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RESEARCH ARTICLE

Feasibility assessment of sensorial accepted novel dairy based dip during storage

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Abstract: In recent era, the inclination of people towards convenient food products has increased due to health consciousness and growing urbanization as well as rapid change in social and cultural practices. The preparation of sauce or dip like products with some diversification and enhanced nutritional as well as functional value have become an area of research. Therefore, an attempt was made to develop a novel dairy-based dip like product from heat-acid induced milk gel and whey. Based on the sensory analysis during preliminary trails, level of cream (40% milk fat), whey, common salt, glycerol monostearate, trisodium citrate and sodium hexametaphosphate were optimised. A good quality of dairy based dip could be prepared using heat-acid induced milk gel from bovine skim milk, cream (40% fat), whey, common salt, trisodium citrate, sodium hexametaphosphate and glycerol monostearate @ 52.67%, 14.70%, 31.73%, 0.42%, 0.16%, 0.16% and 0.16%, respectively. The developed product was stored at refrigeration temperature (4±1 ºC) in PET bottles. It was stable up to 11 days in in the aspect of physico-chemical, sensorial and microbiological point of view. For the first time, a novel dairy based dip was formulated in a stable form using direct application dairy byproducts (whey and skim milk).

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Introduction

Numerous studies have been focused nowadays to design new food products that can provide better health, eating habit and nutrition. It can also provide positive impact on human health. Changes in food formulation, food service procedures, and eating customs have resulted from this. Currently, a lot of work is being done on dietary solutions to meet the increasing demands of the ageing population. Food design must therefore include the needs of contemporary populations, especially ageing populations, taking into account convenience, enjoyment, health and nutrition (Sun-Waterhouse et al. 2021). Heat-acid induced milk gel (also known as *Chhana* in India) offers enormous scope in the development of new dairy products due to its immense popularity and nutritive value among all age groups people. Several works have been done to develop spread like products from heat-acid induced milk gel (Dixit, 2006; Chappalwar et al. 2010; Kumar et al. 2016) to cope up with the demand for both low fat but nutritious and diversified foods with ethnic flavour. However, no reference is available in the literature on the development of sauce or dip like product from heat-acid induced milk gel.

Dip has a thinner consistency than spread but thicker than sauce. It is served in separate container in cold condition, while sauce can be served both in warm or cold conditions (IFIS, 2009). Additionally, the market for cheese sauces and similar product was US$ 1438.39 million in 2020 and same is expected to grow up to US$ 2218.38 by 2030 with a CAGR of 4.5 % as reported by Prophecy Market insights (2023). Demott *et al.* (1977) developed chip dip (solid content 13.07-13.30%) from cottage cheese whey by adding xanthan gum at the rate of 1.2 - 1.4% followed by slow blending and was stored 4°C. Saad *et al.* (2016) developed a processed cheese sauce (25% dry matter and 40% fat on dry matter basis) from ras cheese by blending it with milk protein, butter fat, nisin, stabilizer (admixture of guar gum and corn starch), NaCl, and emulsifying salt. The effect of milk protein from different sources such as milk protein concentrate, total milk proteinate, UF-retentate curd, skim milk powder and soy protein concentrate were evaluated. The final products were found acceptable in terms of sensorial properties and shelf life but the most acceptable was the product made using UF-retentate curd. Shalaby *et al.* (2017) developed plain processed cheese sauce by admixing whey protein concentrate and acid casein curd. The effect of essential oils was evaluated from different sources such as turnip, shallots, capsicum and cardamom on the sensorial quality of the cheese sauce with an aim of providing improved flavour to the product. Dixit (2006) reported the manufacturing process of heat-acid induced milk gel spread by blending with salt, whey and preservatives, packaged, and stored at 5±1°C. Gamay *et al.* (2011) observed that whey protein contribute mouthfeel as well as texture of cheese sauce, while the viscosity and texture of were largely influenced by the presence of gum like stabilizers such as sodium alginate, guar gum, xanthan gum. Flavour and texture profile of the product was provided by phosphate salt and common salt. Hine (1994) observed that desired quality cheese sauce can be obtained by using either natural or unmodified food-grade starch (e.g. rice starch, tapioca starch and potato starch) as ingredient. Spanier (1986) suggested to use either maltodextrin or corn syrup solids as filler material for improving the texture of cheese sauce. Bansal et al. (2017) prepared a cheese dip using 8.82% protein blend (whey protein concentrate-70:sodium caseinate = 80:20), 6% Cheddar cheese and 9.72% cream. During preparation of cheese dip, trisodium citrate, carboxy methyl cellulose and glycerol monostearate were used. Bansal et al. (2021) also evaluated the storage (4±1 ºC) induced changes in developed product with and without spices in PET bottles for 30 days. This study revealed that blending of spices prevented the deterioration in terms of sensorial, physico-chemical and microbiological aspect. Furthermore, inter-relationship of food quality and its storage stability plays a vital role for the introduction of new products. In order to estimate the shelf life of food product, package material choice, and storage conditions necessary to preserve the quality of food products, it is strategically important to investigate changes in the sensory, physico-chemical, textural, and microbiological characteristics of foods. A suitable shelf life also confirms that consumers can obtain high-quality food (Bansal et al. 2021).

In view of the opportunity of bringing diversification in food products through the use of heat-acid induced milk gel and to cater to the need of health-conscious consumers, an attempt was made to develop a dip like product. Production of such dairy based dip with lower fat content using heat-acid induced milk gel from skim milk and whey will not only meet the demand of health-conscious consumers, but also improve the scale of economy in dairy sector through the utilization of surplus skim milk and whey and help in product diversification. Till date, not a single research study reported that advocate the development and estimation of storage stability of heat and acid coagulated gel-based dip. The utilization of dairy by products i.e., whey and skim milk were also focused in this study. So that, a feasibility assessment was done in this current study using dairy based dip for the first time.

Materials and Methods

Materials

Fresh cow milk was acquired from the farm of West Bengal University of Animal and Fishery Sciences (Mohanpur Campus, West Bengal, India). Skim milk and cream were separated using a centrifugal cream separator. The fat percentage in skim milk and cream was standardized at 0.5 and 40%, respectively. Whey obtained during cow skim milk heat-acid induced milk gel preparation, was pasteurized to 72°C for 15 s and cooled to room temperature. Glycerol monostearate (GMS) was procured from Tripathi Products Pvt. Ltd., New Delhi. Common salt was procured from Tata chemicals Ltd., Mumbai. Food grade citric acid and trisodium citrate (TSC) were procured from Urban Platter, New Delhi. Sodium hexametaphosphate (SHMP) was obtained from Choice Organochem LLP, Hyderabad.

Preparation of heat-acid induced milk gel

The method for heat-acid induced milk gel preparation as suggested by Kumar et al. (2016) was followed with some modification. The cow milk after receiving was filtered, separated and standardized to 0.5% fat and 8.5% SNF. The standardized skim milk was heated to 90°C followed by immediate cooling to coagulation temperature 65°C. The coagulation was done with citric acid solution of 2% strength till a clear whey separation. Finally, whey was drained out using a muslin cloth and rest part was hung for 30 min to obtain the heat-acid coagulum i.e., heat-acid induced milk gel.

Preparation of dairy based dip

Dairy based dip was prepared using heat-acid induced milk gel from cow skim milk and whey (Figure 1). Here, level of pasteurized whey, sodium hexametaphosphate, tri-sodium citrate and common salt of the total of heat-acid coagulated gel was optimised on the basis of sensory analysis during preliminary trails. Similarly, pasteurized cream (40% fat) and salt level were also optimised. The optimised level of pasteurized whey, sodium hexametaphosphate, tri-sodium citrate and common salt were 60.26%, 0.3%, 0.3% and 0.8% on total weight of heat-acid induced milk gel and they were blended with heat-acid induced milk gel thoroughly with a domestic hand blender (Philips Hand Mixer Model: HR3705, equipped with two kneading hooks) at speed control level 5 (1200 rpm), respectively. After that, pasteurized cream (40% fat) and glycerol monostearate were also added into that homogeneous slurry at the level of 27.92% and 0.3% on the basis of total weight of heat-acid induced milk gel. The entire mixture was blended to obtain a product with homogeneous consistency. The product was heat treated for 5 min at 65 °C. It was then cooled to room temperature. After that, the dairy based dip was filled in a PET bottle and stored under refrigeration (4±1 ºC) for further analysis.

Physico-chemical analysis

The moisture, fat, protein, lactose, salt, and ash of the optimized product were estimated using AOAC (2005). Acidity of dairy based dip was estimated using the standard method of IS: SP (1981). Adopting the described method by Juffs (1973), tyrosine value for the dairy based dip estimated. While, 2-thiobarbituric acid (TBA) value was measured as the standard method described by Tarladgis et al. (1960). Similarly, free fatty acid of the optimised product was estimated using Deeth et al. (1975). The pH of the optimised product during entire storage period was recorded using a pre-calibrated pH meter at 25 ± 1 ºC.

Sensory analysis

The sensory evaluation conducted in this study received ethical approval and participant consent, adhering to the ethical standards of both the institutional and national research committees. This process also complied with the principles outlined in the 1964 Helsinki declaration and its subsequent amendments or equivalent ethical guidelines. A panel of 7 trained judges (they have prior experience in sensorial analysis of milk and milk products and trained for 6 h before the sensory analysis of dairy based dip) from the Faculty of Dairy Technology, West Bengal University of Animal and Fishery Sciences (Mohanpur Campus, West Bengal, India) evaluated dairy based dip samples for sensory characteristics through 9-point hedonic scale. Flavour, body and texture, colour and appearance (CA) and overall acceptability (OA) are the sensory attributes of dairy based dip sample. Panel members carried out sensory evaluation in individual booths where 50 g of sample in a glass container was given to the judges at 20ºC. Ethical consent was obtained from all trained panellist of this study.

Microbiological analysis

Standard plate count (SPC), coliform and yeast and mold (YM) count were conducted as per the standard method outlined by Bansal et al. (2021). Here, obtained results were represented in total number of colonies in each gram of sample. Required agars were obtained from HiMedia Laboratories Pvt. Ltd. (Maharashtra, India).

Statistical analysis

Obtained results were analysed using one-way analysis of variance (ANOVA) in IBM SPSS program (version 25) with α=0.05 and Tukey HSD was used as a post hoc test for comparison the means. While, descriptive statistics was used to analyse chemical composition of dairy based dip.

Results and Discussion

Chemical composition of dairy based dip

The optimized product contained 72.59 ± 0.26% moisture, 8.34 ± 0.05% fat, 12.20 ± 0.08% protein, 0.71 ± 0.01% salt, 5.98 ± 0.38% lactose and 0.11 ± 0.002% ash, respectively. The optimised product

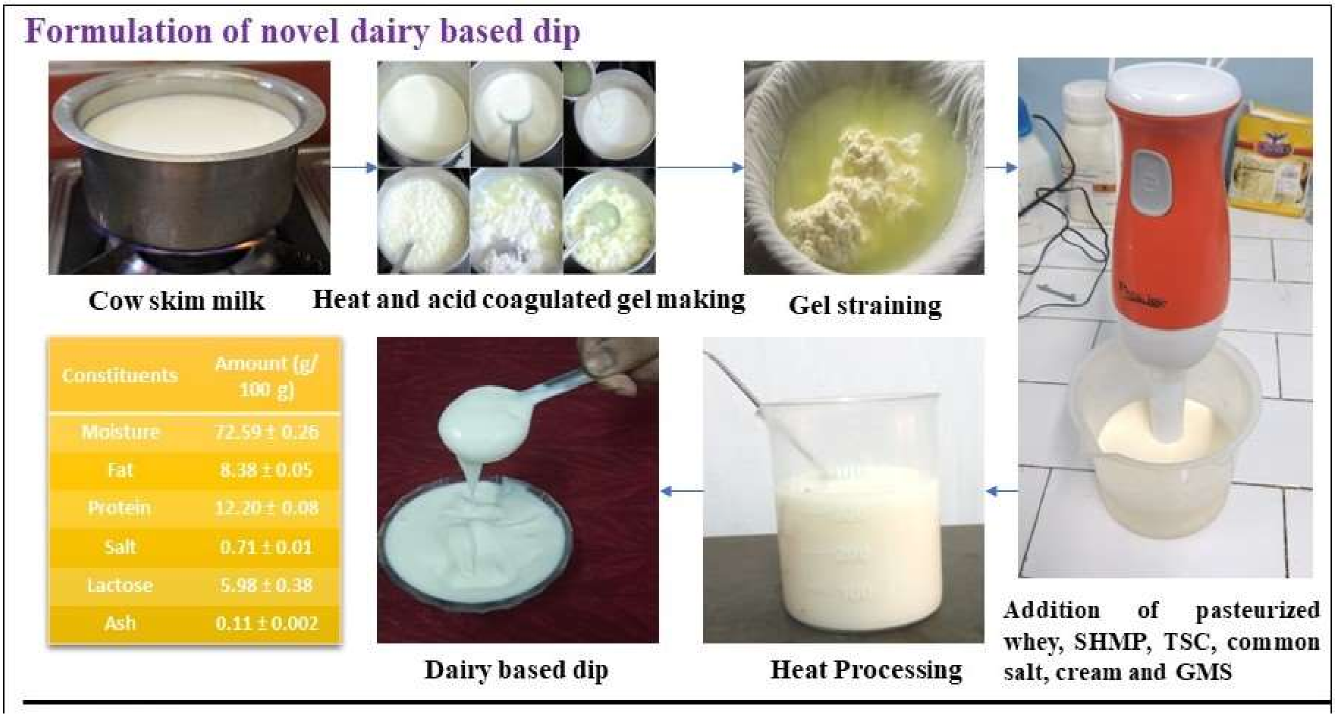


Fig. 1 Process flow diagram for novel dairy based dip and graphical representation of current study

contained lower moisture, fat, salt and ash content over cheese dip (76.21%, 11.60%, 1.06% and 2.54%, Bansal et al. 2017). While higher protein and lactose content was observed in dairy based dip than cheese dip (8.12 and 0.46%, Bansal et al. 2017).

Physico-chemical changes in dairy based dip during storage at 4±1°C

The moisture content of dairy based dip sample decreased from 72.57% at 1st day to 72.47% at 11th day of storage. The difference between the moisture content of the product at 1st and 11th day of storage was significant ($p<0.05$) (Figure 2a.). The increase in total solids content in paneer spread with progression of storage was observed by Dwivedi et al. (2014). The result was in accordance with the present result. Moreover, decline of moisture content of the product with the progression of storage was attributed due to the free water evaporation in the product (Bansal et al. 2021). Similar trend was observed with earlier work (Rafiq and Ghosh, 2018; Bansal et al. 2021).

The acidity of dairy based dip increased from 0.426% lactic acid at 1st day to 0.580% lactic acid at 11th day of storage. The acidity of dairy based dip sample from 1st day to 3rd day increased significantly ($p<0.05$) but with progression of storage, the acidity from 3rd day to 11th day increased non-significantly ($p>0.05$) (Figure 2b.). The increase in titratable acidity in dairy based dip was probably due to the growth of lactic acid producing bacteria, resulted in lactic acid production. The present result is in accordance with the result was obtained during storage study of paneer spread by Dwivedi et al. (2014). The increase in acidity in paneer spread during storage was observed.

The pH value of dairy based dip decreased from 6.30 at 1st day to 6.10 at 11th day of storage. The pH of the product decreased non-significantly ($p>0.05$) with progression of storage (Figure 2c) The increase in lactic acid content and free fatty content during storage might be the reason of lowering pH in all samples. Saad *et al*. (2015) also observed the lowering of pH with progression of storage day in processed cheese sauce. It was proposed that hydrolysis of lactose, activity of resistant enzymes present in sauces, presence of polymerized phosphate of emulsifying salts and their interaction with proteins was responsible for pH reduction (Saad et al. 2015).

The tyrosine value of dairy based dip increased from 0.217 mg/100 mL at 1st day to 0.881 mg/100 mL at 11th day of storage. The tyrosine value of sample increased significantly ($p<0.05$) at the middle of the storage period (Figure 2d.). The proteolysis

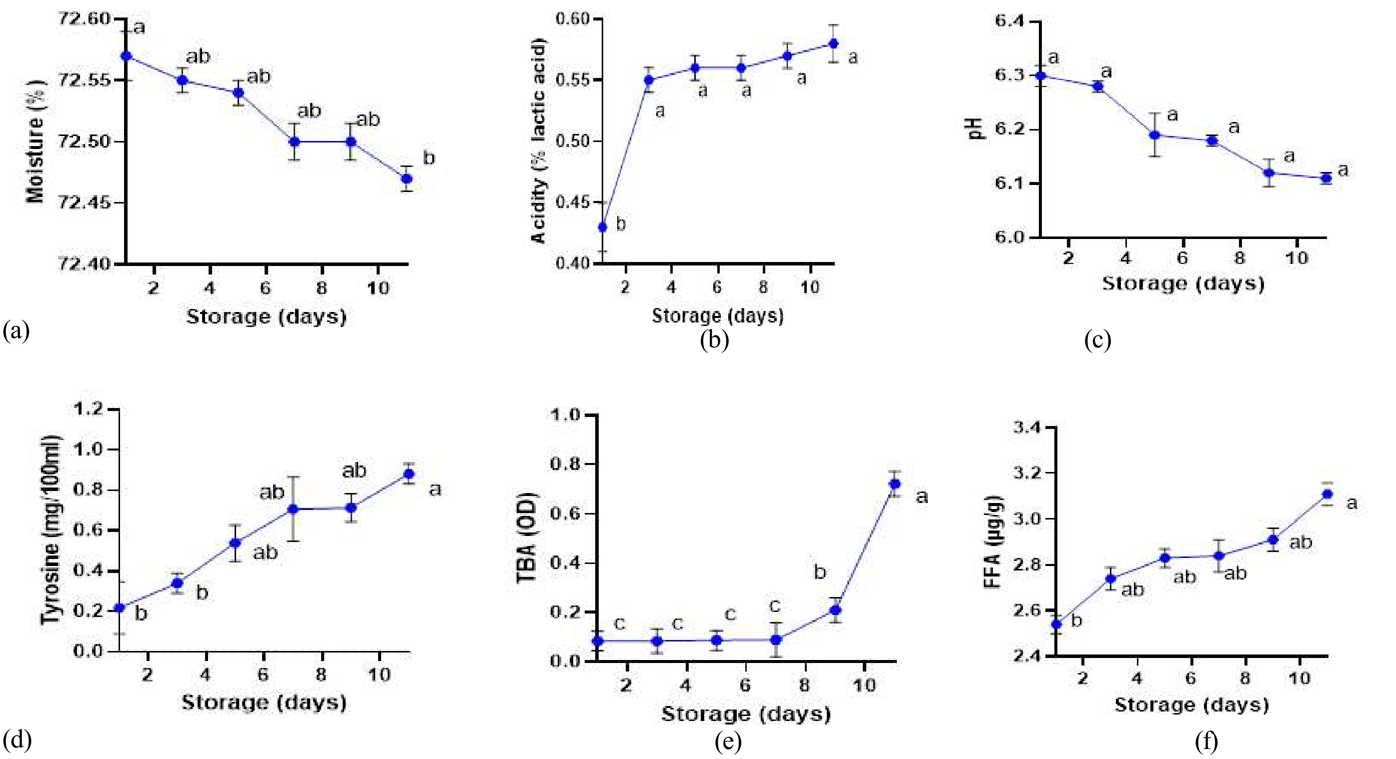
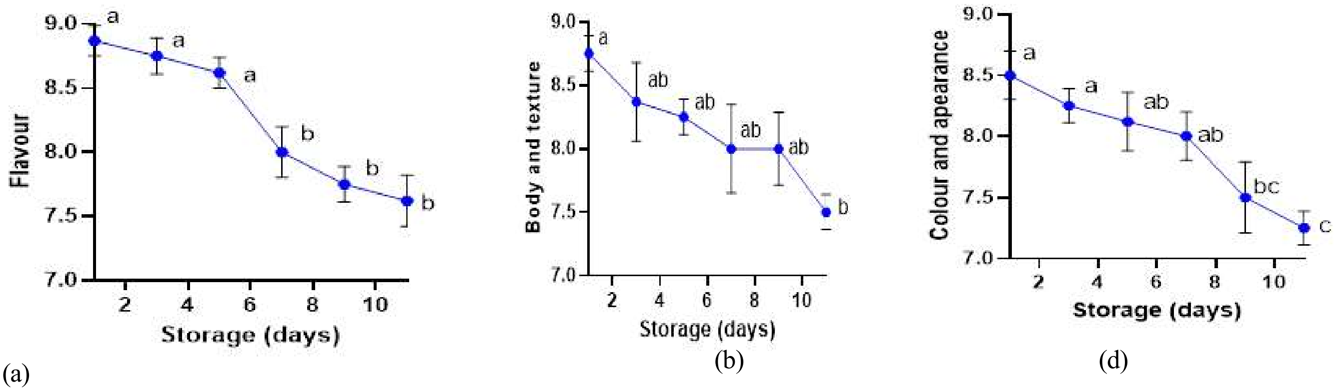


Fig. 2 Physico-chemical changes in dairy based dip during storage at 4±1°C. (a) Moisture (%), (b) Acidity (% lactic acid), (c) pH, (d) Tyrosine value (mg/ 100 g), (e) TBA value (OD), (f) FFA (µg/g). Values are the mean of the three replicates (n=3) with SD (standard deviation). a, b, c: Different superscripts lowercase letters denote significant ($p<0.05$) differences between the storage days within the same sample



occurred either due to protein oxidation or due to proteases enzymes present either in sample or produced by proteolytic bacteria. Dalsgaard et al. (2010) observed light induced oxidation of protein in cheese. The lipid radicals, when interacted with protein resulted in higher level of tyrosine generation within the cheese (Dalsgaard et al. 2010). The increase of tyrosine value with extension of storage in processed cheese was observed by Rafiq and Ghosh (2018). They proposed that tyrosine value increased due to the breakdown of protein by the action of protease enzymes which are released during the lysis of microbial cells.

The TBA value measures the degree of oxidation. The TBA value of dairy based dip increased from 0.084 OD at 1st day to 0.722 OD at 11th day of storage. The TBA of the product increased significantly ($p>0.05$) at later stage of storage (Figure 2e). Oxygen in the packed product headspace and oxygen diffusing through the PET bottles may be the cause of the TBA value increase during storage. Earlier research works related to milk fat also advocated the increment of lipid oxidation during progression of storage (Olmedo et al. 2013; Smet et al. 2008; Pettersen et al. 2005). Bansal et al. (2021) also reported that TBA value of cheese dip increased during storage. So that, significant ($p<0.05$) increase in TBA value of dairy based dip could be attributed due to the oxidation of milk fat.

One of the primary chemical processes that reduces shelf life and deteriorates food quality in storage is lipolysis. The extent of lipid lipolysis can be measured by FFA content. The FFA value of dairy based dip increased from 2.54µg/g at 1st day to 3.113 µg/g at 11th day of storage. The FFA value of the product increased significantly ($p<0.05$) with progression of storage (Figure 2f.). The FFA content of the processed cheese also increased with progression of storage (Rafiq and Ghosh, 2018). Bansal et al. (2021) reported that yeast and mould proliferation significantly ($p<0.05$) increased FFA content in the final product and the same was attributed in cheese dip. So that, increase in yeast and mould count of dairy based dip could be attributed the increase of FFA throughout the storage period.

Sensorial changes in dairy based dip during storage at 4±1°C

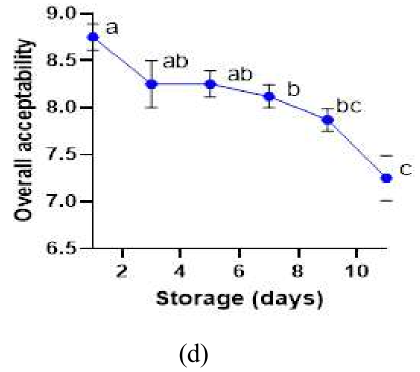


Fig. 3 Sensorial changes in dairy based dip samples during storage at 4±1°C. (a) Flavour, (b) Body and texture, (c) Colour and appearance, (d) Overall acceptability. Values are the mean of the three replicates (n=3) with SD (standard deviation). a, b, c: Different superscripts lowercase letters denote significant ($p<0.05$) differences between the storage days within the same sample

The flavour score of dairy based dip decreased from 8.87 at 1st day to 7.62 at 11th day of storage. The flavour score of the product decreased significantly ($p<0.05$) with progression of storage (Figure 3a). The higher lactic acid concentration, proteolysis, production of free fatty acids through lipolysis as well as oxidation of fat affected the flavour of dairy based dip adversely. The body and texture score of dairy based dip decreased from 8.75 at 1st day to 7.50 at 11th day of storage. The body and texture score of the product decreased significantly ($p<0.05$) with progression of storage (Figure 3b). The decrease in moisture content, the occurrence of lipolysis, lipid and protein oxidation, protein degradation might affect the body and texture of dairy based dip during storage. The CA score of dairy based dip decreased from 8.50 at 1st day to 7.21 at 11th day of storage. The CA score of the product decreased significantly ($p<0.05$) with progression of storage (Figure 3c). The OA score of dairy based dip decreased from 8.75 at 1st day to 7.37 at 11th day of storage. The OA score of the product decreased significantly ($p<0.05$) with progression of storage (Figure 3d.). The deterioration of sensorial quality of processed cheese with progression of storage also was observed

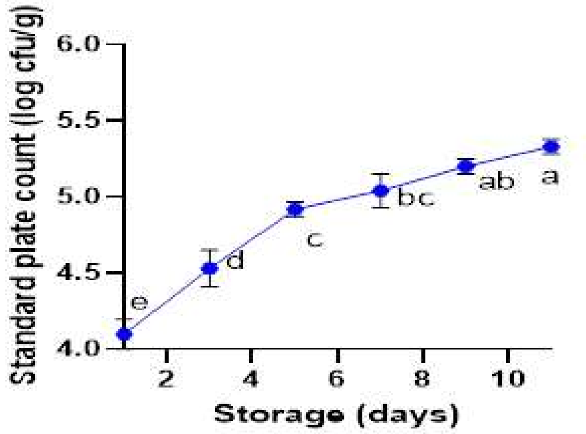


Fig. 4 Standard plate count changes in dairy based dip samples during storage at 4±1°C. Values are the mean of the three replicates (n=3) with SD (standard deviation). a, b, c, d, e: Different superscripts lowercase letters denote significant ($p<0.05$) differences between the storage days within the same sample

by Saad et al. (2015) in processed cheese sauce and Desouky et al. (2019) in camel milk powder incorporated cheese sauce.

Microbiological changes in dairy based dip during storage at 4±1°C

The standard plate count (SPC) of dairy based dip sample increased from 4.10 log cfu/g at 1st day to 5.33 log cfu/g at 11th day of storage. The SPC of the product increased significantly ($p<0.05$) with progression of storage (Figure 4). The result was in agreement with the previous study reported by Smigic et al. (2018), where authors found an increase in aerobic count of processed cheese with progression of storage period. Similarly, Bansal et al. (2021) also reported an increase in SPC count in cheese dip. Change in quality parameters could be affected by the growth of microorganisms.

The presence of yeast and mold, and coliform in dairy based dip was not detected with progression of storage of 11 day. The result indicated the good quality of the product. Bansal et al. (2021) reported that cheese dip had no coliform and yeast and mold at 1st day of storage, Although, presence of yeast and mould was detected during 10th day of storage and same was increased gradually. This work clearly indicates the good hygienic practice during formulation of dairy based dip.

Conclusions

A good quality of dairy based dip was formulated using heat-acid induced milk gel from cow skim milk, cream (40% fat), whey, common salt, trisodium citrate, sodium hexametaphosphate and glycerol monostearate @ 52.67%, 14.70%, 31.73%, 0.42%, 0.16%, 0.16% and 0.16%, respectively. Current study showed the stability of dairy based dip at refrigeration temperature in the aspect of physico-chemical, sensorial and microbiological point of view. The product showed a promising market potentiality as consumers are ready to pay for nutritious, healthy and diversified food product. In a nutshell, direct utilization of dairy byproducts (whey and skim milk) to formulate a dairy based novel product was done for the first time. The product showed a promising market potentiality as consumers are ready to pay for nutritious, healthy and diversified food product.

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Conflict of interest

There was no conflict of interest for this article.

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