

Effect of Edible Packaging Film Treated with Essential Oil of Clove in Extending the Shelf Life of Paneer

Saurabh Karunamay¹, Shekhar. R. Badhe^{2*} and Vivek Shulka³

^{1&3}Department of Livestock Products Technology, Mumbai Veterinary College (MAFSU), Mumbai, Maharashtra, INDIA

²Department of Livestock Products Technology, Nagpur Veterinary College (MAFSU), Nagpur, Maharashtra, INDIA

*Corresponding Author: drshekhar15@gmail.com

How to cite this paper:

Karunamay, S., Badhe, S., & Shukla, V. (2020). **Effect of edible packaging film treated with essential oil of clove in extending the shelf life of paneer.** International Journal of Livestock Research, 10(9), 178-183. doi: <http://dx.doi.org/10.5455/ijlr.20200422100708>

Received : Apr 22, 2020
Accepted : Jul 30, 2020
Published : Sep 30, 2020

Copyright © Karunamay *et al.*, 2020

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Abstract

The present study was conducted to evaluate the shelf- life of paneer wrapped with clove essential oil treated carboxymethyl cellulose (CMC) and starch based edible packaging film. Preparation of edible film was done by adding starch (5g), glycerol (40ml/100g starch) and carboxymethyl cellulose (15 % W/W starch) in distilled water (100mL). Prepared paneer was wrapped with edible film and evaluated for physico-chemical, microbiological and sensory properties at (4±1 °C) till spoilage. Control sample was unacceptable by sensory evaluation after 5th day of storage and found microbiologically unfit on 9th day of storage. The paneer packed in edible film treated with 0.5% clove essential oil was found unattractive on 10th day of sensory evaluation but found microbiologically sound at 12th day of storage. The results revealed that paneer packed in edible film treated with clove essential oil was found microbiologically safe for at least 12 days as compared to 5-6 days for control sample under refrigerated condition (4±1 °C).

Keywords: Clove oil, CMC, Edible film, Paneer, Shelf-life

Introduction

Paneer refers to the product obtained from the cow or buffalo milk or a combination there of by coagulation with sour milk, lactic acid or citric acid. It should not contain more than 70.0 per cent moisture and milk fat less than 50.0 per cent of the dry matter (FSSAI, 2011). Shelf- life of Paneer is 5-6 days under refrigeration temperature ($4\pm 1^\circ\text{C}$) and surface growth of micro- organisms are considered to be mainly responsible for the spoilage of paneer. Many modern packaging methods have been developed to increase the shelf life of the paneer. Some of the packaging methods for paneer are retort packaging, vacuum packaging etc. But, most of the packaging materials used in the food industry are non-biodegradable. Therefore, in order to solve the problems generated by plastic waste, the research has been carried out to develop techniques involving use of natural compounds for the preservation of paneer. Thus, an eco-friendly, biodegradable and essential oil treated edible packaging film was developed for this purpose. Clove essential oil (CEO) have been identified to possess outstanding antioxidant as well as high antimicrobial activity against a wide range of spoilage and pathogenic microorganisms. Clove oil also shows plasticizing effect (Echeverría *et al.*, 2016). Furthermore, at level below 1500 ppm FDA has granted clove essential oil the generally recognized as safe (GRAS) status, which has led to extensive studies on incorporation of this oil in carboxymethyl cellulose and starch based edible coatings. The objective of present work was to study the efficiency of carboxymethyl cellulose and starch base edible film, incorporated with clove essential oil to extend the shelf life of paneer stored at refrigeration temperature.

Material and Methods

Freshly drawn buffalo milk was brought from buffalo farm of Mumbai Veterinary College and used throughout the experiments. The fat percentage and S.N.F was standardized to 6% and 9% respectively for optimum product characteristics. Citric acid of strength 1% was used to coagulate the milk for preparation of paneer. Paneer was prepared by the method suggested by Kumar *et al.*, (2014) with slight modifications. After minimum inhibitory concentration of clove essential oil, 0.5 % concentration of essential oil was incorporated in edible film. The Edible film suspension was prepared by adding starch (5 g), glycerol (40 ml/100 g starch) and carboxyl methyl cellulose (15% W/W starch) in 100 mL distilled water at (25°C for 5 min). Suspension was then agitated by magnetic stirrer (500rpm) for 30 min in water bath at 90°C (Ghanbarzadeh *et al.*, 2011). Two samples were prepared viz. control (C) and treatment (T). Control sample contained paneer packed in LDPE bag and kept at $4\pm 1^\circ\text{C}$. Whereas Treatment (T) group contained paneer wrapped in edible packaging film treated with 0.5% clove essential oil and then packed in LDPE bag and stored at $4\pm 1^\circ\text{C}$. The control and treatment paneer were analyzed for physico-chemical, microbiological and sensory attributes at an interval of 3 days till spoilage. All the parameters for control and treatment were evaluated and analyzed in the laboratory of Department of Livestock Products Technology, Mumbai Veterinary College, Mumbai. The pH of control and treated paneer sample were determined by the method of Trout *et al.*, (1992). The pH of suspension was recorded with the help of digital pH meter (Model-HI 99163, HANNA). TBA was determined as per the method described by Witte *et al.*, (1970) with little modification and the absorbance (A) was measured at 530nm in a spectrophotometer (Model no. EQ 820 with wavelength range of 350-950 nm, INDIA). Tyrosine value was determined by the procedure described by Strange *et al.*, (1977) with slight modifications. The optical density was measured at 730 nm using Spectrophotometer. Tyrosine value was calculated as milligram tyrosine per 100 gram of sample by referring to a standard graph, which was prepared as per the procedure described by Pearson (1968). Total plate count, psychrophilic count, coliform count and yeast and mold count of paneer samples were estimated by the standard methods of APHA (1992). The sensory evaluations were conducted by semi-trained panel of 6 judges and it was repeated at the interval of 5 days. The samples were judge for various sensory attributes using nine point descriptive scales (Keeton, 1983).

Statistical Analysis

The data were recorded in triplicate ($n=3$) during the experiment and analyzed by analysis of variance (ANOVA) using complete randomized block design (CRBD) following standard procedure (Snedecor and Cochran, 1989).



Figure 1: Edible packaging film (treated with 0.5% clove oil)

Results and Discussion

Physico-chemical Parameters

The paneer with and without edible packaging film was analyzed for physico-chemical parameters like pH, tyrosine value, TBA value and titratable acidity at 0th, 3rd, 6th, 9th, 12th and 15th day of storage (Table 1). The initial pH values were non-significant till 6th day for control and treatment. Significant difference among control and treatment was observed on day 9th and day 15th of storage. Phenolic compound in clove essential oil helps to maintain the pH of paneer during entire storage. Results were in accordance with Rai *et al.*, (2008), Shan *et al.*, (2011) and Makhal *et al.*, (2014).

The average tyrosine values for control and treatment indicates a non-significant difference on 0 day. But a significant difference was noticed between 3rd day to 15th day of storage. Rai *et al.*, (2008) analyzed chemical quality of paneer at 7±1°C and showed a similar finding. Yadav and Wadehra (2016) also reported a similar tyrosine value for clove added spicy paneer at refrigeration condition. At the end of storage, the tyrosine value for control was found to be much higher as compared to treatment, which indicates less proteolysis in treated paneer samples.

Table 1: Physico-chemical parameters of control and treatment during storage period

Parameters	pH		Tyrosine		TBA		Titratable Acidity	
	C	T	C	T	C	T	C	T
0 th Day	a5.85±0.03 ^A	a5.85±0.03 ^A	a12.52±0.06 ^A	a12.47±0.01 ^A	a0.22±0.01 ^A	a0.22±0.02 ^A	a0.29±0.01 ^A	a0.29±0.01 ^A
3 rd Day	a5.83±0.04 ^A	a5.75±0.01 ^A	b15.38±0.05 ^B	b15.88±0.05 ^A	b0.36±0.01 ^B	b0.31±0.02 ^A	b0.43±0.01 ^A	b0.41±0.01 ^A
6 th Day	a5.77±0.02 ^A	a5.74±0.03 ^A	c19.78±0.05 ^B	c17.90±0.04 ^A	c0.48±0.01 ^B	c0.36±0.02 ^A	c0.55±0.02 ^B	c0.49±0.02 ^A
9 th Day	a5.76±0.03 ^A	b5.65±0.02 ^B	d31.14±0.02 ^B	d27.35±0.12 ^A	d0.68±0.02 ^B	d0.61±0.02 ^A	d0.62±0.02 ^B	d0.55±0.02 ^A
12 th Day	b5.56±0.01 ^B	b5.64±0.03 ^B	e40.53±0.03 ^B	e31.51±0.13 ^A	e0.93±0.02 ^B	e0.87±0.03 ^A	e0.74±0.01 ^B	e0.63±0.02 ^A
15 th Day	b5.55±0.03 ^A	c5.63±0.04 ^B	f47.54±0.25 ^B	f37.66±0.08 ^A	f1.16±0.06 ^B	f0.94±0.07 ^A	f0.79±0.02 ^B	f0.70±0.01 ^A

*Note: Row wise mean bearing subscript and column wise mean bearing superscript indicates significant and non-significant difference at (p<0.05%).

The average TBA values for control and treatment shows a non-significant difference on 0 day. But a significant difference was noticed in control and treatment from 3rd day to 15th day of storage. The value of TBA in paneer sample treated with essential oil of clove was considerably lower than that of the control, indicating that the clove essential oil protected paneer against lipid oxidation. The results were in agreement with the reports of Shan *et al.*, (2011) for cheese and Chauhan *et al.*, (2015) for paneer.

Initial acidity of the control and treated paneer samples were 0.29%. Progressing storage, development of acidity followed a slow and gradual increase. The average titratable acidity values for control and treatment showed a non-

significant difference on day 0 and day 3. But a significant ($p < 0.05$) difference was noticed in control and treatment from 6th day to 15th day of storage. Incorporation of clove essential oil into edible coating of paneer delayed the acid development during storage, possibly because of its antimicrobial activity against the spoilage causing microorganisms. The results were in agreement with the reports of Verma and Khan (2009), Lamdande *et al.*, (2012) and Makhal *et al.*, (2014) for paneer.

Microbiological Parameters

The paneer with and without edible packaging film were subjected to microbiological count subsequently at 0th day, 3rd, 6th, 9th, 12th and 15th day of storage (Table 2).

Table 2: Microbiological count (log cfu/g) of control and treatment of paneer during storage period

Parameters	Total Plate Count		Psychrophilic count		Yeast and Mold Count	
	C	T	C	T	C	T
0 th Day	NIL	NIL	NIL	NIL	NIL	NIL
3 rd Day	^a 1.97±0.09 ^B	^a 1.27±0.18 ^A	NIL	NIL	^a 2.53±0.18	NIL
6 th Day	^b 3.30±0.15 ^B	^b 2.47±0.18 ^A	^a 4.63±0.01 ^A	NIL	^b 3.28±0.17 ^B	^a 2.73±0.07 ^A
9 th Day	^c 5.0±0.10 ^B	^c 3.60±0.12 ^A	^b 5.03±0.01 ^B	^a 3.67±0.02 ^A	^b 3.37±0.01 ^B	^b 3.14±0.01 ^A
12 th Day	^d 5.80±0.12 ^B	^d 4.77±0.09 ^A	^a 5.18±0.00 ^B	^b 4.84±0.02 ^A	^b 3.45±0.02 ^B	^c 3.31±0.02 ^A
15 th Day	^e 6.77±0.03 ^B	^e 5.47±0.09 ^A	^a 5.20±0.01 ^A	^c 5.17±0.02 ^A	^b 3.52±0.01 ^B	^d 3.43±0.02 ^A

*Note: Row wise mean bearing subscript and column wise mean bearing superscript indicates significant and non-significant difference at ($p < 0.05\%$).

Total plate count (TPC log₁₀cfu/g) for control and treatment was nil on zero day. A significant difference was noticed in control and treatment from 6th day to 15th day of storage. Control sample was in unacceptable limit on 9th day of storage whereas treatment was under acceptable limit till 12th day of storage. The reduction was perhaps on account of the bactericidal effect of clove essential oil. A similar result of total plate count for clove essential oil treated paneer stored at 8±1°C was reported by Khatkar *et al.*, (2017) and Havanur and Adi (2020).

Psychrophilic count of control and treatment samples on 0 day and 3rd day were nil. On 6th day only control showed the growth with count of 4.63±0.01 log cfu/g. A significant difference was noticed by control and treatment from 9th day to 12th day of storage. Gradual increase in psychrophilic count was observed in control than treatment upon 15th day of storage. Numerous studies show that clove essentials oils have strong bactericidal effect Badhe and Fairoze (2012), Liu *et al.*, (2017). Similar result was also reported by Makhal *et al.*, (2014) that stated the lower growth of psychrotrophs in cottage cheese samples added with essential oils is due to its strong antimicrobial action.

On day zero, the average yeast and mold count for control and treatment were nil. A significant difference was observed in control and treatment from 6th day to 15th day of storage. Owing to the antifungal action (Lopez *et al.*, 2005), the clove oil was observed to exhibit a significant inhibitory effect against growth of yeast and molds during the entire storage period. The results of yeast and mold count were in agreement with Buch *et al.*, (2014) for paneer, Eresam *et al.*, (2015) for clove powder incorporated paneer and Badola *et al.*, (2018) for clove oil treated burfi.

The coliform count for the entire period of storage was negative. It shows that the sample was not contaminated by any coliform bacteria from any route.

Sensory Evaluation

On day zero and day fifth, sensory attributes like appearance, juiciness and texture of control were more favorable but flavor of treatment was more acceptable. The overall acceptability of control was significantly different from treatment. On day 10th, only treatment's sensory evaluation was done because microbiologically control was spoiled on 9th day of storage. The scores for appearance, flavor, juiciness and texture were affected by the increase acidity and decreasing moisture content, similar finding was reported by Kumar *et al.*, (2008) and Deshmukh *et al.*, (2009). Ahmed & Bajwa (2019) also stated the similar result as degradation of reducing sugar leads to pH drop and alteration of sensory qualities in paneer.

Table 3: Sensory scores of control and treatment during storage period

Day	0 th Day	5 th Day	10 th Day
Sensory Evaluation			
Appearance			
Control	^a 8.98±0.02 ^A	^b 7.97±0.12 ^A	NC
Treatment	^a 8.98±0.15 ^B	^b 8.43±0.01 ^B	^a 7.35±0.07 ^A
Juiciness			
Control	^a 8.46±0.14 ^A	^b 7.54±0.18 ^A	NC
Treatment	^a 8.42±0.15 ^B	^b 7.61±0.12 ^B	^a 6.11±0.22 ^A
Flavour			
Control	^a 7.95±0.18 ^A	^b 7.32±0.16 ^A	NC
Treatment	^a 8.43±0.17 ^B	^b 7.66±0.17 ^B	^a 7.52±0.30 ^A
Texture			
Control	^a 8.98±0.02 ^A	^b 8.12±0.18 ^A	NC
Treatment	^a 8.97±0.02 ^B	^b 8.42±0.14 ^B	^a 7.02±0.12 ^A
Overall Acceptability			
Control	^a 8.59±0.04 ^A	^b 7.74±0.08 ^A	NC
Treatment	^a 8.7±0.07 ^B	^b 8.03±0.11 ^B	^a 7.00±0.08 ^A

*Note: Row wise mean bearing subscript and column wise mean bearing superscript indicates significant and non-significant difference at ($p < 0.05\%$). NC=Not conducted

Conclusion

In the present study paneer coated with edible film treated with 0.5 % clove essential oil was microbiologically and physico-chemically accepted till 12th day of storage. Whereas, control paneer was found microbiologically unfit on 9th day of storage. Sensory acceptability for treatment was good till 10th day of storage, whereas control was not acceptable after 5th day. Further conclusion can be drawn that carboxymethyl cellulose and starch based film can be used as edible packaging material. Clove essential oil can be successfully incorporated in edible packaging film to increase shelf life of perishable products.

Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

References

- Ahmed, A., & U. Bajwa. (2019). Composition, texture and microstructure appraisal of paneer coagulated with sour fruit juices. *Journal of Food Science and Technology*, 56(1), 253-261.
- American Public Health Association. (1992). Compendium of Methods for the Microbiological Examination of Foods 3rd Edition APHA Inc. Washington DC. Retrieved Dec, 27, 2013.
- Badhe, S.R., and Fairoze, M.N. (2012) Antibacterial efficacy of clove powder of chicken legs spiked with pathogenic reference strains under refrigeration temperature (8 ± 2 °C) *Indian Journal of Animal Research*. 2012;46:371–375
- Badola, R., Panjagari, N. R., Singh, R. R. B., Singh, A. K., & Prasad, W. G. (2018). Effect of clove bud and curry leaf essential oils on the anti-oxidative and anti-microbial activity of burfi, a milk-based confection. *Journal of Food Science and Technology*, 55(12), 4802-4810.
- Buch, S., Pinto, S., & Aparnathi, K. D. (2014). Evaluation of efficacy of turmeric as a preservative in paneer. *Journal of Food Science and Technology*, 51(11), 3226-3234.
- Chauhan, O. P., Kumar, S., Nagraj, R., Narasimhamurthy, R., & Raju, P. S. (2015). Effect of high pressure processing on yield, quality and storage stability of peanut paneer. *International Journal of Food Science & Technology*, 50(6), 1515-1521.
- Deshmukh, D. S., Zanjad, P. N., Pawar, V. D., & Machewad, G. M. (2009). Studies on the use of acidified and cultured whey as coagulant in the manufacture of paneer. *International Journal of Dairy Technology*, 62(2), 174-181.

8. Echeverría, I., López-Caballero, M. E., Gómez-Guillén, M. C., Mauri, A. N., & Montero, M. P. (2016). Structure, functionality, and active release of nanoclay–soy protein films affected by clove essential oil. *Food and Bioprocess Technology*, 9(11), 1937-1950.
9. Eresam, E. K. K., Pinto, S., & Aparnathi, K. D. (2015). Concise and informative title: evaluation of selected spices in extending shelf life of paneer. *Journal of Food Science and Technology*, 52(4), 2043-2052.
10. FSSAI (2011). Food Products Standards and Food Additives. Food Safety and Standards Regulations, 7th edition. International law book company publication, Delhi, India, 270.
11. Ghanbarzadeh, B., H. Almasi, H., & Entezami, A. A. (2011). Improving the barrier and mechanical properties of corn starch-based edible films: Effect of citric acid and carboxymethyl cellulose. *Industrial Crops and Products*, 33(1), 229-235.
12. Havanur, S., & Adi, V. K. (2020). Spice Based Treatment to Increase the Shelf Life of Paneer–Clove a Promising Spice. *Journal of Microbiology, Biotechnology and Food Sciences*, 9(5), 463-466.
13. Keeton, J. T. (1983). Effect of fat and NaCl/ phosphate level on the chemical and sensory properties of pork patties. *Journal of Food Science*.48: pp 787-885.
14. Khatkar, A. B., Ray, A., & Kaur, A. (2017). Effect of addition of clove essential oil on the storage stability of paneer. *The Pharma Innovation*, 6(9, Part A), 39.
15. Kumar, S., Rai, D. C., & Verma, D. N. (2008). Effect of different levels of lactic acid on the physico-chemical and sensory attributes of buffalo milk paneer. *Indian Journal of Animal Research*, 42(3), 205-208.
16. Kumar, S., Rai, D. C., Niranjana, K., & Bhat, Z. F. (2014). Paneer—An Indian soft cheese variant: a review. *Journal of Food Science and Technology*, 51(5), 821-831.
17. Lamdande, A. G., Garud, S. R., & Kumar, A. (2012). Impact of coating, packaging materials and temperatures on acidity of paneer. *Bioinfolet-A Quarterly Journal of Life Sciences*, 9(4), 445-447.
18. Liu, Q., Meng, X., Li, Y., Zhao, C. N., Tang, G. Y. and Li, H. B. (2017). Antibacterial and Antifungal Activities of Spices *International Journal of Molecular Sciences*, 18(6), 1283.
19. Lopez P, Sanchez C, Batlle R and Nerin C. (2005). Solid- and vapor-phase antimicrobial activities of six essential oils: susceptibility of selected foodborne bacterial and fungal strains. *Journal of Agricultural and Food Chemistry*, 53: 6939–6946.
20. Makhal, S., Kanawjia, S. K., & Giri, A. (2014). Effectiveness of thymol in extending keeping quality of cottage cheese. *Journal of Food Science and Technology*, 51(9), 2022-2029.
21. Pearson, D. (1968). Application of chemical methods for the assessment of beef quality. II methods related to protein break down. *Journal of the Science of Food and Agriculture*, 19 (7): 366-369.
22. Rai, S., Goyal, G. K. and Rai, G. K. (2008). Effect of modified atmosphere packaging and storage on the chemical quality of paneer. *Journal of Dairying, Food and Home Sciences*, 27:33–37.
23. Shan, B., Cai, Y. Z., Brooks, J. D., & Corke, H. (2011). Potential application of spice and herb extracts as natural preservatives in cheese. *Journal of Medicinal Food*, 14(3), 284-290.
24. Snedecor, G. W., and Cochran, W. J. (1989). *Statistical Methods*, 8th Edition; Iowa State University press, Amer. Iowa, USA.
25. Strange, E. D., Benedict, R. C., Smith, J.C., and Swift, L. E., (1977). Evaluation of rapid tests for monitoring alterations in meat quality storage. I. Intact Meat. *Journal of Food Protection*, 40: 843-847.
26. Trout, E. S., Hunt, M. C., Johnson, D.E., Claus, J. R., Kastner, C. L., Kropf, D. H., and Stroda, S. (1992) Chemical, physical and sensory characterization of ground beef containing 5 to 30 percent fat. *Journal of Food Science*, 57: 25-29.
27. Verma, A., & Khan, B. L. (2009). Effect of Coagulants and their Concentration, Coagulation Temperature, Packaging Materials and Storage Periods on Chemical Composition of Soy Substituted Buffalo Milk Paneer. *Progressive Agriculture*, 9(2), 282-285.
28. Witte, V. C., Krause, S. F., and Baily, M. E. (1970). A new extraction method for determining 2 thiobarbituric acid values of pork and beef during storage. *Journal of Food Science*, 35, 582-585.
29. Yadav, R., & Wadehra, A. (2016). Formulation and study on the chemical and microbiological aspect of spiced paneer. *International Journal of Enhanced Research in Science, Technology & Engineering*. Vol. 5 Issue. ISSN: 2319-7463.
