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Snehal Giri
Ph. D Scholar, Department of Food Science and Nutrition, University of gricultural Sciences, Bangalore, Karnataka, India

Dr. Neena Joshi
Professor, Department of Food Science and Nutrition, University of Agricultural Sciences, Bangalore, Karnataka, India

Corresponding Author:
Snehal Giri
Ph. D Scholar, Department of Food Science and Nutrition, University of gricultural Sciences, Bangalore, Karnataka, India

Changes in physicochemical properties of yogurt enriched with encapsulated carrot coagulum powder during storage

Snehal Giri and Dr. Neena Joshi

Abstract
Yogurt was prepared with the incorporation of 2.5, 5, 7.5 and 10% encapsulated carrot coagulum powder (ECCP). Yogurts with and without addition of ECCP were subjected to sensory evaluation; 5 % incorporation of ECCP was most preferred as compared to other variations with significantly higher colour and overall acceptability scores. Therefore, yogurt with 5% ECCP incorporation was selected for the storage study. Storage was in refrigerated condition (5°C) for 20 days. Yogurt without ECCP incorporation served as control. Physicochemical and microbiological characteristics were determined to assess the quality of both the yogurt samples during storage. During the storage, pH was significantly decreased whereas titratable acidity was significantly increased. Water holding capacity and total solids were decreased significantly during storage in case of control, whereas the decrease was not significant in ECCP incorporated yogurt. Total carotenoid content on the initial day in yogurt incorporated with ECCP was 0.83 mg/100g which significantly decreased to 0.56 mg/100g at end of storage period. The total lactic acid bacterial counts of yogurt were 99.83 CFU/ml and 97.33 CFU/ml in control and ECCP added yogurt on the first day. Further with the increase in storage time, it significantly decreased to 97.16 CFU/ml and 94.5 CFU/ml respectively. Initially, yeast and mould were absent, some increase was observed as storage period increased. No coliforms were detected throughout the refrigerated storage. The results of present study confirms that, incorporation of ECCP in yogurt significantly improved the sensorial acceptability without affecting its physicochemical properties when compared to control yogurt during storage. ECCP incorporated yogurt did not exhibit a greater loss in the viability of lactic acid bacteria compared to plain yogurt during the storage period.

Keywords: Carrot out-grades, spray drying, yogurt, yogurt culture, sensory quality, total carotenoid content

Introduction
Carrots *(Daucus carrot L.)* have been a most popular vegetable for a long time, due to their nutritive value and culinary uses. Carrots are usually consumed in raw, processed or manufactured into many kinds of products, like carrot juices, dehydrated soups, or sometimes mixed to some food with high nutritional value. Carrots are important source of healthy components such as carotenoids and phenolics (Jabbar *et al.,* 2014) [18] that promote antioxidant activity in humans by scavenging free radicals. Carotenoids have the provitamin A activity which helps to protect night vision. Carrots are also a good source of dietary fibre, vitamins such as vitamin A, C, E and K, vitamin B_1, B_2, B_6 and B_9 and minerals like Ca, P, Fe and Mg (Hashimoto and Nagayama, 2004; Sharma *et al.,* 2009) [17, 36]. However, carrots face high loss during post-harvesting operations from farm till it reaches the consumer. Most of the time carrots are rejected due to mishappen, cracked, forked, and poorly developed roots but nutritional content in these edible out-grades is on par with regular carrot (Kasale *et al.,* 2019) [23]. Encapsulation by using a spray drier is an economical method for the preservation of functional compounds by entrapping the ingredient in a coating material (Tonon *et al.,* 2011) [42]. Carrier agent, maltodextrin is neutral smell additive, and often used in spray drying production due to its low cost and bulking properties (Bae and Lee, 2008) [2]. Spray-dried powders have good reconstitution characteristics, low water activity, and reduce weight, resulting in easier storage and transportation (Ersus and Yurdagel, 2007) [10]. Therefore, in the present study, carrot out-grades were utilized to produce encapsulated carrot coagulum powder with maltodextrin using spray drying technique.
Yogurt is one of the most popular fermented dairy products widely consumed all over the word (Loveday *et al.,* 2013) [28].

Yogurt is usually made from pasteurized milk mixed by the activity of a symbiotic blend of two microorganisms namely *Streptococcus thermophilus* and *Lactobacillus delbruckii subsp. bulgaricus* (Chandan and Kilara, 2011; Chandan *et al.,* 2008) [3, 4]. After fermentation the finished product set or stirred must include approximately 10^7 of these live bacteria/mL (Jeantet *et al.,* 2008) [20]. Yogurt is characterized by a soft, viscous, gel consistency and a delicate flavour. Its production and consumption are growing continuously due to its therapeutic properties beside its high organoleptic and nutritional properties (Karagul *et al.,* 2004; Mckinley, 2005) [22, 29].

Yogurt is regarded as a probiotic carrier. Probiotics are defined as 'live microorganisms which when administered in adequate amount confer health benefits to the host' (FAO/WHO, 2002) [11]. Yogurt is nutritionally rich in available protein, milk fat and calcium. It is also a very good source of phosphorus, potassium, magnesium, iodine, zinc, vitamin B_2, B_5, B_6 and vitamin B_{12} (Staffolo *et al.,* 2004; Mckinley, 2005) [38, 29]. Generally, yogurts are flavored with natural fruit and vegetables pieces or juice according to the consumer preferences which is varied from country to country (Gunawardhana and Dilrukshi, 2016) [16]. Addition of fruit and vegetable mixtures, flavors and sugar in yogurt improves the nutritional and sensory properties (taste, color and texture) (Farahat and El-Batawy, 2013) [12]. Furthermore, fruits and vegetable addition cause the decrease of sour taste of fermented products (Januário *et al.,* 2017) [19]. Fruit and vegetable additions result in a greater variety and may increase yogurt consumption (Farahat and El-Batawy, 2013) [12]. The addition of carrot juice in yogurt produces a nutritionally balanced food because carrot is rich in beta carotene, ascorbic acid and tocopherol (Salwa *et al.,* 2004) [33]. Research on yogurt formulation with carrot powder is scanty. Therefore, in this study attempt was made to formulate the yogurt incorporated with ECCP. The objective of this study is to produce yogurt enriched with encapsulated carrot coagulum powder and to determine the sensory score, physicochemical, microbial properties and study changes during refrigerated storage.

Material and methods

Raw materials

Carrot out-grades were procured from Yelahanka local market, Bangalore. Two enzymes pectinase (Pectinex Ultra SPL) and cellulase (Celluclast 1.5L) were procured from Novozymes, Bangalore. Raw materials such as food grade citric acid, skimmed milk powder (Amul), cow's milk (Nandini) and sugar were obtained from local market in Bangalore. Glass bottles of 100 ml capacity also purchased from the local market in Bangalore, India. Freeze-dried DVS bacterial cultures (Mild 1.0 Yo-Flex) containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp*. *Bulgaricus* were obtained from the company Christian Hansen, Bangalore.

Preparation of encapsulated carrot coagulum powder

Carrot out-grades were used for the preparation of enzymatically extracted carrot coagulum. Enzymatic extraction of carrot coagulum from carrot out-grades was followed according to the procedures outlined by Wagner and Warthesen (1995) [43]; Stoll *et al.* (2003) [39]; Darshan (2015) [7] with modification. Pectinase and cellulase enzymes were used in the concentration of 0.02 % for the enzymatic extraction. Enzymatic extracted carrot coagulum thus obtained was used for spray drying (Lab spray dryer, LSD-48, JISL, Mumbai). Maltodextrin DE 20 in 15 % concentration was then added to carrot coagulum and volume was made up to 100 ml. Encapsulation of spray drying was carried out at the constant aspirator rate of 90%, feed pump 12% and at pressure 1.5-2.0 kg cm^{-2}. The spray dryer operated at inlet temperatures at 170 °C and outlet temperatures maintained at 86 ±5 °C. After the encapsulation process the powder was collected and packed in high density polyethylene bags and stored in airtight container containing silica gel. The process for the production of encapsulated carrot coagulum powder using spray drier, is presented in the Figure 1.

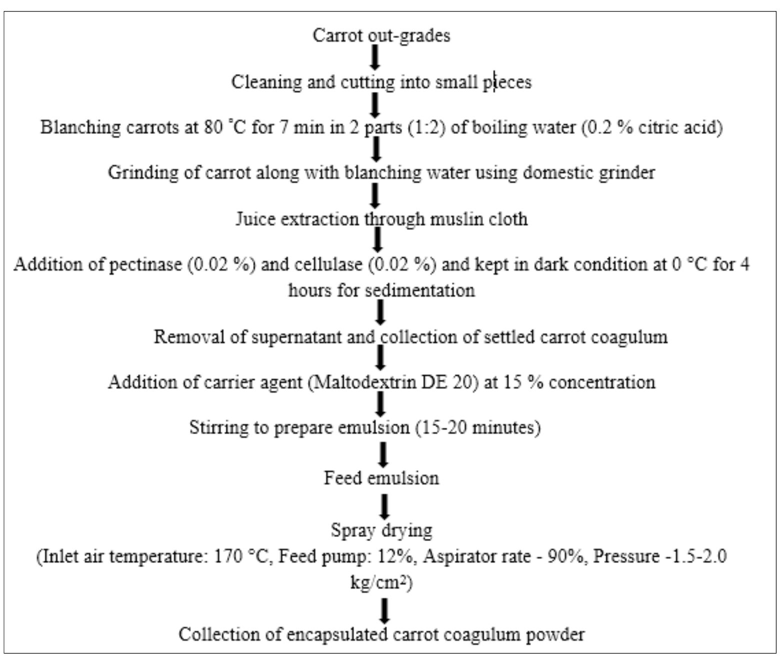

Fig 1: Flow chart for the development of encapsulated carrot coagulum powders

Development of yogurt

Preparation of starter culture: Cow milk (Fat 8% and SNF 2.5%) was pasteurized at 75 °C for 30 min and it was immediately cooled to 45 °C. Then 0.15 g/L of the freeze-dried DVS probiotic culture of *Lactobacillus delbrueckii ssp. Bulgaricus and Streptococcus thermophilus* (Christian Hansen) were propagated in pasteurized milk by inoculation and the yogurt base was incubated at room temperature for 24 hours. After incubation the culture was stored at 5 °C (Leahu and Hretcanu, 2017) [26].

Preparation of different variations of yogurt: In cow milk, 2.5 % skimmed milk powder, 10 % sugar were added respectively to each 100 ml glass bottle and pasteurized at 75 °C for 30 min and cooled to 45 °C. Further, 2.5, 5, 7.5 and 10 % encapsulated carrot coagulum powder was added in each glass bottle and the mixture was inoculated with 6 % (v/v) starter culture. Once the starter culture was completely mixed, it was then incubated at 42±2 °C for 4-5 hours, until pH value reached a value of 4.5. Ingredients used for preparation of yogurt was shown in Table 1 and process flow chart for yogurt preparation was shown in Fig. 2.

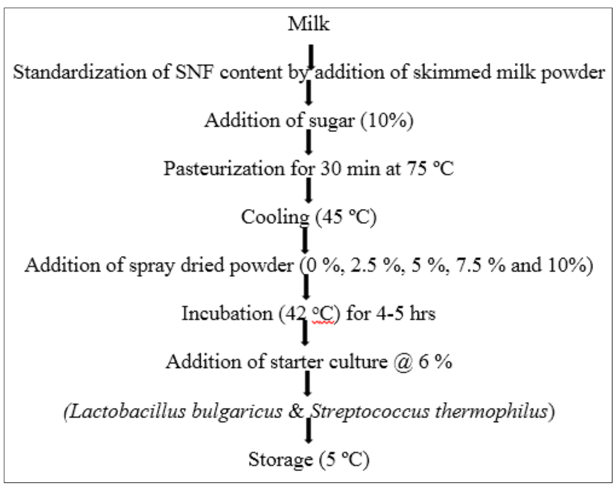

Fig 2: Flow chart for the preparation of yogurt

Table 1: Preparation of different variations of yogurt using encapsulated carrot coagulum powder

Ingredients (%)	Proportion#				
	YT_0	YT_1	YT_2	YT_3	YT_4
Starter culture	6	6	6	6	6
Skimmed milk powder	3.5	3.5	3.5	3.5	3.5
Sugar	10	10	10	10	10
Encapsulated carrot coagulum powder	0	2.5	5	7.5	10

\# YT_0- Control
YT_1- 2.5% carrot coagulum powder incorporated yogurt
YT_2- 5% carrot coagulum powder incorporated yogurt
YT_3- 7.5 % carrot coagulum powder incorporated yogurt
YT_4- 10% carrot coagulum powder incorporated yogurt

Sensory evaluation

Sensory evaluation of developed yogurt with and without ECCP addition was conducted based on appearance, colour, taste, flavour, consistency and overall acceptability to identify best proportion of ECCP incorporation. The panellists (n=21) were instructed to evaluate the above attributes of the various samples and to rate each attribute. A nine-point hedonic scale with 1 (dislike extremely), 2 (Dislike very much), 3 (Dislike moderately), 4 (Dislike slightly), 5 (neither like nor dislike), 6 (like slightly), 7 (like moderately), 8 (like very much) and 9 (like extremely) was used.

Physicochemical and microbiological analysis of yogurt incorporated with ECCP and without ECCP during storage

All the variations of yogurt were analysed for sensory characteristics and yogurt prepared with 5 % of encapsulated carrot coagulum powder was best accepted. Best accepted variation of yogurt along with a control without ECCP in glass bottles were kept at refrigeration temperature (5 ± 2˚C) for 20 days. Physicochemical parameters such as titratable acidity, pH, total solids, water holding capacity, total carotenoid content, total lactic acid bacterial counts, yeast, mould and *E. coli.* were analyzed on initial, 5th, 10th, 15th, 20th days of storage.

pH

The pH of the yogurt was measured using pH meter. The pH was measured by inserting the pH meter into the sample in a beaker for few minutes and reading was taken when the displayed value could be read.

Titratable acidity

Titratable acidity of samples was determined by titration method. To the known volume of sample, 2-3 drops of phenolphthalein indicator was added and titrated against 0.1 N sodium hydroxide (Ranganna, 1986) [30]. Titratable acidity was expressed as percent citric acid.

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value X N of alkali X Vol.made up X Eq.wt.of acid}}{\text{Vol.of sample taken for estimn.X Wt.or vol.of sample taken}}\ x\ 100$$

Total solids

Total solids of both the yogurt were measured following AOAC (2005) [1] method. In detail, samples were dried at 105°C until obtaining constant weight. The total solids content was determined by the multiplying the weight of residue by 100, dividing weight of sample take and expressed as percentage.

$$\text{Total solid (\%)} = \frac{Weight\ of\ residue}{weight\ of\ yogurt} \times 100$$

Water holding capacity

The water-holding capacity (WHC), reflecting the degree of syneresis, was also determined using the method developed by Ladjevardi *et al.* (2016) [25]. Yogurt (10g) were weighed into a test tube and then centrifuged in a laboratory centrifuge at 5 ºC for 30 min at 5000 rpm. After the indicated time, the precipitated whey was weighed. WHC was calculated based on the formula

$$\text{WHC (\%)} = (10 - W)/10 \times 100\%$$

Where
W—mass of the separated whey (g)

Estimation of total carotenoid content (TCC)

Total carotenoids of yogurt were analysed by the method described by Ranganna (1986) [30]. About 5 g of yogurt sample was mixed with 5 ml acetone. The mixture was shaken on vortex for 10 min. The filtrate was poured in separating funnel and 15 ml of petroleum ether was added and then washed repeatedly with distilled water to remove residual acetone. Lower aqueous phase was discarded. Filter paper (Whatman No. 1) covered with anhydrous sodium sulfate (10 g) was used to remove residual water. The extract volume was adjusted to 25 ml using petroleum ether containing 3% of acetone followed by absorbance estimation at 452 nm using spectrophotometer.

Microbial profile

The viable lactic acid bacteria count in yogurt was determined by cultivating on synthetic culture media. MRS agar was used for enumeration of Lactic acid bacteria according to Tharmaraji and Shah (2003) [35]. Plates were incubated under anaerobic condition at 37 °C for 72 hours. Colonies of lactic acid bacteria were counted and expressed as colony-forming units (CFU) per gram of yogurt. The viability was assessed on days 1, 5, 10, 15 and 20th day of storage.

Yeast, mould and coliform count were evaluated according to standard methods. Martins Rose Bengal Agar (MRBA) medium was used to evaluate yeast and mold count and plates of yeast and moulds were incubated for 3-5 days at 25 ºC (room temperature). Eosine Methylene Blue Agar (EMBA) medium was used to analyse coliform count and plates were incubated at 35 ºC for 24 hours (Tate, 1995) [40].

Statistical analysis

The experiments were carried out in triplicate and the data were analysed statistically using SPSS software (IBM, SPSS Statistics 22) and the means were separated using the Duncan's multiple range test. All the data were presented as means with the standard deviation.

Result and discussion

Development of yogurt incorporated with carrot coagulum powder

Yogurt is acidified, custard like semisolid dairy product produced by fermenting pasteurized milk with starter culture containing lactic acid producing bacteria (Roy *et al.,* 2005) [31]. The addition of fruits and vegetable, may increase the taste and further enhance the health benefits of yogurt. FAO and WHO recommend 5-15% of fresh fruit concentration to be used in making value-added yogurt (Farahat and El-Batawy, 2013) [12]. Yogurt was developed with the incorporation of 0, 2.5, 5, 7.5 and 10 % encapsulated carrot coagulum powder and incubated at 42±2 °C for 4-5 hours and then yogurt was stored at 5° C for 12 hours and analysed for sensory scores. Images of developed yogurt are shown in Fig. 4.

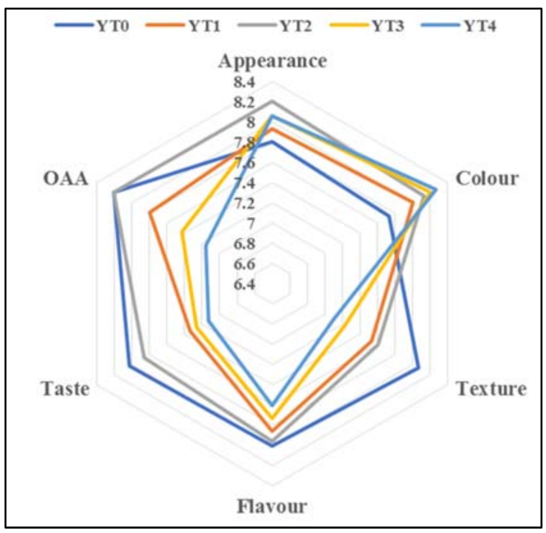

Fig 3: Mean sensory scores of developed yogurt with encapsulated carrot coagulum powder
YT_0- Control
YT_1- 2.5% carrot coagulum powder incorporated yogurt
YT_2- 5% carrot coagulum powder incorporated yogurt
YT_3- 7.5 % carrot coagulum powder incorporated yogurt
YT_4- 10% carrot coagulum powder incorporated yogurt

Fig 4: Development of yogurt incorporated with encapsulated carrot coagulum powder

Evaluation of sensory characteristics of developed yogurt

Sensory evaluation of yogurt is an important tool in determining its acceptance. The Table 2 and Fig. 3 shows the respective mean sensory values for control (yogurt) and yogurts incorporated with ECCP.

The use of ECCP led to creating an attractive orange color in the product. The color of yogurt was significantly influenced by the higher percentage of ECCP. As the incorporation percentage of powder increased, scores for colour also increased significantly. Taste, flavor, and texture of yogurt scored less at a higher level of incorporation of powder, though, it was not statistically significant. On comparing the overall acceptability score for different levels of carrot powder a significant difference was observed between the mean values of all yogurts. From the Table 2, it is concluded that among all the variations, 5% inclusion of carrot powder to the yogurt was considered as ideal based on overall acceptability score (8.20) which was similar to control yogurt (8.20). Desai *et al.* (1994) [8] also observed the addition of fruit juice improved the color and texture score of Dahi.

Effect of storage on developed yogurt

Yogurt enriched with 5 % of ECCP along with control without ECCP were assessed for their shelf life and storage stability based on physicochemical (pH, acidity, total solids, water holding capacity and TCC) and microbial parameters (total lactic acid bacterial count, yeast, mould and coliform count). Results are presented in Table 3.

Table 2: Mean sensory scores of developed yogurts with encapsulated carrot coagulum powder

Variation#	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
YT0	7.80	7.73	8.06	8.00	8.03	**8.20**
YT1	7.93	8.10	7.53	7.86	7.33	7.80
YT2	8.20	8.23	7.60	7.96	7.86	**8.20**
YT3	8.06	8.30	7.23	7.73	7.26	7.43
YT4	8.06	8.36	7.10	7.60	7.13	7.16
F value	NS	*	NS	NS	NS	*
SEm±	0.276	0.291	0.334	0.284	0.370	0.263
CD@5%	0.551	0.581	0.666	0.568	0.738	0.525

*Significant at 5%

YT_0- Control

YT_1- 2.5% carrot coagulum powder incorporated yogurt

YT_2- 5% carrot coagulum powder incorporated yogurt

YT_3- 7.5 % carrot coagulum powder incorporated yogurt

YT_4- 10% carrot coagulum powder incorporated yogurt

Table 3: Physico-chemical parameters of developed yogurt during storage

Parameters	Duration	YT_0	YT_2
Titratable acidity (%)	Initial day	0.95±0.00^a	0.89±0.00^e
	5th day	1.03±0.01^d	0.91±0.00^d
	10th day	1.10±0.00^c	0.95±0.00^c
	15th day	1.16±0.10^b	0.98±0.00^b
	20th day	1.22±0.10^a	1.01±0.00^a
	Mean	1.09±0.99	0.95±0.04
	F value	*	*
	SEm±	0.04	0.023
	CD@5%	0.018	0.01
pH	Initial day	4.36±0.01^e	4.56±0.25^e
	5th day	4.31±0.00^d	4.48±0.01^d
	10th day	4.27±0.00^c	4.37±0.15^c
	15th day	4.21±0.01^b	4.33±0.15^b
	20th day	4.16±0.01^a	4.27±0.15^a
	Mean	4.2±0.07	4.40±0.10
	F value	*	*
	SEm±	0.03	0.053
	CD@5%	0.01	0.03
Total solids (%)	Initial day	21.58±0.133^a	24.54±0.06
	5th day	20.75±0.11^b	24.05±0.14
	10th day	19.90±0.06^c	24.02±0.81
	15th day	19.6±0.12^d	23.96±1.04
	20th day	19.61±0.03^d	23.06±0.20
	Mean	20.29±0.80	23.93±0.71
	F value	*	**NS**
	SEm±	0.40	0.35
	CD@5%	0.186	-
Water Holding capacity (%)	Initial day	95.01±0.00^a	91.93±0.05^e
	5th day	94.13±0.28^b	90.87±0.02^d
	10th day	93.53±0.17^b	90.85±0.04^c
	15th day	92.60±0.05^c	89.60±0.56^b
	20th day	91.95±0.01^d	88.65±0.10^a
	Mean	93.44±1.12	90.38±1.19
	F value	*	*
	SEm±	0.56	0.59
	CD@5%	0.276	0.467

*Significant at 5%

*Mean± standard deviation

*Values with different superscripts differ significantly

YT_0- Control yogurt

YT_2- Yogurt incorporated with 5% of ECCP

Effect of storage on titratable acidity and pH of yogurt

Data on changes in pH and titratable acidity is shown in Table 3. In the present study, pH of control yogurt and incorporated yogurt with ECCP decreased during the 20 days of storage. Lactic acid bacteria produce lactic acid during fermentation of milk lactose, thus lowering the pH during refrigerated storage of yogurt. pH measurement is considered a sensitive tool in monitoring acidity (Salwa *et al.,* 2004) [33]. The pH of the control and ECCP incorporated yogurt ranged from 4.36 to 4.16 and 4.56 to 4.27 respectively. Initially pH values of control yogurt was lower than incorporated yogurt. According to Lee and Hwang (2006) [27] the range of optimum pH of thick fermented milk available into the market is 3.27–4.59. In this study, yogurt samples stored for 20 days showed a pH within this range, indicating no difference in quality compared to fermented milk available in the market. Probiotic lactobacillus bacteria grow optimally under anaerobic conditions between 37-41 ºC. However, these bacteria may be active even at refrigerated temperature resulting in noticeable pH decrease during storage. Decrease in the pH results in accumulation of acetic acid, acetaldehyde, formic acid and lactic acid (Shah, 2007) [35]. Sokolinska *et al.* (2004) [37] reported that the pH values decreased from 4.34 to 4.11 during the 21day storage period.

Titratable acidity of control and yogurt with ECCP incorporation, increased significantly from initial day to 20th day of storage. Rise in titratable acidity was from 0.95% to 1.09% in control and 0.89% to 1.01 in ECCP incorporated yogurt and this corresponded with the increase in pH level of yogurt samples. Similar observation was reported by Cho *et al.* (2020) [5]. Kroger (1976) [24] reported that in probiotic yogurt the *Lactobacilli* will grow continuously in between pH 4.0 and 4.4, since they are also capable of producing acid, so ultimately the acidity of probiotic yogurt tends to increase as pH decreased during storage.

Effect of storage on total solids (%) and water holding capacity (%) of yogurt

The values for total solids and water holding capacity of yogurt through the storage period stored at 4°C for 20 days are shown in Table 3. The total solids at the beginning of storage was 21.58 % and 24.54 % in control and incorporated yogurt respectively. Increase in total solids in incorporated yogurt is due to addition of 5% of encapsulated powder. At the end of storage period total solids significantly decreased in the case of control but not in ECCP incorporated yogurt.

Water holding capacity of both types of yogurts decreased significantly throughout the 20 days of storage. Water holding capacity is directly affected by acidity. Acidification of product reduces the net negative electric charge of casein micelles by steadily dissolving calcium and inorganic phosphate, which reduces colloid stability and further decrease the water holding capacity (Fox *et al.,* 2000) [14]. Similar finding was reported by Cho *et al.* (2020) [5].

Effect of storage on total carotenoid content

In the present study. total carotenoid content was analysed for yogurt incorporated with ECCP. Carotenoids were gradually decreased in ECCP incorporated yogurt throughout the storage period as shown in Table 4. Carotenoids content in yogurt decreased during the subsequent storage period in comparison to initial content. Total carotenoid content in yogurt incorporated with ECCP was 0.83, 0.77, 0.74, 0.53 and 0.56 mg/100g on initial, 5th, 10th, 15th and 20th day of refrigerated storage. There was a decline in the carotenoids of yogurt which is due to its degradation during storage. Similar finding was reported by Gad *et al.* (2015) [15] who reported that, there was gradual decrease in carotenoids along the 12 days of cold storage in the yogurt fortified with carrot juice. Scibisz *et al.* (2009) [34] reported loss of pigment, anthocyanin content in yogurts during storage, especially for the first 2 weeks. The losses of anthocyanins compared to the freshly produced yogurt were about 11–43% after 2 weeks and 19–63% after 8 weeks of storage.

Table 4: Total carotenoid content of yogurt incorporated with encapsulated carrot coagulum powder during storage

Duration	Total Carotenoids (mg/100g)
Initial day	0.83±0.01^a
5th day	0.77±0.01^b
10th day	0.74±0.01^b
15th day	0.53±0.02^c
20th day	0.36±0.02^d
Mean	0.63±0.17
F value	*
SEm±	0.077
CD@5%	0.042

*Significant at 5%
*Mean± standard deviation
*Values with different superscripts differ significantly

Effect of storage on the microbial population of yogurt

The results of the viability of control and incorporated yogurt during refrigerated storage are shown in Table 5. The total lactic acid bacterial counts of yogurt were 99.83 CFU/ml and 97.33 CFU/ml in control and ECCP added yogurt on the first day of storage. There was a significant progressive decrease in the total lactic acid bacterial counts 97.16 CFU/ml and 94.5 CFU/ml in control and yogurt with added ECCP during storage. The loss of viability of probiotic cultures may be related to the decrease in pH during storage, due to the accumulation of organic acids in yogurt. Both the types of yogurts, however, contained the recommended levels of (10^6–10^7 CFU/ml) probiotic bacteria at the end of 20 day of refrigerated shelf life (Donkor *et al.,* 2006) [9]. Kailasapathy *et al.* (2008) [21] observed effects of commercial fruit addition on viability of probiotic yogurt. They reported the yogurts incorporated with 5 or 10 g/100 g fruit preparation did not exhibit a greater loss in the viability of probiotic bacteria compared to plain yogurt during the storage period.

Yeast and mould count indicate contamination with these organisms (Kroger, 1976) [24]. At the time of storage, the yeast and mould population were not detected but further increased to 0.013 CFU/ml in control and ECCP incorporated yogurt on 90th day. Yeast and mould count can also come from the environment where a proper air control system is not in place. Salji *et al.* (1987) [32] found that the initial count of yeast and mould 1 CFU/ml increased to 3×10^3 CFU/ml at 10 days of storage.

Both the test yogurts were subjected to a coliform test and it was found to be negative. This indicated that the product was prepared in hygienic condition and thus free from gas-producing organisms. The similar result was observed by Damunupola *et al.* (2014) [6] while developing plain and beetroot incorporated goat milk yogurt.

Table 5: Microbial load of yogurt with encapsulated carrot coagulum powder during storage

Products	Duration	YT_0	YT_2
Total lactic acid bacterial count ($\times 10^7$ CFU/ ml)	0th day	99.83	97.33
	5th day	98.73	96.0
	10th day	98.16	95.83
	15th day	97.40	95.50
	20th day	97.16	94.50
	F value	*	*
	SEm±	0.458	0.642
	CD@5%	0.504	0.968
Moulds ($\times 10^3$ CFU/ ml)	0th day	ND	ND
	5th day	0.003	0.004
	10th day	0.007	0.007
	15th day	0.011	0.011
	20th day	0.013	0.013
	F value	*	*
	SEm±	2.373	2.23
	CD@5%	0.939	1.522
Coliforms ($\times 10^3$ CFU/ ml)	Not detected		

Conclusion

The findings confirm that the addition of ECCP at 5% concentration, improved the color, taste and overall acceptability of yogurt. Further, ECCP incorporation did not change the titratable acidity, pH, water holding capacity and microbial count significantly compared to control yogurt during storage. Importantly, incorporation of ECCP improved total carotenoid content in the yogurt with ECCP incorporation. Therefore, incorporation of ECCP can be suggested as a promising method to enhance the consumer preference towards yogurts without affecting the characteristics physicochemical and microbial qualities of plain yogurt.

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