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Functional paneer using A_2 milk and encapsulated spray dried mint powder: Physico-chemical and microbiological analysis

M Aruna, M Ilamaran, V Meenakshi, S Saravanan and B Sivasankari

Abstract
Paneer is a kind of soft variety of cheese obtained from heat-acid coagulation of milk. It is high in vitamin D and calcium, both of which are helpful in the prevention of breast cancer. It is a great source of bone-building minerals due to its high calcium and vitamin D concentration. A_2 milk is better suited for making paneer as compared to other types of milk. Because, it produces soft, and fragile product. In the present study is an attempt to formulate higher nutritional value of paneer with added health benefit by using A_2 milk with encapsulated mint leaf extract powder. The A_2 milk has many advantages regarding nutritional qualities and chemical composition as characterized by higher fat, total solids, proteins, caseins, lactose, ash contents and antioxidant activity. The process for development of functional paneer was optimized by using A_2 milk with different concentrations of encapsulated mint leaf extract powder of 100:00, 100:0.25, 100:0.75, 100:1.0 and 100:3.0. It was found that paneer from A_2 milk with 0.25 percent of encapsulated spray dried mint leaf powder (T_1) was found to be maximum nutritional and sensory qualities. The nutrient composition functional paneer with encapsulated mint powder was found to 7.76 g/100 g of fat, 18.80 g/100 g of protein, 24.01 g/100 g of carbohydrate, 2.62 g/100 g of ash, 44.97 g/100 g of total solid, 0.21 percent of acidity.

Keywords: A_2 milk, encapsulated spray dried mint leaf powder, functional paneer, quality characteristics, shelf-life

Introduction
India is the largest milk producer in the world with an annual production of 165.4 million tons having per capita availability of 355 g/day for the year 2016-2017. About 46 percent of milk produced is consumed as liquid milk and 50-55 percent is converted into Traditional Indian Dairy Products like paneer and paneer based products, chhana and chhana based products, khoa and khoa based sweets and desserts. Paneer is one of the popular Traditional Indian Dairy Products, offers an enormous opportunity to dairy sector (Ghosh *et al.*, 2019) [4]. Paneer is prepared by a combined action of acid coagulation and heat treatment of milk. It is a kind of soft variety of cheese obtained from heat-acid coagulation of milk (Khan and Pal *et al*., 2011) [1]. Paneer has a fairly high level of fat (22–25%), protein (16–18%) and also contains low level of lactose (2.0–2.7%). Good quality paneer is characterized by a creamy white colour, mildly acidic but sweetish taste and nutty flavour, spongy body and a smooth close knit structure (Paul *et al*., 2020) [3]. Paneer like other indigenous dairy products, is a highly perishable product and suffers from limited shelf-life, largely because of its high moisture content, approx. 55 percent (Sarnaik *et al.*, 2021) [6]. A_2 milk is currently popular in and around the world. Before the mutation, there was only the A_2 variety of casein or A_2A_2. This mutation is occurs due to selective breeding for the maximum milk production. The mutation caused beta casein gene to have 13 variations, including A1, A_2, A3, A4, B,C, D, E, F, H1, H2, I and G. A1 is one of the variations that is consider as harmful to human health. A1 variant milks potentially health impacts, including type 1 diabetes, autism, coronary heart disease, SIDS, etc. (Kulkarni *et al.*, 2019) [23]. A_2 milk had more polyunsaturated fatty acids and had lower fat globule sizes than A1 milk. The physicochemical, nutritional, and sensory characteristics of milk and milk products are influenced by milk fatty acids and fat globule size (Perna *et al.*, 2016) [19]. A_2 milk protein is one of the best natural antioxidants, which also lowers serum cholesterol levels. It has been proven to be effective in the treatment of cancer and boosted the immune system (Tronin *et al.*, 1996) [24]. Due to it high nutritional content, A_2 cow's milk is one of the greatest pre and post workout options for athletes.

Even though consumption of A_2 milk has a significant beneficial effect on an athlete's health and performance.
Incorporation of functional ingredients like essential oils (lemon, orange, clove, etc.), fibers (soy fiber, inulin etc.), proteins (groundnut protein isolate etc.), hydrocolloids, herbs (mint, moringa etc.) and other such ingredients will help to improve the quality, flavour and shelf-life of paneer thus making it attractive to health-conscious people (Yashavantha *et al.*, 2020) [5]. Thus, the main aim of the present study was to investigate to optimize the process for development of functional paneer and quality characteristics of fresh and stored functional at refrigerated temperature.

Materials and Methods

A_2 milk from Pulikulam breed was procured from Thozhuvam Farmers Producer Company Private Limited, Madurai, Tamil Nadu. Mint leaf was procured from local market of Madurai.

Processing of encapsulated spray dried mint powder

Fresh mint leaves are washed separately under running water for the removal of dust and unwanted materials from there surface to prevent spoilage. The leaves were dried in forced conventional tray drier. Dried leaves were ground by using pulverizer and sieved through mesh (size of 100 microns) to obtain uniform fraction of powder for extraction. The extraction was carried out by taking 100 g of dried mint powder separately in 1000 ml of deionised water and heated at 80 °C for 1 hr in water bath. After 1 hr, the extracts were filtered through muslin cloth and the extraction is carried out again from the remaining crude residues with another 500 ml of distilled water for 30 min. After second extraction, both the extracts were mixed together and collected separated in amber colour bottles.
Maltodextrin and the produced mint leaf extract were separately blended, and the combined extract was left overnight to allow the carrier agents to completely hydrate into the extract. Spray drying took place after homogenizing the liquids. The leaf extract was capsulated by using a laboratory scale spray dryer (Spraymat LSD-48 Model) with counter-current airflow. Optimize the many operational aspects of leaf extract encapsulation. The inlet and outlet temperature was optimized to retain the quality characteristics of the leaf extract. The feed flow rate and pressure were constantly maintained for all the leaf extracts. The process conditions were optimized by taking into account all the experimental trials to enable the maximum powder yield with more antioxidant activity. The spray dried encapsulated mint leaf extract powder was collected in glass bottles with pre-weighed contents and kept cold until analysis was completed. The processing for preparation of encapsulated spray dried mint powder.

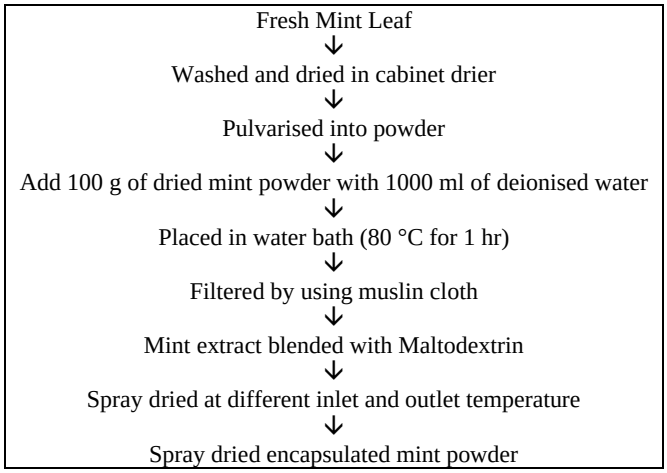


Fig 1: Flow diagram of encapsulated spray dried mint powder

Processing of A_2 milk based functional paneer with encapsulated mint powder

Pulikulam breed of A_2 milk was filtered, cleaned heated upto 85 – 90 ºC in a stainless steel vessels. Different concentration of encapsulated spray dried mint leaf extract powder was added to heated milk. The heated milk was allowed to cool to 70 ºC and different concentration of coagulant (citric acid and lemon juice) were added with continuous stirring until the complete coagulation and whey separation clearly. The coagulated curd was allowed to settled down for 5-10 min and drain the whey completely from the curd by using muslin cloth. The coagulated curd was transferred to paneer press device to produce compact block of paneer. The pressed paneer was immersed in chilled water for one hour. The chilled paneer was separated from the chilled water and allowed to drain the excess amount of water. The functional paneer with encapsulated mint powder were covered with polythene sheets and stored at refrigerated conditions for further analysis.

Physical-chemical analysis encapsulated mint powder and functional paneer

Physico-Chemical analysis of encapsulated mint powder and functional Paneer were analyzed for their different physico-chemical characteristics by using analytical methods. According to Garca Tejeda *et al.*, 2016 [31], the encapsulation efficiency was calculated. Hauser's ratio and car's index was estimated method proposed by Farimin and Nordin (2009) [25]. Hygroscopicity was determined according to the methodology proposed by Cai *et al*., 2000 [21]. Polyphenol content was estimated according to Siddhuraju *et al*., 2003 [26]. Water activity was water activity was estimated method given by Jinapong *et al*., 2008 [22].
The moisture content of the sample was analyzed by Chemists' *et al*, 1980. The acidity of the sample was calculated using a technique described by Chemist *et al.*, 1980. Carbohydrate content was estimate by anthrone method (Sadasivam *et al.*, 1996) [14]. Protein content was estimate by Kjeldahl method (Sadasivam *et al.*, 1996) [14]. The fat content

was followed by method given Cohen *et al*. (1917) [27]. Fibre content was estimated method given by (Sadasivam *et al.*, 1996) [14]. Free fatty acid content was determined by method described by Koniecko *et al.*, (1979) [28]. Jafari *et al.*, (2017) [29] determined the water solubility.

Microbiological analysis

The microbiological analysis i.e. bacteria, yeast and mould test of the different functional paneer samples was done by using the technique given by Farkas, 1984 [30]

Statistical Analysis

The data obtained for various parameters were analysis statistically using OPSTAT and analysis of variance and critical difference test.

Results and Discussion

Physico-chemical analysis of encapsulated spray dried Mint powder

The physic-chemical characteristics of the encapsulated spray dried mint leaf extract powder was depicted in Table 1.

The tapped and bulk density values of encapsulated spray dried mint powder are 0.38 and 0.48 g/ml respectively. The encapsulation efficiency of the encapsulated mint powder was in the range of 91.34-93.2 percent. The flow properties of mint powder presented as Carr's index (%) and Hausner's ratio are summarized in table 1. Samples were viscous with poor flow ability, showing a Hausner's ratio of 0.82 and a Carr index of 62.82 percent. The hygroscopicity and water activity content of the encapsulated spray dried mint leaf powder was 5.4 and 0.392%. The moisture content of the encapsulated spray dried mint leaf powder was 3.33 percent, it is due to the samples with maltodextrin had lower moisture and decreased the adsorption power of the powders when compared to the samples without the carrier agent. Quek *et al.*, (2007) [12] found that the addition of 3 and 5 percent of maltodextrin in feed solution also improved process yield. Movahhed *et al*., (2016) [13] studied the drying of carrot-celery by spray drying and identified a significant effect of Maltodextrin and the inlet air temperature in powders' moisture. Increasing drying air temperature resulted in lower moisture because, the higher temperature leads to high water diffusion of the particles. The encapsulated spray dried mint powder has contained high amount of protein (20.06) and low amount of fibre (0.25). The phenolic content of encapsulated mint powder is 0.104 mg/GAE.

Physico-chemical analysis of A_2 milk based functional paneer with encapsulated spray dried mint powder

Moisture

Table 2 summarizes the changes noted in the moisture content of A2 milk with encapsulated spray dried functional mint paneer during storage at refrigeration temperatures. The highest mean value of moisture content was recorded in the sample of T_1 (56.38%) followed by T_2 (56.30%), T_3 (56.25%), T_4 (56.22%). During 30 days of storage the moisture content of control sample (T_0) and paneer with encapsulated spray dried mint powder (T_1, T_2, T_3, T_4) was significantly decreased to 55.76, 55.84, 55.97, 55.86 and 55.78 percent respectively. At the end of the storage the moisture content in all treatments were decreased to 54.91 (T_0), 54.90 (T_1), 54.89 (T_2), 54.87 (T_3) and 55.53 (T_4) respectively. Significant (p<005) differences were observed in all the treatments. Nageswara Rao *et al.* (1984) [10] found that the gradual decrease in moisture content of paneer during storage was mostly due to expulsion of moisture from the product to surrounding, but with slower rate that might be mostly due to oily layer formed on the surface of paneer samples which act as a barrier for moisture expulsion.

pH

The changes in the pH content of A2 milk functional paneer with encapsulated spray dried mint powder stored at refrigeration condition shown in Table 2. Highest value of pH observed in control T_0 (5.96) followed by functional paneer with encapsulated mint powder (T_1, T_2, T_3, T_4) was found to be 5.89, 5.85, 5.80, 5.74. At the end of the storage, the pH content in all treatments were decreased to 4.81 (T_0), 4.74 (T_1), 4.65 (T_2), 3.94 (T_3) and 4.47 (T_4) respectively. Significant (p<005) differences with respect to all the treatments were observed. Pal *et al*. (1993) [11] reported that in most of the developed paneer, pH was decreased with storage time. Bhattacharya *et al*, (1971) [2], observed decreasing in pH in citric acid and cultured whey treated samples of vacuum packaged skim milk paneer and paneer prepared from standardized buffalo milk (pH from 6.60 to 5.80) during storage under room refrigeration temperature (7 °C).

Total solids

The changes in the total solids content of encapsulated spray dried mint powder incorporated paneer during storage are shown in Table 3. The highest total solids content was recorded in the sample of T_1 (44.97) followed by T_2 (44.86), T_3 (44.53), T_4 (43.96) and T_0 (43.63). At the end of the storage, the total solids in all treatments were significantly (p<005) reduced to 43.81 (T_1), 43.68 (T_2), 43.27 (T_3), and 42.81 (T_4). Kakad *et al.* (2021) [15] reported that the total solids content showed gradual decrease with increase in level of spice powder and their combinations.

Acidity

The changes observed in the Acidity content of the encapsulated spray dried mint paneer during storage are shown in Table 3. The data regarding acidity content in control and functional paneer prepared from A_2 milk with encapsulated spray dried mint at different proportions were analyzed that mean value for acidity of T_0, T_1, T_2, T_3 and T_4 was found to 0.17, 0.21, 0.23, 0.27 and 0.29 percent respectively. At the end of the storage, the acidity content in all treatments (T_0, T_1, T_2, T_3, T_4) were increased 1.98, 1.34, 1.68, 1.75 and 1.62 percent. Significant (p<005) increase was noticed in all the functional paneer samples with encapsulated mint powder. An increase in titrable acidity of control paneer and functional paneer is a natural process and with higher extent. El-Tantawy *et al.* (2006) [8] find that acidity in paneer increased from 0.63 to 0.90. Khatkar *et al.* (2017) [7] stated that less increase in titrable acidity of control paneer samples during storage due to high moisture and oxygen barrier properties.

Carbohydrate

Carbohydrate in A_2 milk based paneer with encapsulated spray dried mint powder at refrigeration conditions in different levels of incorporation are summarized in Table 4. The value of T_0, T_1, T_2, T_3 and T_4 was found to be 26.90, 27.01, 26.71, 25.93 and 25.94 percent respectively. It was

observed that mean treatment a value was decreased from T_0 to T_4 experimental samples. A significant (p<005) decrease in moisture content with respect to all the treatments was observed. Mishra *et al.* (2022) [17] find that significant decrease in carbohydrate of paneer samples during storage might be due to utilization of lactose by microorganisms and its conversion to lactic acid.

Protein

Table 4 summarises the changes noted in the protein content of the control and functional paneer with encapsulated mint powder sample at refrigeration temperature. The protein value of A_2 milk with encapsulated spray dried mint paneer was found to 18.05 in control (T_0), 18.80 in T_1, 18.83 in T_2, 18.89 in T_3 and 18.97 percent in T_4 samples. During 30 days of storage T_1 has contain highest amount of protein 17.86 (T_1) followed by 17.85 (T_2), 17.80 (T_4), 17.37 (T_3) percent. At the end 45 days of storage, the protein content in all the treatments were decreased to 17.12 (T_1), 16.46 (T_2), 17.20 (T_3) and 16.42 (T_4). A significant (p<005) decrease was observed with respect to moisture content in all the treatments. Devaki *et al*. (2021) [32] reported that protein content was higher in all the spice-based paneer samples.

Fat

The changes in the fat content of encapsulated spray dried mint incorporated functional paneer during storage at refrigeration are given in Table 5. The data on fat content of functional paneer by using pulikulam breed of A_2 milk with encapsulated spray dried mint powder had highest fat content was recorded in T_1 (7.76) followed by 7.70 (T_0), 7.64 (T_2), 6.45 (T_3) and 6.21 (T_4) percent. The fat content of paneer of control (T_0) and functional paneer with encapsulated spray dried mint powder was decreased to 7.21 in T_1, 6.61 in T_2, 6.48 in T_3 and 5.82 in T_4 at 30 days of storage. At the end of the storage (45 day), the fat content in all the treatments were slightly decreased to 6.12 (T_1), 5.43 (T_2), 5.40 (T_3) and 5.47 (T_4) percent. A significant (p<005) decrease in fat content with respect to all the treatments was observed during storage. Selvamuthukumaran *et al*, (2021) [18] found that during storage of paneer the fat content also reduced and this may be due to lipolytic and proteolytic reaction as a result of enzymatic reaction of microorganisms.

Ash

The changes in ash content of the functional with encapsulated spray dried mint samples during storage are given in Table 5. The highest ash percentage was recorded A_2 milk paneer with encapsulated spray dried mint powder. The highest mean ash content was recorded in T_3 (2.70*)* followed by 2.69 (T_2), 2.68 (T_4), 2.62 (T_1) and 2.59 (T_0) percent. At the end of the storage, the ash content in all functional paneer samples (T_0, T_1, T_2, T_3, T_4) were gradually reduced to 1.42, 1.41, 1.45, 1.23 and 1.18 percent. A significant (p<005) decrease in ash content with respect to all the paneer samples was observed. This may be due to lower ash content in A_2 milk and mint powder was observed. Mrunali *et al*. (2018) [16] reported that ash content of paneer decreased gradually due to with addition of spice powder.

Free fatty acid

The changes in the free fatty acid content of functional paneer with encapsulated spray dried mint powder during storage are presented in Table 6. Initially free fatty acid content of functional paneer with encapsulated spray dried mint powder was 0.826 in T_1, 0.787 in T_2, 0.756 in T_3 and 0.643 percent in T_4. At the end of the storage the free fatty acid content in all paneer samples were increased to 1.856 (T_0), 1.994 (T_1), 1.920 (T_2), 0.973 (T_3) and 0.969 (T_4) percent. Significant (p<005) increase was noticed in all the functional paneer samples with encapsulated mint powder during storage. The increase in free fatty acid content of paneer during storage was mostly due to lipolytic action reported by Khatkar *et al*, (2017) [7].

Microbial population of A_2 milk based paneer with encapsulated spray dried mint powder: The changes in microbial population of functional paneer samples during storage in refrigeration conditions are shown in Table 7.

Bacteria: There was no bacterial growth observed in both control (T_0) and functional paneer with encapsulated spray dried mint powder samples (T_1, T_2, T_3, T_4) upto midterm 30 days in the. After 45 days the bacterial content in paneer samples was decreased from 1.63×10^5 to 0.52×10^5.

Fungi: Initially no fungal load observed in both control (T_0) functional paneer with encapsulated spray dried mint powder samples (T_1, T_2, T_3, T_4) upto midterm (30) days. After 45 days, there was slight growth of fungi content was observed in control (T_0) and functional paneer with encapsulated spray dried mint powder samples (T_1, T_2, T_3, T_4) and found to 4.40×10^2, 3.81×10^2, 3.24×10^2, 2.80×10^2 and 2.65×10^2 respectively.

Yeast: There was no yeast growth up to 30 days in both control (T_0) and functional paneer with encapsulated spray dried mint powder samples (T_1, T_2, T_3, T_4). After 45 days the control (T_0) and encapsulated spray dried mint incorporated functional paneer (T_1, T_2, T_3, T_4) was decreased.

Table 1: Physico-chemical characteristics of encapsulated spray dried mint powder

Quality parameter	Composition
Bulk density (g/ml)	0.38
Tapped density (g/ml)	0.48
Encapsulation efficiency (%)	91.34-93.2
Swelling capacity	0.66
Hauser's ratio (%)	0.82
Car's index (%)	62.82
Hygroscopicity (%)	5.4
Moisture (%)	3.33
Water activity(aw)	0.392
Carbohydrate (%)	2.98
Protein (%)	20.06
Fat (%)	4.9
Fibre (%)	0.25
Poly phenol (mg/GAE)	0.104

Table 2: Changes in moisture and pH of paneer samples during storage in refrigeration conditions

Storage period (days)	Moisture (%)					pH				
	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4
Initial	56.37±0.83	56.38±0.96	56.30±0.59	56.25±1.19	56.22±1.51	5.96±0.13	5.89±0.13	5.85±0.12	5.80±0.03	5.74±0.09
15 days	56.18±0.34	56.15±0.42	56.22±0.72	56.19±0.38	56.17±1.64	5.52±0.06	5.63±0.07	5.63±0.05	5.54±0.12	5.42±0.09
30 days	55.76±1.18	55.84±0.03	55.97±0.15	55.86±0.53	55.78±0.11	5.26±0.01	5.21±0.00	5.38±0.17	4.31±0.16	4.76±0.10
45 days	54.91±0.84	54.90±1.45	54.89±0.61	54.87±1.49	55.53±0.88	4.81±0.17	4.74±0.09	4.65±0.13	3.94±0.14	4.47±0.17

Table 3: Changes in total solids and acidity content of paneer samples during storage in refrigeration conditions

Storage period (days)	Total Solids (%)					Acidity (%)				
	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4
Initial	43.63±0.48	44.97±0.07	44.86±1.26	44.53±0.36	43.96±0.59	0.17±0.01	0.21±0.02	0.23±0.08	0.27±0.06	0.29±0.06
15 days	43.32±0.80	44.93±0.06	44.67±0.27	44.23±0.51	43.54±1.22	0.65±0.03	0.65±0.03	0.56±0.06	0.46±0.04	0.44±0.05
30 days	42.53±0.88	43.66±0.64	44.32±0.21	44.09±0.57	42.83±1.04	0.86±0.05	1.29±0.05	1.45±0.08	1.43±0.07	1.34±0.07
45 days	42.41±0.02	43.81±1.43	43.68±0.45	43.27±1.14	42.81±0.50	1.98±0.04	1.34±0.02	1.68±0.09	1.75±0.01	1.62±0.08

Table 4: Changes in carbohydrate and protein of paneer samples during storage of Refrigeration conditions

Storage period (days)	Carbohydrate (%)					Protein (%)				
	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4
0 days	26.90±0.66	27.01±0.20	26.71± 0.00	25.93± 0.33	25.94± 0.30	18.05± 0.39	18.80± 0.16	18.83± 0.32	18.89± 0.12	18.97± 0.47
15 days	26.73± 0.54	26.54± 0.51	26.49± 0.38	25.62± 0.51	25.44± 0.38	18.03± 0.60	18.13± 0.21	18.25± 0.42	18.34± 0.39	18.23± 0.48
30 days	25.96± 0.74	26.23± 0.62	26.31± 0.21	24.86± 0.21	24.96± 0.22	17.83± 0.26	17.86± 0.31	17.85± 0.50	17.37± 0.27	17.80± 0.44
45 days	25.42± 0.77	25.82± 0.47	25.92± 0.81	24.55± 0.77	24.62± 0.38	16.02± 0.23	17.12± 0.16	16.46± 0.60	17.20± 0.02	16.42± 0.14

Table 5: Changes in fat and ash content of paneer samples during storage in refrigeration condition

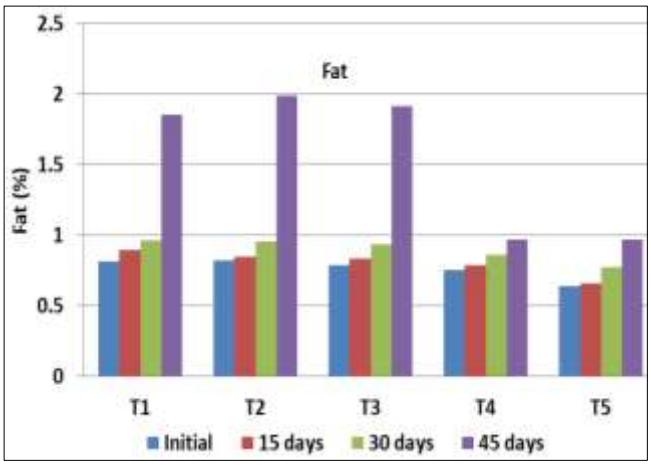
Storage period (days)	Fat (%)					Ash (%)				
	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4
Initial	7.70±0.02	7.76±0.07	7.64±0.21	6.45±0.21	6.21±0.19	2.59±0.06	2.62 ±0.04	2.69±0.06	2.70±0.04	2.68 ±0.03
15 days	7.54±0.08	7.70±0.08	7.32±0.17	6.51±0.13	6.05±0.09	2.53±0.07	2.45±0.03	2.33±0.03	2.52±0.06	2.48±0.01
30 days	6.92±0.14	7.21±0.09	6.61±0.25	6.48±0.20	5.82±0.14	2.06±0.03	1.57±0.02	1.86±0.01	1.43±0.04	1.21±0.05
45 days	6.65±0.16	6.12±0.09	5.43±0.14	5.40±0.06	5.47±0.16	1.42±0.09	1.41±0.03	1.45±0.02	1.23±0.02	1.18±0.03

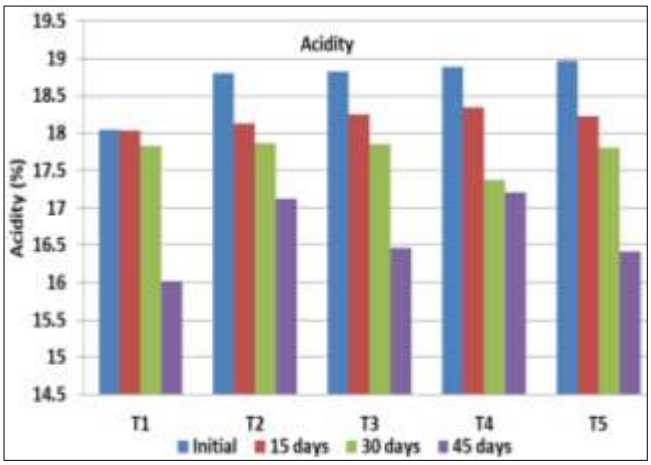
Table 6: Changes in Free Fatty Acid (%) content of paneer samples during storage in refrigeration conditions

Storage period (days)	T_0	T_1	T_2	T_3	T_4
Initial	0.819±0.02	0.826±0.00	0.787±0.01	0.756±0.01	0.643±0.01
15 days	0.895±0.04	0.847±0.02	0.840±0.09	0.787±0.02	0.662±0.01
30 days	0.964±0.02	0.958±0.01	0.941±0.07	0.862±0.01	0.778±0.01
45 days	1.856±0.05	1.994±0.02	1.920±0.01	0.973±0.00	0.969±0.01

Table 7: Changes in microbial population of paneer samples during storage in refrigeration conditions

Storage days	Bacteria x 10^5 cfu/g					Fungi x 10^2 cfu/g					Yeast x 10^3 cfu/g				
	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4	T_0	T_1	T_2	T_3	T_4
Initial	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Midterm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Final	1.63	1.47	1.28	0.86	0.52	4.40	3.81	3.24	2.80	2.65	3.95	3.87	3.53	2.87	2.70





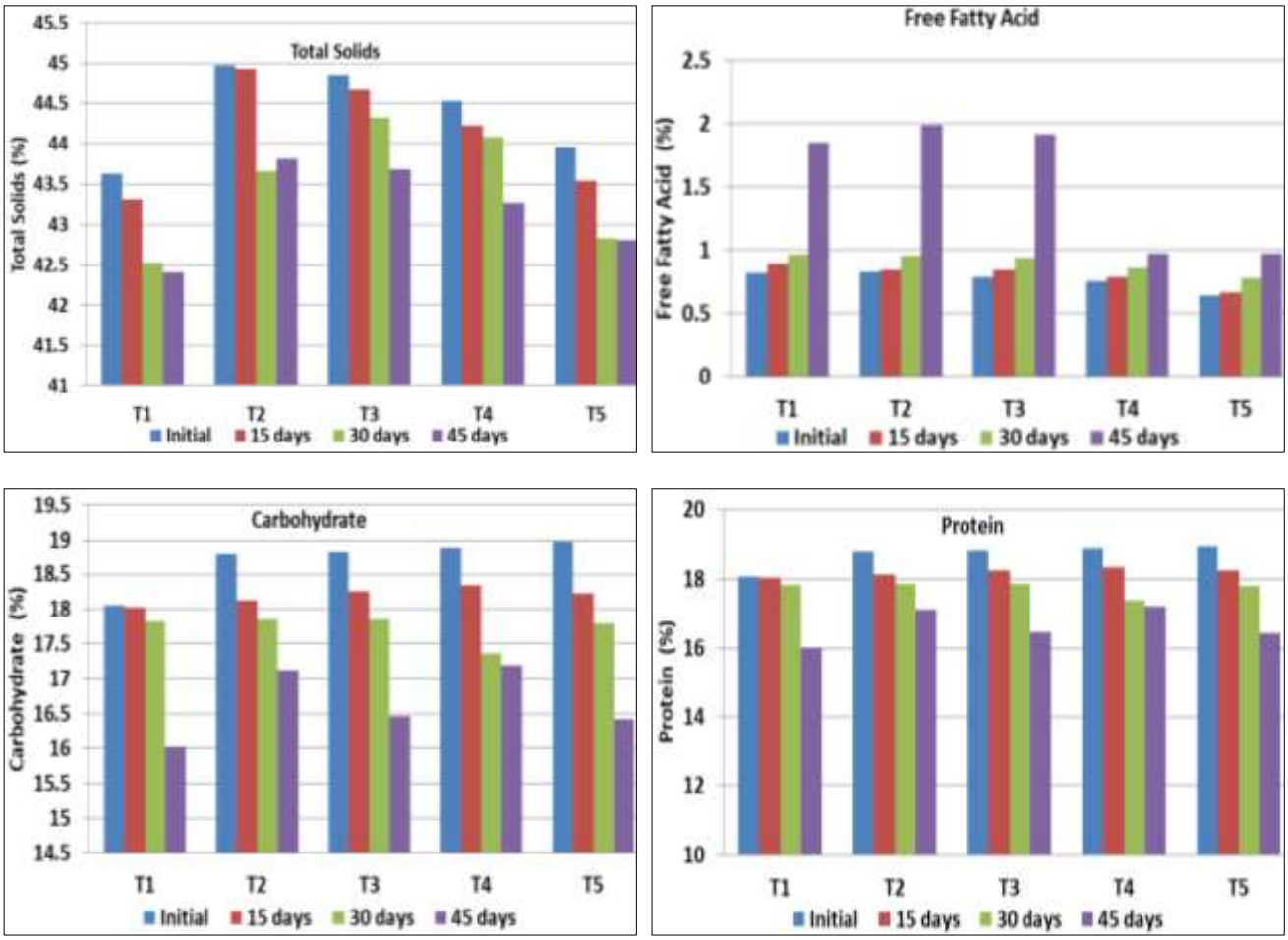


Fig 1: Chemical analysis of A2 milk based functional paneer with encapsulated spray dried mint powder

Conclusion

In the present study, pulikulam breed of A_2 milk was chosen for production of paneer. Throughout the research of paneer; different proporation of encapsulated spray dried mint powder (0.25, 0.75, 1.0 and 3.0%) was added. Encapsulated spray dried mint power at the level of 0.25 and 0.75 percent were acceptable. The functional paneer with encapsulated spray dried mint powder samples prepared using 0.25 percent encapsulated spray dried powder (T_1) had moisture, pH, total soluble solids, acidity, carbohydrate, protein, fat, ash and free fatty acids was 56.28, 5.89, 44.97, 0.21, 24.01, 18.80, 7.76, 2.62 and 0.826 percent respectively. During storage, the carbohydrate, protein, and moisture content are decreased and increased in the acidity and free fatty acid content in the developed functional paneer samples.

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