Production of spread cheese by incorporating micro-encapsulated pepper oil with corn oil

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Abstract. The incorporation of functional ingredients in cheese is a new technology application in the food industry. Black pepper oil and corn oil were purchased from commercial stores and micro-encapsulated with the 0:0 g, 15:0 g, 0:15 g, 7.5:7.5 g named as T1 to T4 respectively and added into the cheese while maintaining the standard process. Prepared samples were put into 175 ml glass bottles and kept for sensory, chemical, and microbiological analyses at room temperature and then chilled. The sensory attributes were examined using the hedonic test. The exception of taste, no significant differences in qualitative attributes was identified in all samples. To assess the shelf life of the product designed for marketability, measurements were made on a regular basis for microbiological characteristics such as total plate count, yeast and molds, and coliforms, as well as chemical data such as pH, moisture content, and titratable acidity. The micro-encapsulated products showed a minimum change in the sensory and chemical attributes therefore, it can be concluded that the microencapsulation technology is useful to produce a better spread cheese.

1 Introduction

Milk includes at least 8.25% milk solids and 3.25 percent milk fat. Microorganisms may easily develop in raw milk due to its high nutritional content. Milk is preserved in a variety of ways to improve storage quality and produce more desirable forms of milk products such as sterilized or pasteurized fluid milk, flavored milk, butter, cheese, ice cream, yoghurt, curd, spray dried milk powder, and concentrated milk products, and condensed milk among others [1-3]. Cheese production is an ancient method of preserving food which the removal of whey is the technology and the maturing process is the step during manufacturing cheese.

Other than that, the objective for transforming milk into cheese is to extend the shelf life of the milk ingredient. It also raises the value of the finished product. In general, more water is released during the production of cheese, which increases the shelf life of the finished product [4]. Processed cheese is a product made by heating natural cheese and blending it with appropriate emulsifiers. Processed cheese manufacture is currently

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encouraged since it is more pleasant and has a distinct flavor. Cheddar, Swiss, and Mozzarella cheese are the most common forms of natural cheese used in processed cheese manufacturing across the world. Varieties of processed cheese are manufactured by using natural cheese as a raw material, which typically has distinct smells and levels of the maturity of cheese. Processed cheese comes in two varieties: cheese spreads, which are soft, low in acidity, high in moisture content, and flavorable, and cheese blocks, which are solid, high in acidity, and relatively low in moisture. [5-7].

Processed cheese typically includes 30% to 45% fat, based on total solids. The composition is totally dependent on the level of moisture and the materials utilized in production. Cheese that is intended for processing has the same quality as cheese that is intended for direct consumption; it may be processed even if it has surface, texture, color, size, or a short shelf life. High grade processed cheese can only be made with high-quality raw ingredients. Spreads of processed cheese should be chilled as quickly as possible, whereas cheese blocks should be cooled slowly. After molding, the cheese is kept at room temperature. Incorporating spice, such as pepper, into the cheese spread enhances its taste [8-9].

The public is receiving suggestions to adjust the fat level and composition of their diets, including reducing saturated fat. If the goal is just to lose weight, it's necessary to restore the lost fat. Thais propose using com oil to substitute saturated fat. This study assesses the research on the use of olive oil in food and its potential role in supporting a healthy diet. Com oil, like most culinary oils, comprises acylglycerols (mono-, di-, and trio). There are 24% monounsaturated fatty acids and 59% polyunsaturated fatty acids in corn oil. After more refinement processes including degumming, neutralization, bleaching, winterization, and deodorization, the refined oils are either used straight away or go through additional processing like fractionation, hydrogenation and interesterification. Corn oil has a mild taste, unique smell and it is somewhat yellow in color. It is a noteworthy source of carotenoids, tocotrienols, phytosterols and tocopherols, among other minor bioactive lipids. [10]. One of the most important spices in the world, pepper (Piper nigrum) is prized for both its aroma and pungency. One of the ingredients that gives pepper its aroma is the steam volatile oil, which should generate 1% to 3%. There are three varieties of pepper goods on the market: black, green, and white pepper. Black pepper is the source of most pepper oil used in commercial applications[11-12].

For over a century, several investigations have been conducted on the chemical makeup of pepper oil, which have been evaluated by several writers. Monoterpene hydrocarbons make about 70-80% of pepper flavor, whereas sesquiterpene hydrocarbons (20-30%) contribute to its attractive taste. Global demand for functional spread cheese is rising, with an emphasis on essential and functional oils. Therefore, the goal of this study was to investigate the shelf life of target components during storage as well as the shelf life of spread cheese infused with black pepper oil.

In order to offer a detailed study of the effects of varying the proportion of pepper oils encapsulated with maize oil on the target components' shelf life in storage, this research was carried out.

2 Methods

The purpose of the study was to define the spread cheese by analyzing the chemical makeup of the microencapsulated spread cheese prepared with varying amounts of pepper oil and corn oil. It is evident that microencapsulated pepper oil and corn oil, in particular their bioactivities including antioxidant and antibacterial qualities, have an impact on spread cheese[3]. Initially fresh cream obtained from super marktets containing fat percentage around 36% and the standardization of fat was done using pearson square

method with skimmed milk (0.1% fat) using the cream available at the factory. Black pepper, oil corn oil were purchased from commercial stores and micro-encapsulated with the 0:0 g, 15:0 g , 0 :15 g, 7.5:7.5 g named as T1 to T4 respectively and shown in Table 1.

Table 1. Different treatments of pepper oil and corn oil incorporated spread cheese.

Ingredients (g)	T1	T2	T3	T4
Ripened cheese	1650	1650	1650	1650
Unripened cheese	1350	1350	1350	1350
Fresh cream	2460	2460	2460	2460
Sodium citrate	75.9	75.9	75.9	75.9
Trisodium phosphate	8.1	8.1	8.1	8.1
Citric acid	15	15	15	15
Salt	78	78	78	78
Potassium sorbate	8.1	8.1	8.1	8.1
Vegetable fat	810	810	810	810
Palsgaard	60	60	60	60
Water	135	120	120	120
Black pepper oil	0	15	0	7.5
Corn Oil	0	0	15	7.5

After that, the ingredients were placed in a steam-jacketed kettle and boiled for three minutes at 90.6°C. Sterilized food-grade glass bottles holding 175 g each were filled with prepared cheese. Four treatments were made and kept at ambient temperature as well as in a refrigerator (4°C), as was previously specified. Chemical analysis was performed on all four treatments developed throughout the experiment, and the results are shown in Table 2 along with a standard for comparison and decision-making.

3 Results and Discussion

The Every treatment generated throughout the investigation fell inside the country standard. Chemical compostion of the samples including Fat, moisture, total solid, pH and titratable acidity of the samples were analysed according to the method stated in the previous research [13-14] and shown in Table 2.

Table 2. Chemical compostion of the microencapsulated spread cheese.

Characteristic	T1	T2	T3	T4
Fat % by mass(DB)	35.62	37.02	39.76	37.80
Moisture % by mass	58.36	56.89	55.58	55.45
Total solid	41.64	43.11	44.42	44.55
pH	6.01	6.12	6.31	6.23
Titratable acidity	0.70	0.71	0.81	0.76

As suggested, microencapsulated pepper oil and corn oil were utilized in this investigation, and it was discovered that they had a wide range of impacts on the body and texture of prepared spread cheeses. A low acidic strength resulted in a smooth and soft texture of the body, whereas a high acidic strength resulted in a very hard body of the cheese. Because of its emulsion ability and strength, the microencapsulated oils added to the cheese resulted in a smooth texture and soft spread ability. Chemical analysis of spread cheese samples was performed using the approach described in earlier research publications.

3.1 Sensory evaluation of organoleptic characters

Table 2 shows the chemical makeup of the spread cheese samples, samples were prepared according to the proposed recipes were kept in a constant temperature incubator at a temperature of 40-42°C for 6 hours. The organoleptic appearance of the finished spread cheese samples are shown in web diagram [3, 15-16]. The test was administered by thirty inexperienced panelists. Figure 1 shows the estimated hedonic medians and rankings for each quality feature based on the findings of the tasting panel. These figures give some indication of the considerable differences between treatments in the organoleptic properties of microencapsulated cheese.

The quality characteristics' probability values indicate that there are notable differences between the treatments. Probability values of spreadability, Color, flavour, overall acceptance and appearance of sample T4 was found to be higher than all other samples while having a flavour of T4 and T3 were almost same which does not show a significant differnces in the samples (p-values ≥0.05) This suggest that the three treatments' colors and appearances are not significantly different from one another. However, spreadability (0.001) and overall appearance (0.001) are less than 0.05, indicating a substantial difference between treatments that demonstrates the cheese sample's encapsulation efficiency.

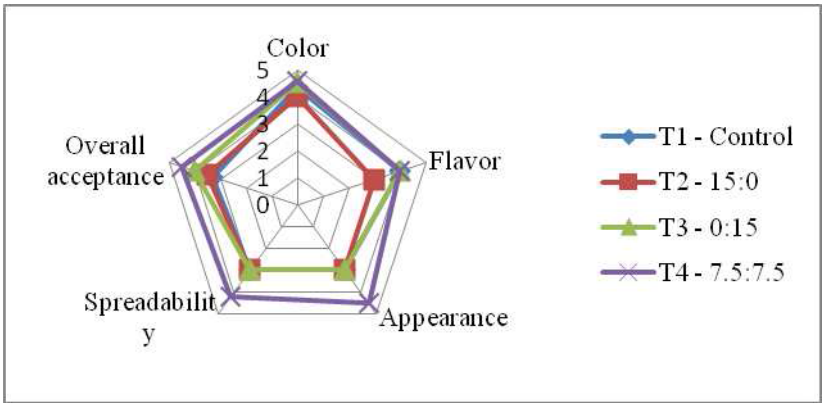

Fig. 1. Estimated hedonic median for each organoleptic characters.

Based on the experiments carried out, the following results were obtained; the organoleptic properties of product samples were studied. Analysis of the samples showed that a liquid mass had formed in T1 due to syneresis and it affected the quality of the cheese, which did not give the expected outcome. T2 was having a homogeneous, thick, viscous mass, while T3 was having slight improvement and T4 showed an expected outcome where the encapsulation efficiency was observed. T4 was homogeneous mass with the same viscosity. The taste and smell became specific and white.

3.2 Shelf life of the cheese samples

Every week, the chosen treatment was assessed chemically and microbiologically to provide an estimate of the product's shelf life. Periodically evaluated microbiological parameters included moisture content, pH, and titratable acidity as well as chemical parameters. As stated in the earlier study articles [15–17], a 7-week evaluation period was used to assess the total plate count, yeast and mold count, and coliforms. Figures 2 and 3 indicate that, when kept at room temperature, the cheese spread did not deteriorate

chemically after seven weeks of storage; but, during the second week of examination, the sample that was kept at room temperature.

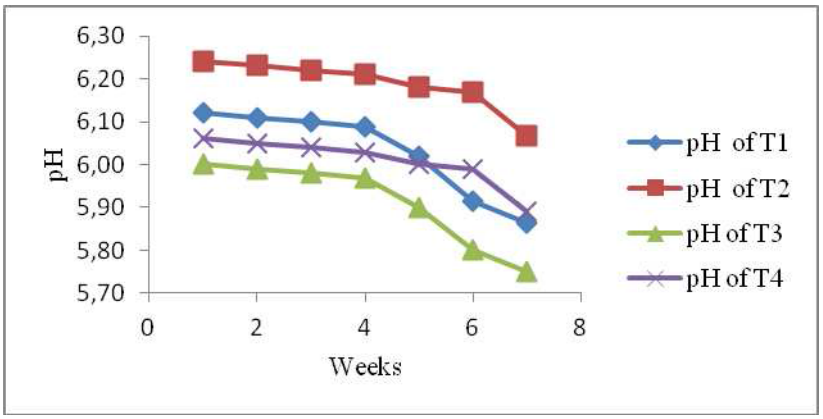

Fig. 2. pH value of spread cheese samples.

The estumated shelf life were obatianed for 2 months (7 weeks) and the data showed that all samples were showing a slight reduction of pH during the storage which showed that the product is having some chemical changes. Figures 2 and 3 describe pH and the titratable acidity through out the 7 weeks respectively. There was a significant difference between control sample and T4 sample observed in the pH redction while having noo significant difference between other samples which shows that there is a chemical effect for the encapsulation of oils and the oswalt reactions [3].

Over the course of seven weeks, there was a modest rise in titratable acidity and a minor drop in moisture content and pH values. One may conclude that the product is safe to use for at least four or five more weeks based on the chemical changes depicted in Figures 2 and 3 below. The product did not exhibit any significant degradation of chemical components. According to the curve of numbers below, the entire product may be utilized for a minimum of twelve weeks (three months) without experiencing any significant quality decline.

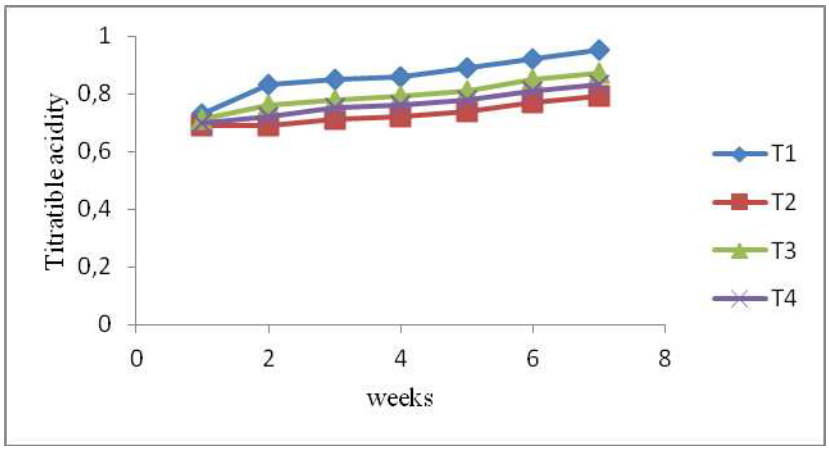

Fig. 3. Titratable acidity of the cheese spread.

Microbiological analysis of the refrigerated samples are shown in the Figure 4 and 5 where the total plate count, total coliform counts, molds content of the samples which was stored referegirations were analysed according to the method mentioned in the previous articles [3, 13, 17-19]. The samples that were kept at room temperature were thrown out after two weeks because there were too many yeast, mold, and total plate count colonies. For a period of seven weeks, samples that were refrigerated underwent constant evaluation. Several graphs were created based on a seven-week study to determine the product's approximate microbiological shelf life. The microbiological variations in total plate count, yeast, and molds are shown in Figures 4 and 5, respectively. The coliforms were absent in the product which obeys the country standard. While having moderate increase in the total plate counts of the smaples until 2 months which is more lesser than the standard therefore it could be used for another one months with respect to the logarithm of microbial growth [19].

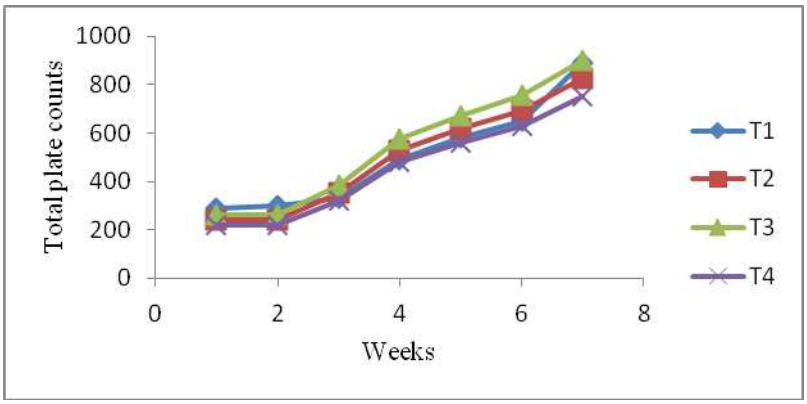

Fig. 4. Total plate count present in cheese spread every week.

It can be seen in the total plate counts of the samples that there were a slight increase in the microorganism which is a normal scenario in food processing and storage but there was a significant redduction of yeast and mold in the T4 sample which clearly provide the inhibitory effects of encapsulation of different oils shown in Figure 5.

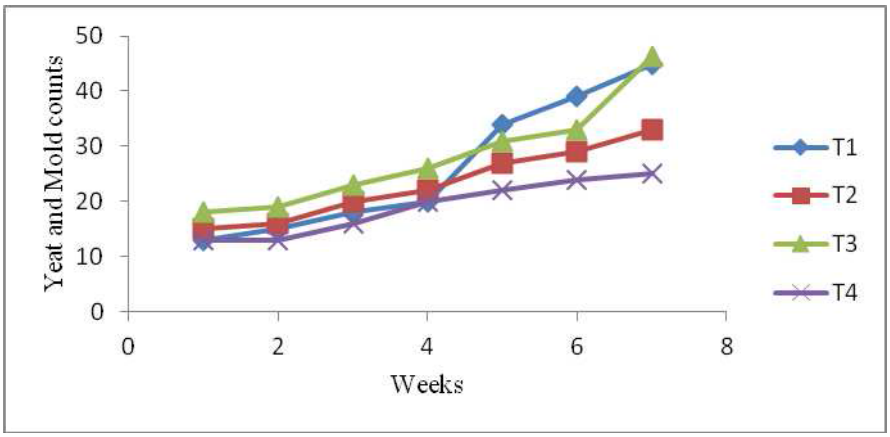

Fig. 5. Yeast and Mold present in cheese product every week.

In a refrigerated state, the overall plate count has somewhat grown over the course of seven weeks, as has the yeast and mold count. Microbial ranges, on the other hand, comply with national regulations, indicating that they might be produced industrially and used for market research. Table 3 displays the initial microbiological content of the best sample that was chosen in the final experiments. Based on the findings of the microbiological study, the chosen treatments meet country Standards specifications. In order to gauge the cheese spread's shelf life over time, its microbiology was assessed.

Table 3. Microbial standards for cheese sample .

Microbes	Standard Amount
E.coli	Absent in 0.1 mg
Staphylococcus aureus	200
Yeast and mould per g(not more than)	Absent in 0.1g

The results shown in Figure 4 indicates that over the 30-day storage period, no harmful microorganisms or bacteria belonging to the *Escherichia coli* group were found in either the control or experimental samples. In contrast to the experimental samples, *staphylococci* were detected in the control samples, however they were still within the expected range. Compared to the control sample, which had a yeast level substantially greater than all other samples [20-21].

4 Conclusion

When compared to conventional cheese spread that is sold in stores, the recently produced processed cheese spread has the same sensory attributes with mild changes in the appearance and texture due to encapsulation of oils. Shelf life analysis indicates that a created product should be stored for three months without experiencing any significant quality issues, similar to that of a standard product. Cost study indicates that it is quite inexpensive when compared to other items offered in the local market and the formula that is already in use. Black pepper oil is added to the product to serve as an antioxidant and improve its health.

References

1. K.I. Taj, M. Bule, R. Ullah, M. Nadeem, S. Asif, K. Niaz, Veterinary world **12**, 1 (2019)
2. J.R. Campbell, T.M. Robert, The science of milk and milk products, Waveland Press (2016)
3. Rifky, M. Jesfar, K. Dissanayake, U. Orif, M. Samadiy, E3S Web of Confer. **480**, 03014 (2024)
4. B. Niloofar, S. Khoshgozaran-Abras, S. Sohrabvandi, N. Khorshidian, A.M. Mortazavian, N. MollaKhalili, S. Jazaeri. Food Sci. Tech. Rese. **24**, 6 (2018)
5. Fox, Patrick F., and Paul LH McSweeney. "Cheese: an overview." Cheese, 5-21 (2017)
6. P.F. Fox, P. Timothy, T.M. Guinee, P.L.H.M Cogan, Fundamentals of cheese science. 1. Boston, MA, USA: Springer (2017)
7. E. Mamdouh, B.M. Mehta, Processed Cheese Sci. Tech, Woodhead Publishing (2022)
8. R.C. Chandan, R. Kapoor, "Principles of cheese technology." Dairy ingredients for food processing (2011)

9. Johnson, Mark E. "Cheese products." food science and technology-new york-marcel dekker (2001)
10. B. Daniel, A.P. Badan-Ribeiro, S.O. Serna-Saldivar. "Corn oil: composition, processing, and utilization," In Corn, AACC International Press (2019)
11. Narayanan, C. S. "Chemistry of black pepper." Black pepper (piper nigrum L.). Harwood Academic, Amsterdam, The Netherlands, 143-162 (2000)
12. Feng, Yong. "Discussion on the making standard of pepper oil." China Condiment, **41**, **3**, 114-117 (2016)
13. Ubaydullaeva, Nilufar B., Dilrabo Q. Maksumova, Shaxzoda J. Shosalimova, and Mohamed Rifky. In E3S Web of Conferences, **486**, 02025 (2024)
14. K. Dissanayake, M. Rifky, M Jesfar, J. Makhmayorov, S. Rahimkulov, B. Abdullayev, IOP Conf. Ser.: Earth Environ. Sci, **1275**, 1 (2023)
15. K. Dissanayake, M. Rifky, M Jesfar, J. Makhmayorov, S. Rahimkulov, B. Abdullayev, M. Samadiy. IOP Conf. Ser.: Earth Environ. Sci, **1275**, 7 (2023)
16. D.W. Everett, A.E.A Mark, International Dairy Journal, **18**, 7 (2008)
17. Liu, R., Ci, X., Liu, L., Wang, X., Rifky, M., Liu, R. Wenjie. S, Tao. W, & Zhang. M, Intl. J. Biol. Macromole. **129615** (2024)
18. A. Christine, F. Berthier. Food microbiology **65** (2017)
19. K. Evert-Arriagada, K., M.M. Hernández-Herrero, B. Juan, B. Guamis, A.J. Trujillo. Journal of Food Engineering **110**, 2 (2012)
20. A.A. Hayaloglu, S. Kirbag. Interna. J. food microbio. **115**, 3 (2007)
21. A. Varnam, P. Jane. Milk and milk products: technology, chemistry and microbiology. Vol. 1. Springer Science & Business Media (2001)