±8.74^{d}	±0.77^{ab}
F	41.79	0.85	0.64	0.83	27.24	22.96	3.55
	±0.85^{ab}	±1.73^{a}	±0.08^{b}	±0.04^{a}	±8.30^{bc}	±7.80^{bc}	±0.62^{a}
G	62.22	0.70	0.47	0.76	30.59	24.00	5.77
	±13.38^{c}	±2.08^{a}	±0.09^{ab}	±0.08^{a}	±11.58^{c}	±11.21^{bc}	±1.96^{b}
H	27.56	0.51	0.46	0.86	12.43	11.37	5.03
	±6.29^{a}	±0.62^{a}	±0.16^{a}	±0.05^{a}	±4.94^{a}	±5.07^{a}	±2.00^{ab}

Note: Values with different superscripts in a column are significantly different from each other ($p < 0.05$); *Mean of 10 samples

value. For springiness, brand "B"showed highest springiness value and vice versa for brand "G". For gumminess, brand "E" showed highest value whereas brand "H" showed lowest value. For chewiness, brand "E" showed highest value ; whereas brand "H" showed lowest value. Also, for resilience, brand "G" showed highest value ; whereas brand "C" showed lowest value. The differences in the textural values per se may not be of much significance because all the paneer samples were sensorily acceptable.

Moreover, there seemed to be no relationship between the instrumentally measured textural parameters and sensory scores. However, the wide variations in instrumentally measured parameters have to be noted, indicating the non - uniform structural nature of paneer. Mhatre, Jain, Murdia, and Jain (2008) concluded that hardness, cohesiveness, adhesiveness, springiness, chewiness, and yield increased with coagulation temperature. Different manufacturers maintain different processing conditions depending on their convenience, which leads to varied textural parameters.

(5) Labeling Aspects of Paneer Packages : As per FSSAI regulations, every package of food product sold in the market has to conform to certain labeling specifications (FSSAI, 2015). Eighty packets of the eight brands were analyzed for compliance to FSSAI labeling requirements such as FSSAI licensing number, ingredient declaration, permitted additives, expiry date, manufacturing date, quantity of composition in gm/mg etc. It was observed that brands "B", "D", "F", "G", and "H" did not conform to FSSAI labeling requirements (Table 7). The non-conformations were smaller size of FSSAI license declaration, claim of paneer as cottage cheese, claim of the product as low fat against the declaration of high fat content, and description of ingredients in units other than prescribed by FSSAI.

Table 7. Compliance of Packaged Paneer Samples Collected from Bengaluru City to FSSAI Labeling Requirements

Brand	Labeling Requirements							
	FSSAI Licensing Number	Ingredient Declaration	Permitted Additives	Best Before Date	FSSAI Logo Format	Manufacturing Date	Quantity of Composition in gm/mg	Company address
A	No Label	No Label	No Label	No Label	No Label	No Label	NoLabel	No Label
B	✓	✓	✓	✓	×	✓	✓	✓
C	✓	✓	✓	✓	✓	✓	✓	✓
D	×	✓	✓	✓	×	✓	✓	✓
E	✓	✓	✓	✓	✓	✓	✓	✓
F	✓	✓	✓	✓	×	✓	✓	✓
G	×	✓	✓	✓	×	✓	×	✓
H	✓	✓	✓	✓	×	✓	×	✓

Managerial Implications

Paneer is a low shelf life product which needs a cold chain, right from the manufacture point to retail sale point. The efficacy of cold chain maintenance actually decides the quality of paneer sold in the market. Thus, it is understood that the quality of paneer sold in the market is not only dependent upon the manufacturing technique, but also on the persons down the line up to the retail seller. The results presented in the study throw some light on how the quality of paneer varies widely, even though manufacturing technique more or less remains the same in all the dairies. Some of the factors identified are : maintenance of cold chain at below 10^{o}C, no exposure of product to ambient temperature and sun, careful handling of the packages, etc. These are managemental factors controlling the quality of paneer that goes into the hands of consumers. The results of the present study would also help in formulating proper standards of paneer. For example, moisture content in paneer sold in various outlets never exceeded 64%, whereas the moisture legally allowed in paneer is up to 70%.

Further, the higher the moisture content, the higher is the microbial load and shorter is the shelf life. The results obtained in the study give us an idea of the type of paneer consumed by people in the country in general and Bangaloreans in particular. This would create awareness among consumers about paneer quality. By the conducted study such as the present one, the technical officers who supervise paneer manufacture in dairies will also be aware of the quality of paneer being sold by other brands. This will also help in evolving marketing strategies by adopting innovative techniques of marketing, for example, better packaging systems, better refrigeration facilities, guidance to consumers about better ways of utilization of paneer, awareness among retailers about cold chain maintenance, product characteristics, and awareness about legal implications.

Conclusion

In this study, it is observed that 75% of the brands were not conforming to FSSAI labeling requirements. In chemical analysis, it was observed that 37% of the brands showed percent fat value less than FSSAI standard. In microbial analysis, 25% brands showed TBC count more than FSSAI requirements. With regard to TPA parameters, brand "G" was found to be the hardest paneer ; whereas, brand "H" was observed to be the softest paneer among all brands. This shows possibilities of non-conformations of a few paneer samples being sold in Bengaluru market to FSSAI regulations, meaning that some consumers are getting sub-standard quality of paneer.

Detailed studies are to be further carried out by FSSAI to verify and confirm non- conformations and bring about consumer awareness to legal standards of paneer.

Limitations of the Study and Scope for Further Research

This study on the quality of paneer being marketed was confined to the market of Bengaluru city. Although Bengaluru is a cosmopolitan city with a huge market, the trend of paneer sales and quality may not be a true reflection of the country's market as a whole. However, results definitely indicate a trend. Moreover, paneer is being prepared in the country using different types of milk namely, cow milk, buffalo milk, goat milk, and mixtures of them. Hence, paneer quality varies from region to region, and accordingly, its marketing scope also varies. Further, paneer is not yet a widely consumed product in southern parts of India as is the case in northern parts of the country. However, it is being viewed as a premium product.

As scope for further research, marketing study of paneer may be conducted in different parts of the country, and results may be collated to arrive at any definite conclusions about quality of paneer being sold throughout the country. However, such studies are time consuming and suffer from budgetary/financial constraints. Hence, such daunting tasks, that are beneficial to consumers, have to be taken up or sponsored by agencies like Food Safety and Standards Authority of India, which by constitution has the responsibility to assure unadulterated and best quality food products to Indian consumers. Of course, such tasks cannot succeed without active involvement of consumers and related forums.

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