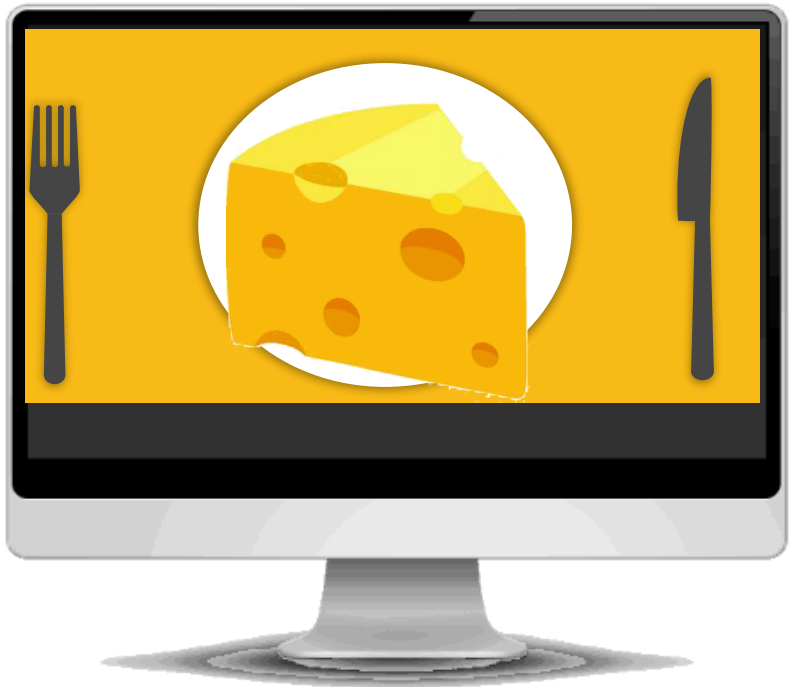
مرکز آموزش عالی
علوم پزشکی
وارستگان

عنوان

اثربخشی مواد پوشش خوراکی بر پایه‌ی آب پنیر برای نگهداری پنیر



ارائه دهندگان

حسنا دانژه ، مبینا یعقوبی

استاد راهنما

دکتر عاطفه صرافان صادقی

تاریخ ارائه

۱۴۰۴/۸/۲۲

مجله علوم دامپزشکی و دامی

Varastegan Institute for Medical sciences

Journal club presentation in department of food science and technology

Title

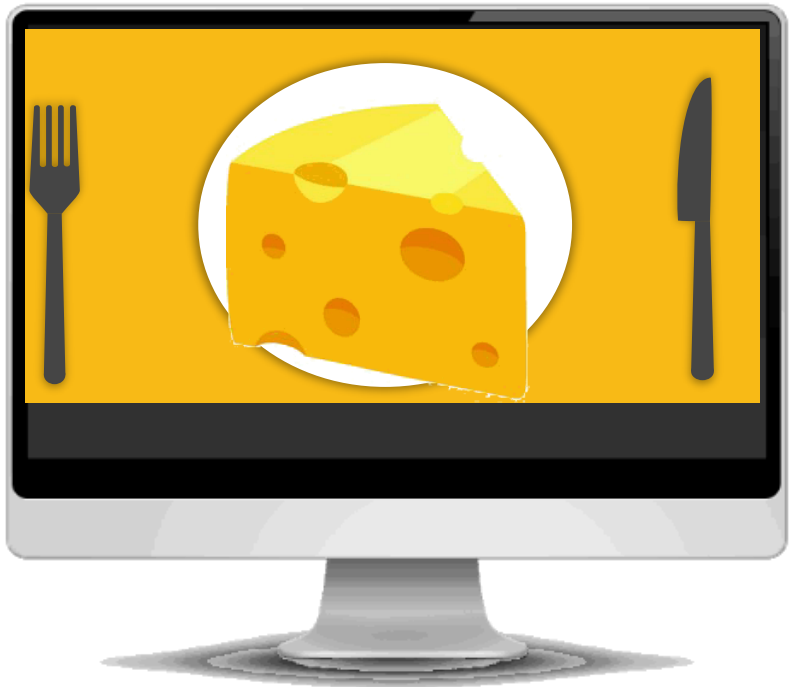
Efficacy of Whey Based Edible Coating Material for Paneer Preservation

By

Hosna Danzhe , Mobina Yaghoobi

Supervisor

Dr. Atefeh Sarafan Sadeghi



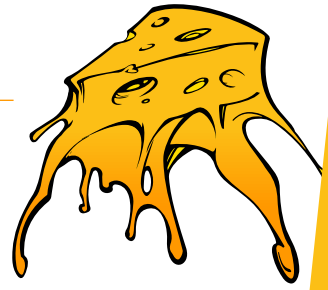
Date

2025/11/13

Journal of Veterinary and Animal Sciences

مرکز آموزش عالی
علوم پزشکی
وارستگان

فهرست مطالب



فهرست اختصارات

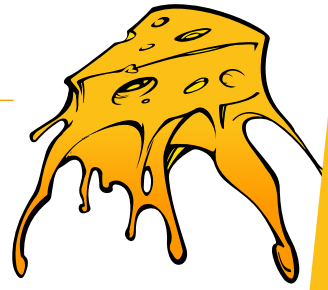
اصطلاح	معادل انگلیسی
pH	Potential of Hydrogen
TVC	Total Viable Count
CFU/g	Colony Forming Units per gram
WPC	Whey Protein Concentrate
SD	Standard Deviation

فهرست اختصارات

اصطلاح	معادل انگلیسی
DM	Dry Matter
TS	Total Solids
TA	Titratable Acidity
RH	Relative Humidity
CFU	Colony Forming Unit

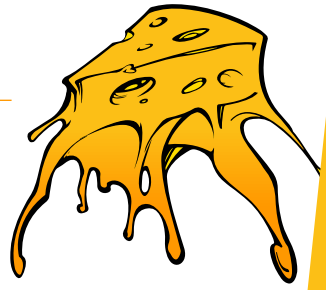
مرکز آموزش عالی
علوم پزشکی
وارستگان

فهرست اختصارات



اصطلاح	معادل انگلیسی
LDPE	Low Density Polyethylene
FSSAI	Food Safety and Standards Authority of India
AOAC	Association of Official Analytical
FFA	Free Fatty Acid
SPC	Standard Plate count

فهرست اختصارات

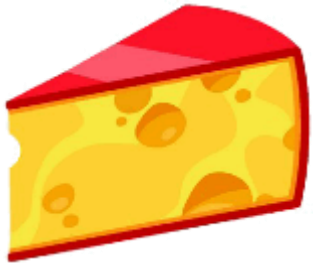


اصطلاح	معادل انگلیسی
TBA	Thiobarbituric Acid
MDA	Malondialdehyde
ANOVA	Analysis of Variance

مرکز آموزش عالی
علوم پزشکی
وارستگان

مقدمه

مقدمه

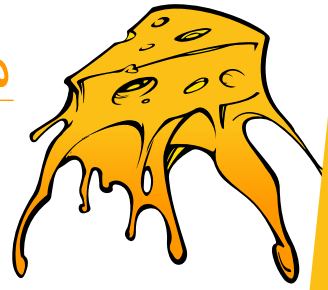


پنیر یکی از محصولات لبنی پرمصرف با ارزش تغذیه‌ای بالا در رژیم غذایی مردم هند است.

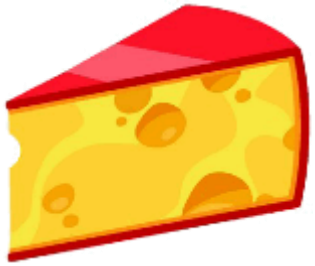
این محصول از انعقاد شیر به وسیله‌ی حرارت یا اسید تهیه می‌شود. به دلیل رطوبت بالا، محیط مناسبی برای رشد میکروارگانیسم‌ها است.

پنیر محصولی سفید با بافت نرم و یکنواخت با طعمی ملایم و اندکی اسیدی است شامل ۲۶ درصد چربی، ۱۶ درصد پروتئین، ۲ درصد لاکتوز و ۲ درصد مواد معدنی است.

مقدمه



محدودیت عرضه‌ی پنیر در بازار هند عمدتا ناشی از عمر ماندگاری کوتاه (۱ روز در دمای محیط، ۶ روز در یخچال) آن است.



فساد به دلیل رشد باکتری‌ها، کپک‌ها، افزایش اسیدیته، اکسیداسیون چربی و تجزیه پروتئین‌ها اتفاق می‌افتد.

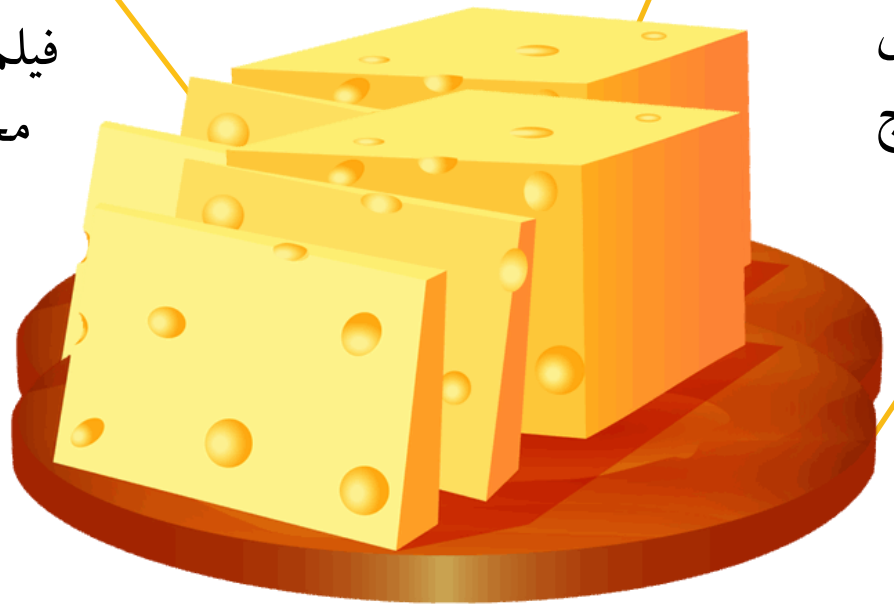
برخی روش‌ها برای افزایش ماندگاری موادغذایی شامل:

استفاده از عوامل ضد میکروبی

اسید لاکتیک : ضد باکتری
سوربات پتاسیم : ضد قارچ

بسته‌بندی خلأ

حذف اکسیژن



استفاده از پوشش‌های خوراکی طبیعی

فیلم‌های نازکی که به عنوان بخشی از محصول نهایی قابل خوردن هستند

مانع تبخیر آب و نفوذ اکسیژن

فیلم های خوراکی بر پایه آب‌پنیر (Whey)

محصول جانبی فرآیند تولید پنیر

افزایش ماندگاری موادغذایی

بهبود ارزش تغذیه‌ای موادغذایی

بازیافت موثر آب پنیر با تهیه فیلم

منبع ارزان، زیست‌تخریب‌پذیر و طبیعی

سدهای خوبی برای عبور اکسیژن، چربی و عطر هستند

مرکز آموزش عالی علوم پزشکی وارستگان

هدف پژوهش

اهداف جزئی:

تعیین اثر پوشش بر کیفیت حسی پنیر

مقایسه دو نوع بسته‌بندی (خلأ و معمولی)

بررسی تغییرات فیزیکوشیمیایی و میکروبی پنیرهای پوشش‌دار

هدف کلی:

ارزیابی پوشش خوراکی بر پایه آب‌پنیر حاوی اسیدلاکتیک و پتاسیم سوربات برای افزایش ماندگاری پنیر تازه

مرکز آموزش عالی
علوم پزشکی
وارستگان

مواد و روش ها

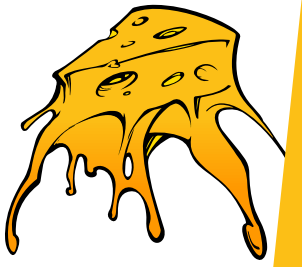
مواد

ماده	کاربرد	تامین کننده
شیر بوفالو	ماده خام تولید پنیر	Kerala Veterinary and Animal Sciences University Dairy Plant, Mannuthy
آب پنیر تغلیظ شده (۴۵٪ مواد جامد)	پایه پوشش خوراکی	University Dairy Plant, Mannuthy
اسید سیتریک	عامل ضد میکروبی	Nice chemicals, Thrissur
سوربات پتاسیم	ضد قارچ	Nice chemicals, Thrissur
گلیسرول با گرید خوراکی (۴٪)	نرم‌کننده (Plasticizer)	Nice chemicals, Thrissur
اسید لاکتیک	عامل ضد میکروبی	Nice chemicals, Thrissur
کیسه پلی‌اتیلن LDPE	بسته‌بندی نمونه‌ها	Capricorn Polymer Packaging Arimbur, Kerala

مواد

ماده	کاربرد	تامین کننده
محیط کشت پلیت کانت آگار	کشت میکروبی	Himedia,Mumbai
محیط کشت ویولت رد بایل آگار	کشت میکروبی	Himedia,Mumbai
محیط کشت پوتیتو دکستروز آگار	کشت میکروبی	Himedia,Mumbai

روش ها



آماده سازی کیسه‌های LDPE

استریل سازی با محلول پراکسید هیدروژن ۳۰ درصد

خشک کردن با هوای گرم ۸۰ درجه سانتی گراد

قرار گرفتن در معرض UV

تهیه‌ی پنیر

تولید پنیر توسط روش Bhattacharya و همکاران (1971)

قرار گرفتن پنیرها در آب سرد

برش به قطعات $5cm^3$

تهیه‌ی پوشش خوراکی

آب پنیر تغلیظ شده دارای ۴۵ درصد مواد جامد

افزودن گلیسرول ۴ درصد

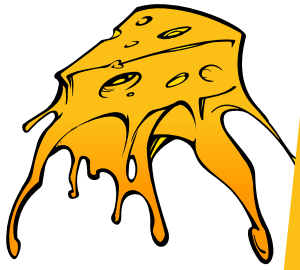
۱ ساعت همزدن به طور یکنواخت

حمام آب ۸۰ در جه سانتی گراد به مدت ۲۰ دقیقه

سرد شدن در دمای اتاق

افزودن اسیدلاکتیک ۲۵درصد سوربات پتاسیم ۱۲درصد

روش ها



اعمال پوشش بر روی پنیر

غوطه وری قطعات در محلول پوشش خوراکی

⬇

خشک شدن نمونه ها به مدت یک ساعت در دمای محیط

⬇

قرار گرفتن نمونه ها در کیسه های استریل LDPE

⬇

بسته بندی به دو روش
(Atmospheric, vacuum)

تعیین ترکیبات شیمیایی در دمای محیط

رطوبت و مواد جامد کل

روش Sachdera (1983)

pH

روش Keeree و همکاران (1976)

اسیدیته

AOAC (1990) برای پنیر

ارزیابی حسی در دمای محیط

بررسی کیفیت از نظر طعم، بافت، رنگ، ظاهر و پذیرش کلی

۵ داور

روش هدونیک ۹ امتیازی

مرکز آموزش عالی علوم پزشکی وارستگان

ارزیابی میکروبی

شمارش کلی باکتری ها با روش پورپلیت Mortan (2001)

شمارش کلی فرم و مخمر و کپک استاندارد ۱۲۲۴ (1981)

آنالیز آماری

آنالیز تغییرات فیزیکوشیمیایی و میکروبی با ANOVA

آزمون T-TEST

آنالیز داده های حسی با آزمون فریدمن و آزمون من–ویتنی

مطالعه پایداری در زمان نگهداری(۵روز)

اسیدهای چرب آزاد (FFA) روش Deeth و همکاران (1975)

شاخص اکسیداسیون چربی (TBA) روش Sidwell و همکاران (1995)

تایروزین (شاخص پروتئولیز) روش Juffs (1973)

مرکز آموزش عالی
علوم پزشکی
وارستگان

نتایج و بحث

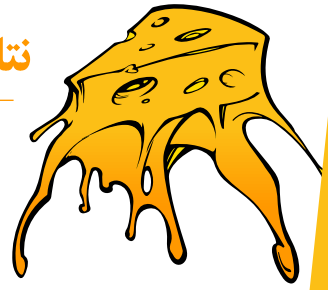
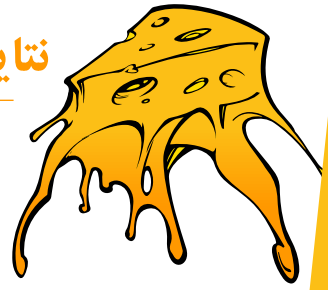


Table 1: Changes in physico-chemical attributes of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN pH DURING STORAGE						
Atmospheric packaging	5.95± 0.008^{a}	5.94 ± 0.006^{a}	5.94 ± 0.006^{a}	5.87 ± 0.008^{b}	5.78 ± 0.006^{c}	spoiled	105.05**
Vacuum packaging	5.95 ± 0.003^{a}	5.95 ± 0.003^{a}	5.94 ± 0.003^{a}	5.88 ± 0.01^{b}	5.79 ± 0.005^{b}	spoiled	179.62**
t- value	0.00^{ns}	-1.34^{ns}	-1.00^{ns}	-0.66^{ns}	-0.38^{ns}	-	
B	CHANGE IN ACIDITY DURING STORAGE (per cent LACTIC ACID)						
Atmospheric packaging	0.21 ± 0.008^{a}	0.22 ± 0.006^{a}	0.23 ± 0.008^{a}	0.24 ± 0.006^{ab}	0.26 ± 0.006^{b}	spoiled	10.21*
Vacuum packaging	0.20 ± 0.003^{a}	0.20 ± 0.003^{ab}	0.21 ± 0.003^{a}	0.24 ± 0.018^{a}	0.27 ± 0.009^{b}	spoiled	88.86**
t- value	1.02^{ns}	2.68^{ns}	1.41^{ns}	1.20^{ns}	1.77^{ns}		
C	CHANGE IN TOTAL SOLIDS DURING STORAGE (per cent)						
Atmospheric packaging	41.21 ± 0.12	41.22 ± 0.11	41.35± 0.10	41.61 ± 0.20	41.79 ± 0.23	spoiled	2.30^{ns}
Vacuum packaging	41.21± 0.10	41.21 ± 0.11	41.27± 0.13	41.42± 0.04	41.42± 0.04	spoiled	1.19^{ns}
t- value	0.00^{ns}	0.04^{ns}	0.48^{ns}	0.93^{ns}	1.72^{ns}	-	



D	CHANGE IN MOISTURE CONTENT DURING STORAGE (per cent)						
Atmospheric packaging	58.79 ± 0.10	58.77 ± 0.11	58.65 ± 0.10	58.39± 0.20	58.20 ± 0.21	spoiled	2.30^{ns}
Vacuum packaging	58.79 ± 0.11	58.78 ± 0.11	58.73± 0.13	58.58 ± 0.03	58.58 ± 0.06	spoiled	1.19^{ns}
t- value	0.00^{ns}	-0.04^{ns}	-0.48^{ns}	-0.93^{ns}	-1.72^{ns}		
E	CHANGE IN TBA VALUE DURING STORAGE (mg MDA / Kg)						
Atmospheric packaging	0.015± 0.002	0.015± 0.003	0.0157± 0.002	0.0203± 0.005	0.024± 0.003	spoiled	2.16^{ns}
Vacuum packaging	0.015 ± 0.002	0.015 ± 0.025	0.015± 0.002	0.015 ± 0.002	0.020 ± 0.004	spoiled	4.83^{ns}
t- value	0.00^{ns}	-0.09^{ns}	0.00^{ns}	0.85^{ns}	0.60^{ns}	-	
F	CHANGE IN TYROSINE DURING STORAGE (mg/100g)						
Atmospheric packaging	20.74 ± 0.07^{a}	20.97 ± 0.200^{a}	21.72 ± 0.233^{ab}	22.93 ± 0.29^{b}	24.35 ± 0.003^{c}	spoiled	59.51^{**}
Vacuum packaging	20.74 ± 0.07^{a}	20.896 ± 0.11^{ab}	21.27± 0.133^{b}	22.10 ± 0.055^{c}	23.40 ± 0.005^{d}	spoiled	128.47^{**}
t- value	0.00^{ns}	0.32^{ns}	1.69^{ns}	2.80^{ns}	142.00^{ns}		

^{ns}non significant ** significant at one percent level ($p \leq 0.01$)

*significant at five percent level ($p \leq 0.05$)

Figures are mean ± standard error of three replicates.

Means with different superscript (a, b, c and d) vary significantly within a row

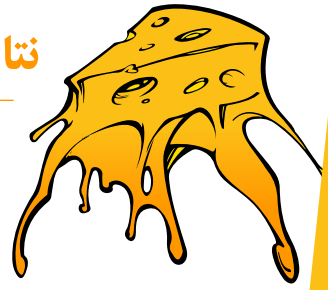


Table 2: Changes in microbial attributes of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN SPC (log_{10} cfu/g)						
Atmospheric packaging	2.20 ± 0.10^{a}	2.36± 0.058^{a}	2.63± 0.032^{b}	3.10± 0.10^{c}	3.72± 0.026^{d}	spoiled	161.39**
Vacuum packaging	2.10 ± 0.10^{a}	2.40 ± 0.099^{b}	2.89 ± 0.29^{abcd}	3.00 ± 0.00^{c}	3.66 ± 0.032^{d}	spoiled	22.67**
t- value	0.71^{ns}	-0.35^{ns}	-0.89^{ns}	1.00^{ns}	1.05^{ns}		
B	CHANGE IN COLIFROM (log_{10} cfu/g)						
Atmospheric packaging	nil	nil	nil	2.18 ± 0.066^{a}	2.63 ± 0.047^{b}	spoiled	319.74**
Vacuum packaging	nil	nil	nil	nil	nil	spoiled	-
t- value	-	-	-	-	-	-	-
C	CHANGE IN YEAST AND MOLD (log_{10} cfu/g)						
Atmospheric packaging	2.100 ± 0.10	2.10 ± 0.10	2.2± 0.10	2.3± 0.00	2.42± 0.058	spoiled	2.52^{ns}
Vacuum packaging	2.1 ± 0.10	2.0 ± 0.00	2.10± 0.10	2.100 ± 0.10	2.30 ± 0.00	spoiled	2.00^{ns}
t- value	0.00^{ns}	1.00^{ns}	0.71^{ns}	2.00^{ns}	2.00^{ns}		

^{ns} non significant ** significant at one percent level ($p \leq 0.01$) *significant at five percent level ($p \leq 0.05$)

Figures are mean±standard error of three replicates.

Means with different superscript (a, b, c and d) vary significantly within a row

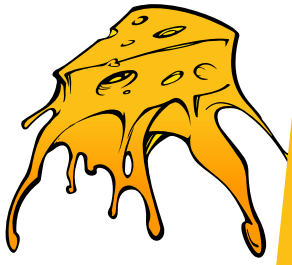
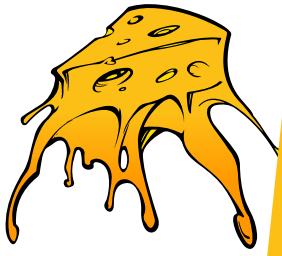


Table 3: Changes in sensory characteristics of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	Chi square value
A	CHANGE IN FLAVOUR						
Atmospheric packaging	8.33 ± 0.166^{a}	8.33± 0.166^{abc}	7.916 ± 0.08^{abc}	7.50 ± 0.38^{bc}	7.166 ± 0.166^{c}	spoiled	10.32*
Vacuum packaging	8.583± 0.08^{a}	8.583 ± 0.083^{abc}	8.08± 0.22^{abc}	7.75 ± 0.144^{bc}	7.33± 0.166^{c}	spoiled	11.09*
Z- value	-1.29^{ns}	-1.29^{ns}	-0.48^{ns}	-0.23^{ns}	-0.75^{ns}		
B	CHANGE IN BODY AND TEXTURE						
Atmospheric packaging	8.25± 0.26^{a}	8.25 ± 0.25^{a}	7.91 ± 0.08^{ab}	7.58± 0.08a^{b}	7.166 ± 0.166^{b}	spoiled	10.44*
Vacuum packaging	8.33 ± 0.166^{a}	8.33 ± 0.17^{a}	7.92 ± 0.08^{ab}	7.66 ± 0.08^{b}	7.33± 0.166^{b}	spoiled	11.21*
Z- value	-0.26^{ns}	-0.25^{ns}	0.00^{ns}	-0.75^{ns}	-0.75^{ns}		



C	CHANGE IN COLOUR AND APPEARANCE						
Atmospheric packaging	8.16± 0.166^{a}	8.16± 0.166^{a}	7.916 ± 0.08^{ab}	7.416 ± 0.33^{ab}	6.58 ± 0.08^{b}	spoiled	11.25*
Vacuum packaging	8.33 ± 0.166 ^{a}	8.17± 0.17^{a}	8.08± 0.22^{ab}	7.66 ± 0.08^{ab}	6.75 ± 0.144^{b}	spoiled	10.94*
Z- value	-0.75^{ns}	0.00^{ns}	-0.47^{ns}	-0.26^{ns}	-0.94^{ns}		
D	CHANGE IN OVERALL ACCEPTABILITY						
Atmospheric packaging	8.25 ± 0.25^{a}	7.91± 0.36^{a}	7.66± 0.33^{a}	7.50 ± 0.25^{a}	7.25 ± 0.25^{a}	spoiled	7.93^{ns}
Vacuum packaging	8.33 ± 0.17^{a}	8.17 ± 0.17^{a}	7.92± 0.08^{ab}	7.67 ± 0.08^{ab}	7.33 ± 0.30^{b}	spoiled	10.50*
Z- value	-0.26^{ns}	-0.47^{ns}	-0.26^{ns}	-0.26^{ns}	-0.47^{ns}		

^{ns} non significant ** significant at one percent level ($p \leq 0.01$)

*significant at five percent level ($p \leq 0.05$)

Figures are mean±standard error of three replicates.

Means with different superscript (a, b, c) vary significantly within a row

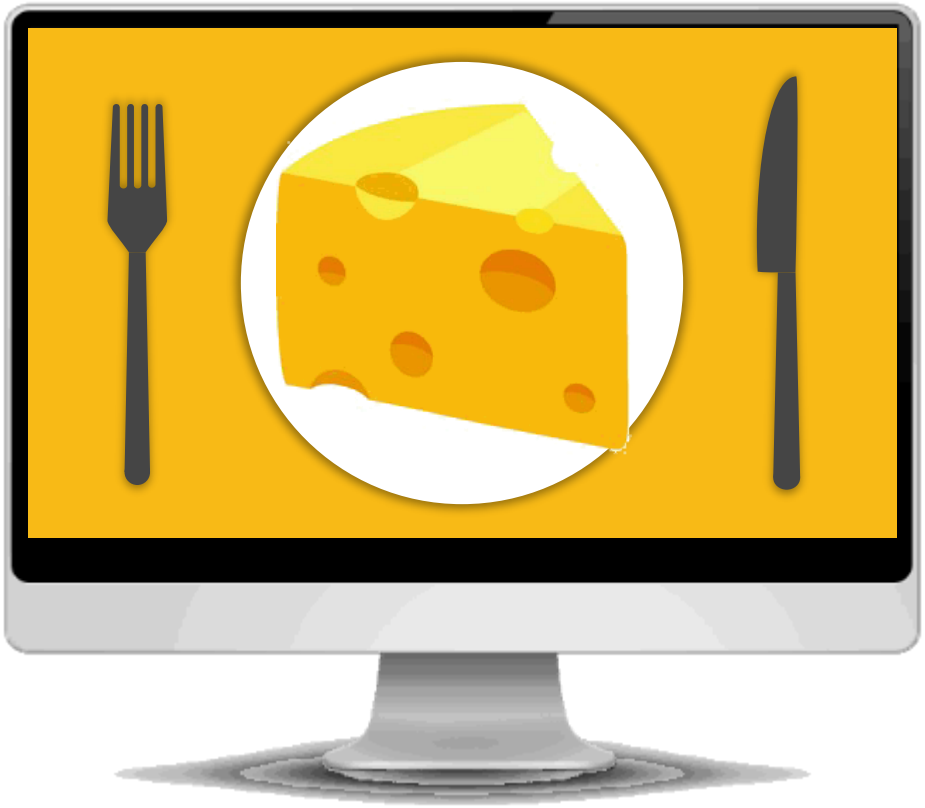
مرکز آموزش عالی
علوم پزشکی
وارستگان

نتیجه گیری نهایی

نتیجه گیری نهایی

نمونه‌های بسته‌بندی‌شده در شرایط خلأ نسبت به بسته‌بندی عادی مقادیر میکروبی پایین‌تری نشان دادند،
اما هیچ‌یک از دو روش نتوانستند ماندگاری پنیر را بیش از چهار روز در دمای محیط افزایش دهند.

نتایج نشان داد که تا روز چهارم، پنیرهای پوشش‌داده‌شده کاملاً سالم، از نظر طعمی قابل‌قبول و از نظر میکروبی در محدوده‌ی ایمن بودند.
اما در روز پنجم، شمارش میکروبی از حدود مجاز فراتر رفت و بوی ناخوشایندی در نمونه‌ها مشاهده شد.



مرکز آموزش عالی
علوم پزشکی
وارستگان

فهرست منابع

Ahuja, K. K. and Goyal, G. K. 2013. Combined effect of vacuum packaging and refrigerated storage on the chemical quality of paneer tikka. J. Food Sci. Technol. 50(3): 620-623.

Anbarasu, K., and Vijayalakshmi, G. 2007. Improved shelf life of protein-rich tofu using Ocimum sanctum (tulsi) extracts to benefit Indian rural population. J . Food Sci. . 72(8): M300-M305.

AOAC. 1990. Official methods of analysis. (15th Ed.). Association Official Agriculture Chemists, Washington D.C,USA.

Archana, S., Divya, K.B., Warrier, A.S., Arshath, M. and Rajakumar, S.N. 2023. Optimization of casein based edible coating for paneer using Response Surface Methodology. J. Vet. Anim. Sci.54(2):552-561

Bhattacharya, D.C., Mathur, O.N., Srinivasan, M.R. and Samlik, O. 1971. Studies on the method of production and shelf-life of paneer (cooking type acid coagulated cottage cheese). J. Food Sci. Technol. 8(5): 117-121.

Bukhari, S.A., Pathak, V., Bhat, Z.F. and Ahmad, S.R. 2012. Effect of Ambient Storage on the Quality Characteristics of Kaladhi: An Acid Coagulated Milk Product. Am. J. Food Technol. 7(4): 192-203.

Dwivedi, B., Yadav, B.L. and Gupta, M.P. 2014. Storage related changes in sensory profile of paneer spread. J. Rural Agric. Res. 14(1):9-11.

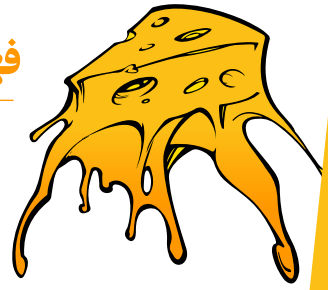
Deeth, H.C., Fitz-Gerald, C.H. and Wood, A.F. 1975. A convenient method for determining the extent of lipolysis in milk. Aust. J. Dairy Technol. 30: 109-111.

Han, J. H. 2002. Protein-based edible films and coatings carrying antimicrobial agents. In: Gennadios, A. (Ed.): Protein-based f ilms and coatings. CRC Press Florida. Pp 485-499.

IS:SP 1224 Part XI. 1981. Handbook of food analysis, analysis of dairy products. Bureau of Indian Standards. New Delhi.

Juffs, H. S. 1973. Proteolysis detection in milk: Interpretation of tyrosine value data for raw milk supplies in relation to natural variation, bacterial counts and other factors.J. Dairy Res.40(3):371-381.

Kanawjia, S.K. and Singh, S. 1996. Sensory and textural changes in paneer during storage. Buffalo J.12(3):329–334



Khatkar, A. B., Ray, A. and Kaur, A. 2017. Effect of addition of clove essential oil on the storage stability of paneer. The Pharma Innovation. 6(9, Part A): 39.

Khwaldia, K.; Ferez, C.; Banon, S.; Desobry, S.; Hardy, J. 2004. Milk proteins for edible f ilms and coatings. Crit. Rev. Food Sci. Nutr. 44: 239–251.

Ozdemir, M. and Floros, J. D. 2008. Optimization of edible whey protein films containing preservatives for mechanical and optical properties.J. Food Eng.84(1): 116-123.

Mishra, D.; Rao, K.J.; Bhardwaj, R.; Sutariya, H.; Kavitkar, R.S.; Subhash, W.S. 2016. Effect of pH on Sensory,Textural, Microbial Quality and Shelf-life of Paneer. Int. J. Food. Ferment. Technol. 6: 405–414.

Mortan, D.R. 2001. Aerobic plate count. In: Downes, F.P. and Ito, K. (ed.), Compendium of methods for the microbial examination of foods. (4th Ed.). American Public Health Association, Washington DC, pp. 63-68.

O’ Keeffee, B.R., Fox, F.P. and Daly, C. 1976. Contribution of rennet and starter proteases to proteolysis in cheddar cheese. J. Dairy Res .43: 97-102.

Ramos, Oscar L., J. O. Pereira, Sara I. Silva, Joao C. Fernandes, M. I. Franco, J. A. Lopes-da-Silva, M. E. Pintado, and F. Xavier Malcata. 2012. Evaluation of antimicrobial edible coatings from a whey protein isolate base to improve the shelf life of cheese.J. Dairy Sci. 95(11): 6282-6292.

Sachdeva, S. 1983. Production, Packaging and Preservation of Paneer. Ph.D. thesis, Kurukshetra University, Kurukshetra,100 p.

Seydim, A.C. and Sarikus, G. 2006. Antimicrobial activity of whey protein based edible films incorporated with oregano, rosemary and garlic essential oils. Food Res. Int. 39(5): 639-644.

Sidwell, C.G., Salwin, H. and Mitchell, J.H. 1955. Measurement of oxidation in dried milk products with thiobarbituric acid. J. Am. Oil Chem. Soc. 32:13-16.

Journal of Veterinary and Animal Sciences

About Journal | Aim and Scope | Author Guidelines | Editorial Board | Indexing and Abstracting

Volume: 55 **Issue:** 2

Open Access | Research Article

Efficacy of whey based edible coating material for paneer preservation

C. Ankitha Anto[1*], S. N. Rajakumar[1], A. T. Grace[1] and S. Archana[1]

1. Department of Dairy Technology College of Dairy Science and Technology, Mannuthy, Thrissur-680651 Kerala Veterinary and Animal Sciences University Kerala, India

*Corresponding author: ankithaanto@gmail.com, Ph. 9656846425

Year: 2024, **Page:** 275-283, **Doi:** https://doi.org/10.51966/jvas.2024.55.2.275-283

Received: Aug. 2, 2023 **Accepted:** March 7, 2024 **Published:** June 30, 2024

PDF

مرکز آموزش عالی
علوم پزشکی
وارستگان

Indexing and Abstracting

NAAS Score : 4.5

DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

Google Scholar

Academic Resource Index ResearchBib

Indian Science Abstracts

J-Gate

INDEX COPERNICUS INTERNATIONAL

Dimensions

CAS
A division of the American Chemical Society

مرکز آموزش عالی
علوم پزشکی
وارستگان

نقد ویراستاری

مرکز آموزش عالی علوم پزشکی وارستگان

Efficacy of whey based edible coating material for paneer preservation#

C. Ankitha Anto[1*], S. N. Rajakumar [2], A. T. Grace[1] and S. Archana[1]

Department of Dairy Technology
College of Dairy Science and Technology, Mannuthy, Thrissur-680651
Kerala Veterinary and Animal Sciences University
Kerala, India

Citation: Ankitha, A.C., Rajakumar, S.N., Grace, A.T. and Archana, S. 2024. Efficacy of whey based edible coating material for paneer preservation.
J. Vet. Anim. Sci. **55**(2):275-283
DOI: https://doi.org/10.51966/jvas.2024.55.2.275-283

ABSTRACT

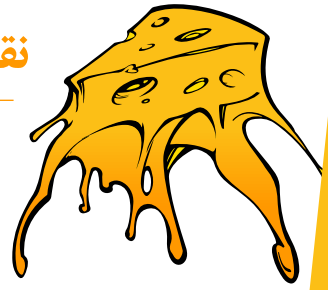
Paneer, a milk product coagulated by heat and acid, typically has a short shelf-life of one day at room temperature thus restricting its availability in the market. In this study, efforts were made to prolong its shelf-life at room temperature by applying an edible coating made from condensed whey mixed with antimicrobials (lactic acid and potassium sorbate). The condensed whey, concentrated to 45 per cent total solids, was combined with four percent glycerol as a plasticizer. A solution containing lactic acid and potassium sorbate (25per cent strength) was added at a 12per cent level to the condensed whey. Samples coated with this mixture and packaged in LDPE pouches showed a shelf-life of four days under ambient conditions. The standard plate count, coliform count and yeast and mould count expressed in Log_{10}cfu/g at the end of fourth day for this sample were 3.72 ± 0.026, 2.63 ± 0.047 and 2.42 ± 0.058 respectively and were within the FSSAI limits prescribed for paneer. This confirms the antimicrobial effect of the coating applied. The analysis of the samples' physicochemical properties indicated that the studied edible coating effectively prevented an undesirable rise in titratable acidity and helped maintain the product's moisture content. There was no significant difference observed in shelf-life between samples packaged using atmospheric and vacuum conditions; both methods provided a shelf-life of four days.

ABSTRACT

Paneer, a milk product coagulated by heat and acid, typically has a short shelf-life of one day at room temperature thus restricting its availability in the market. In this study, efforts were made to prolong its shelf-life at room temperature by applying an edible coating made from condensed whey mixed with antimicrobials (lactic acid and potassium sorbate). The condensed whey, concentrated to 45 per cent total solids, was combined with four percent glycerol as a plasticizer. A solution containing lactic acid and potassium sorbate (25per cent strength) was added at a 12per cent level to the condensed whey. Samples coated with this mixture and packaged in LDPE pouches showed a shelf-life of four days under ambient conditions. The standard plate count, coliform count and yeast and mould count expressed in Log_{10}cfu/g at the end of fourth day for this sample were 3.72 ± 0.026, 2.63 ± 0.047 and 2.42 ± 0.058 respectively and were within the FSSAI limits prescribed for paneer. This confirms the antimicrobial effect of the coating applied. The analysis of the samples' physicochemical properties indicated that the studied edible coating effectively prevented an undesirable rise in titratable acidity and helped maintain the product's moisture content. There was no significant difference observed in shelf-life between samples packaged using atmospheric and vacuum conditions; both methods provided a shelf-life of four days.

Spacing

INTRODUCTION



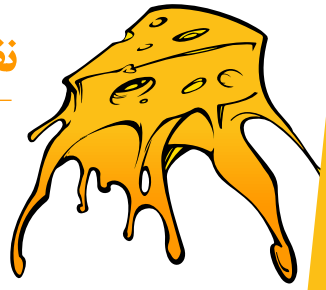
Keywords: *Paneer, edible coating, shelf-life extension*

Paneer is a popular indigenous milk product prepared by heat acid coagulation of cow or buffalo milk or a combination of thereof using citric acid or lactic acid or sour milk as the coagulating agent. It is characterised by a marble white colour, soft body, close knit texture and sweetish acidic nutty flavour. This traditional value-added dairy product contains around 26 percent of milk fat, 16 percent of protein, two percent of lactose and 1.5 to 2 percent of minerals which makes it highly

---

Title Introduction ✖

INTRODUCTION



Paneer is a popular indigenous milk product prepared by heat acid coagulation of cow or buffalo milk or a combination of thereof using citric acid or lactic acid or sour milk as the coagulating agent. It is characterised by a marble white colour, soft body, close knit texture and sweetish acidic nutty flavour. This traditional value-added dairy product contains around 26 percent of milk fat, 16 percent of protein, two percent of lactose and 1.5 to 2 percent of minerals which makes it highly

---

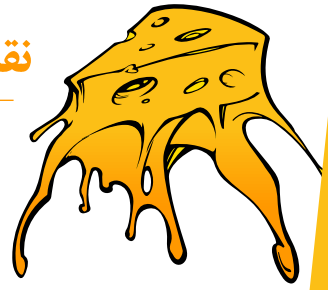
and 

INTRODUCTION

nutritious. However, the availability of paneer in the Indian market is limited due to its poor shelf-life (Kanawjia and Singh, 2000). Paneer can be stored only for a day at room temperature and for about six days under refrigerated condition without deterioration in its chemical and microbiological quality. Lipolysis, proteolysis, increased acidity and lowering of pH are the chemical changes, while increase in yeast and mould counts are the major microbial changes that affect product quality during its course of storage.

✅ Noun

INTRODUCTION



lactic acid and antifungal agents like potassium sorbate to this coating is expected to further ensure food safety and extension of shelf-life by reducing (or even preventing) growth of pathogenic and spoilage microorganisms. Hence treating paneer with whey based edible coating would certainly be effectual and practical (Archana *et al.*, 2023).

The present study focuses on investigating potential possibilities of employing whey based edible coatings containing glycerol (as plasticiser), lactic acid (as antimicrobial agent) and potassium (as antifungal agent) as an alternative shelf-life extension technique for paneer.

Materials and Methods

Plate count agar, Violet Red Bile Agar and Potato Dextrose Agar procured from Himedia, Mumbai.

Packaging material

LDPE pouches of size 10 cm x 5 cm was purchased from Capricorn Polymer Packaging, Arimbur, Kerala. The pouches were rinsed with 30 per cent hydrogen peroxide solution followed by hot air blast at 80°C and then subjected to UV irradiation for sterilisation.

were

Preparation of paneer

Paneer was prepared as per procedure by Bhattacharya *et al*. (1971) using buffalo milk. The paneer block was then cooled

nutritious. However, the availability of paneer in the Indian market is limited due to its poor shelf-life (Kanawjia and Singh, 2000). Paneer can be stored only for a day at room temperature and for about six days under refrigerated condition without deterioration in its chemical and microbiological quality. Lipolysis, proteolysis, increased acidity and lowering of pH are the chemical changes, while increase in yeast and mould counts are the major microbial changes that affect product quality during its course of storage.

Use of edible films and coatings is an emerging technique put into use for successful increase in the storage life of various products. "Edible coatings are a particular form of film designed for application directly onto the surface of target materials; they are normally regarded as part of the final product" (Han, 2002). The main advantage of edible films over traditional synthetics is that they can be consumed with the packaged products. Seydim and Sarikus (2006) reported that milk protein based edible coatings are excellent oxygen, lipid, and aroma barriers. Whey is obtained as

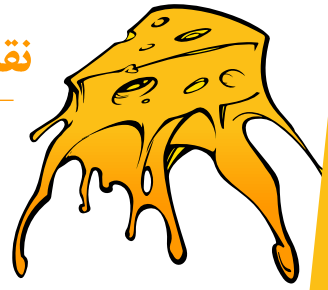
Preparation of paneer

Paneer was prepared as per procedure by Bhattacharya *et al*. (1971) using buffalo milk. The paneer block was then cooled and immersed in chilled water for one hour for texturisation. Later it was cut into uniform pieces of dimensions 5cm^3.

Materials and Methods

Microbiological quality

Standard plate count (SPC) of each paneer sample was estimated by pour plate technique, as described by Mortan (2001). Coliform count and yeast and mould counts of each paneer sample were enumerated using the method given in IS: 1224, 1981.



Sensory analysis

The paneer samples were evaluated organoleptically for different quality attributes like flavour, body and texture, colour and appearance and overall acceptability by a selected panel of judges comprising of five members. A nine-point hedonic scale score card was used for evaluation Mishra *et al.* (2016).

Microbiological quality

Standard plate count (SPC) of each paneer sample was estimated by pour plate technique, as described by Mortan (2001). Coliform count and yeast and mould counts of each paneer sample were enumerated using the method given in IS: 1224, 1981.

Storage studies

Sensory evaluation was performed for normal packed and vacuum-packed samples stored at room temperature. The free fatty acid (FFA) content of paneer samples was determined by extraction titration method suggested by Deeth *et al.* (1975). Thiobarbituric acid (TBA) value of paneer sample was determined according to the method recommended by

Application of edible coatings

The uniformly cut paneer pieces, were dipped completely into the edible coating solutions using sterilized tongs. The samples were then dried at room temperature for an hour. The coated paneer samples were aseptically packed into the previously sterilized pouches and sealed under normal and vacuum conditions.

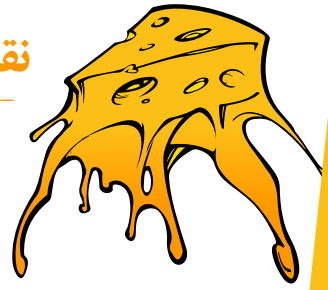
Proximate composition

Moisture and total solids in paneer samples were determined as per Sachdeva (1983). pH of the sample was estimated as per the procedure followed by O' Keeffee *et al.*

standard plate count, coliform count, yeast and mould count were also enumerated during storage. Paneer samples were analysed daily for a period of five days when stored at room temperature.

Statistical analysis

The statistically analysis of data for physico-chemical changes and microbiological changes were performed using repeated measures ANOVA and pair wise comparison was done using t-test. The data obtained from sensory analysis was statistically analysed using Friedman's test and Mann Whitney U test. All the statistical analysis was performed employing suitable computer packages under



ensure food safety and extension of shelf-life by reducing (or even preventing) growth of pathogenic and spoilage microorganisms. Hence treating paneer with whey based edible coating would certainly be effectual and practical (Archana *et al.*, 2023).

The present study focuses on investigating potential possibilities of employing whey based edible coatings containing glycerol (as plasticiser), lactic acid (as antimicrobial agent) and potassium (as antifungal agent) as an alternative shelf-life extension technique for paneer.

Preparation of edible coating

Edible coating was prepared as per the procedure by Ramos *et al.* (2012) with slight modifications. Whey was vacuum concentrated using vacuum evapourator Anhydro, Lab E, 1688 to 45per cent total solids (TS). To this glycerol was added at level four per cent as plasticizer. The coating mixture was magnetically stirred for one hour. This was then heated in a water bath at 80°C for 20 min and subsequently cooled to room temperature. To this coating, antimicrobial solution of lactic acid and anti-fungal solution of potassium sorbate

emerging technique put into use for successful increase in the storage life of various products. "Edible coatings are a particular form of film designed for application directly onto the surface of target materials; they are normally regarded as part of the final product" (Han, 2002). The main advantage of edible films over traditional synthetics is that they can be consumed with the packaged products. Seydim and Sarikus (2006) reported that milk protein based edible coatings are excellent oxygen, lipid, and aroma barriers. Whey is obtained as

Results and Discussion

Changes in TBA Value

The degree of lipid oxidation during storage is measured by using the TBA value. The TBA values for atmospheric packaged samples showed an increasing trend from the second day of storage while the same was observed for vacuum packaged sample on the fourth day. The TBA values for atmospheric and vacuum packaged samples changed from initial mean value of 0.015 to 0.024 mgMDA/kg and from 0.015 to 0.020 mgMDA/kg respectively on the fourth day of storage at ambient conditions. These results are consistent with the findings of

Results and Discussion

Vacuum packaging	0.015 ± 0.002	0.015 ± 0.025	0.015± 0.002	0.015 ± 0.002	0.020 ± 0.004	spoiled	4.83^{ns}
t- value	0.00^{ns}	-0.09^{ns}	0.00^{ns}	0.85^{ns}	0.60^{ns}	-	
F	CHANGE IN TYROSINE DURING STORAGE (mg/100g)						
Atmospheric packaging	20.74 ± 0.07^{a}	20.97 ± 0.200^{a}	21.72 ± 0.233^{ab}	22.93 ± 0.29^{b}	24.35 ± 0.003^{c}	spoiled	59.51**
Vacuum packaging	20.74 ± 0.07^{a}	20.896 ± 0.11^{ab}	21.27 ± 0.133^{b}	22.10 ± 0.055^{c}	23.40 ± 0.005^{d}	spoiled	128.47**
t- value	0.00^{ns}	0.32^{ns}	1.69^{ns}	2.80^{ns}	142.00^{ns}		

Changes in Tyrosine values

The extent of proteolysis during storage was measured using tyrosine value. The tyrosine value showed an increasing trend over the four days of storage. The values for atmospheric packaged samples increased from initial mean value of 20.74 to 24.35 mg/100ml while that for vacuum packaged

References

AOAC. 1990. *Official methods of analysis.* (15th Ed.). Association Official Agriculture Chemists, Washington D.C,USA.

Archana, S., Divya, K.B., Warrier, A.S., Arshath, M. and Rajakumar, S.N. 2023. Optimization of casein based edible coating for paneer using Response Surface Methodology. *J. Vet. Anim. Sci.* **54**(2):552-561

Khatkar, A. B., Ray, A. and Kaur, A. 2017. Effect of addition of clove essential oil on the storage stability of paneer. *The Pharma Innovation.* 6(9, Part A): 39.

Khwaldia, K.; Ferez, C.; Banon, S.; Desobry, S.; Hardy, J. 2004. Milk proteins for edible films and coatings. *Crit. Rev. Food Sci. Nutr.* **44:** 239–251.

مرکز آموزش عالی
علوم پزشکی
وارستگان

نقد علمی

ABSTRACT

Paneer, a milk product coagulated by heat and acid, typically has a short shelf-life of one day at room temperature thus restricting its availability in the market. In this study, efforts were made to prolong its shelf-life at room temperature by applying an edible coating made from condensed whey mixed with antimicrobials (lactic acid and potassium sorbate). The condensed whey, concentrated to 45 per cent total solids, was combined with four percent glycerol as a plasticizer. A solution containing lactic acid and potassium sorbate (25per cent strength) was added at a 12per cent level to the condensed whey. Samples coated with this mixture and packaged in LDPE pouches showed a shelf-life of four days under ambient conditions. The standard plate count, coliform count and yeast and mould count expressed in Log_{10}cfu/g at the end of fourth day for this sample were 3.72 ± 0.026, 2.63 ± 0.047 and 2.42 ± 0.058 respectively and were within the FSSAI limits prescribed for paneer. This confirms the antimicrobial effect of the coating applied. The analysis of the samples' physicochemical properties indicated that the studied edible coating effectively prevented an undesirable rise in titratable acidity and helped maintain the product's moisture content. There was no significant difference observed in shelf-life between samples packaged using atmospheric and vacuum conditions; both methods provided a shelf-life of four days.

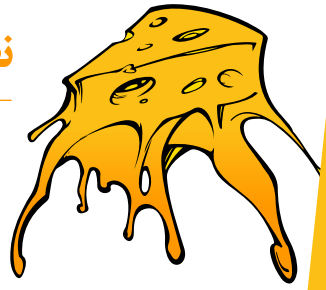
Keywords: *Paneer, edible coating, shelf-life extension*

whey

P-value
اندازه نمونه (n)

No Practical Conclusion in Abstract

INTRODUCTION



nutritious. However, the availability of paneer in the Indian market is limited due to its poor shelf-life (Kanawjia and Singh, 2000). Paneer can be stored only for a day at room temperature and for about six days under refrigerated condition without deterioration in its chemical and microbiological quality. Lipolysis, proteolysis, increased acidity and lowering of pH are the chemical changes, while increase in yeast and mould counts are the major microbial changes that affect product quality during its course of storage.

No Reference is Provided

Materials and Methods

Procurement of raw materials

Good quality buffalo milk used for paneer preparation was procured from Kerala Veterinary and Animal Sciences University Dairy Plant, Mannuthy. Freshly prepared whey obtained as a by-product of paneer manufacture was collected from University Dairy Plant, Mannuthy. Citirc acid, edible grade glycerol, lactic acid, potassium sorbate and analytical grade chemicals were purchased from Nice chemicals, Thrissur.

Materials and Methods

Preparation of paneer

Paneer was prepared as per procedure by Bhattacharya *et al*. (1971) using buffalo milk. The paneer block was then cooled and immersed in chilled water for one hour for texturisation. Later it was cut into uniform pieces of dimensions $5cm^3$.

Preparation of edible coating

Edible coating was prepared as per the procedure by Ramos *et al.* (2012) with slight modifications. Whey was vacuum concentrated using vacuum evapourator Anhydro, Lab E, 1688 to 45per cent total solids (TS). To this glycerol was added at level four per cent as plasticizer. The coating mixture was magnetically stirred for one hour. This was then heated in a water bath at 80°C for 20 min and subsequently cooled to room temperature. To this coating, antimicrobial solution of lactic acid and anti-fungal solution of potassium sorbate

Materials and Methods

Preparation of edible coating

Edible coating was prepared as per the procedure by Ramos *et al.* (2012) with slight modifications. Whey was vacuum concentrated using vacuum evapourator Anhydro, Lab E, 1688 to 45per cent total solids (TS). To this glycerol was added at level four per cent as plasticizer. The coating mixture was magnetically stirred for one hour. This was then heated in a water bath at 80°C for 20 min and subsequently cooled to room temperature. To this coating, antimicrobial solution of lactic acid and anti-fungal solution of potassium sorbate

Expression of Change

Materials and Methods

Sensory analysis

The paneer samples were evaluated organoleptically for different quality attributes like flavour, body and texture, colour and appearance and overall acceptability by a selected panel of judges comprising of five members. A nine-point hedonic scale score card was used for evaluation Mishra *et al*. (2016).

Chart

Materials and Methods

Statistical analysis

The statistically analysis of data for physico-chemical changes and microbiological changes were performed using repeated measures ANOVA and pair wise comparison was done using t-test. The data obtained from sensory analysis was statistically analysed using Friedman's test and Mann Whitney U test. All the statistical analysis was performed employing suitable computer packages under the guidance of a statistician.

The Software Names were not Mentioned

pouches and sealed under normal and vacuum conditions.

Proximate composition

Moisture and total solids in paneer samples were determined as per Sachdeva (1983). pH of the sample was estimated as per the procedure followed by O' Keeffee *et al*. (1976). The titratable acidity was determined by the method recommended by AOAC (1990) for cheese.

Sensory analysis

The paneer samples were evaluated organoleptically for different quality attributes like flavour, body and texture, colour and appearance and overall acceptability by a selected panel of judges comprising of five members. A nine-point hedonic scale score card was used for evaluation Mishra *et al*. (2016).

Microbiological quality

Standard plate count (SPC) of each paneer sample was estimated by pour plate technique, as described by Mortan (2001). Coliform count and yeast and mould counts of each paneer sample were enumerated using the method given in IS: 1224, 1981.

Storage studies

The statistically analysis of data for physico-chemical changes and microbiological changes were performed using repeated measures ANOVA and pair wise comparison was done using t-test. The data obtained from sensory analysis was statistically analysed using Friedman's test and Mann Whitney U test. All the statistical analysis was performed employing suitable computer packages under the guidance of a statistician.

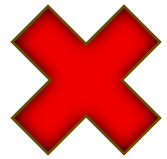
Results and discussion

Storage studies

In the present study storage stability of paneer coated with whey based edible coating was studied at room temperature storage under atmospheric and vacuum packaged conditions. The results of physico-chemical changes, microbiological changes and sensory changes are represented in Tables 1, 2 and 3 respectively.

Changes in pH and acidity

The pH of the atmospheric packaged and vacuum packaged samples changed from initial mean value of 5.95 to 5.78 and 5.95 to 5.79 respectively over a period of four days storage at room temperature. The F values for pH in both the samples were significant ($p \leq 0.01$) during the storage period. The acidity of the atmospheric and vacuum packaged samples changed from initial mean value of 0.21 to 0.28



Replicates

Results and Discussion

Storage studies

In the present study storage stability of paneer coated with whey based edible coating was studied at room temperature storage under atmospheric and vacuum packaged conditions. The results of physico-chemical changes, microbiological changes and sensory changes are represented in Tables 1, 2 and 3 respectively.

Results and Discussion

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN pH DURING STORAGE						
Atmospheric packaging	5.95± 0.008^{a}	5.94 ± 0.006^{a}	5.94 ± 0.006^{a}	5.87 ± 0.008^{b}	5.78 ± 0.006^{c}	spoiled	105.05**
Vacuum packaging	5.95 ± 0.003^{a}	5.95 ± 0.003^{a}	5.94 ± 0.003^{a}	5.88 ± 0.01^{b}	5.79 ± 0.005^{b}	spoiled	179.62**
t- value	0.00^{ns}	-1.34^{ns}	-1.00^{ns}	-0.66^{ns}	-0.38^{ns}	-	
B	CHANGE IN ACIDITY DURING STORAGE (per cent LACTIC ACID)						
Atmospheric packaging	0.21 ± 0.008^{a}	0.22 ± 0.006^{a}	0.23 ± 0.008^{a}	0.24 ± 0.006^{ab}	0.26 ± 0.006^{b}	spoiled	10.21*
Vacuum packaging	0.20 ± 0.003^{a}	0.20 ± 0.003^{ab}	0.21 ± 0.003^{a}	0.24 ± 0.018^{a}	0.27 ± 0.009^{b}	spoiled	88.86**
t- value	1.02^{ns}	2.68^{ns}	1.41^{ns}	1.20^{ns}	1.77^{ns}		
C	CHANGE IN TOTAL SOLIDS DURING STORAGE (per cent)						
Atmospheric packaging	41.21 ± 0.12	41.22 ± 0.11	41.35± 0.10	41.61 ± 0.20	41.79 ± 0.23	spoiled	2.30^{ns}
Vacuum packaging	41.21± 0.10	41.21 ± 0.11	41.27± 0.13	41.42± 0.04	41.42± 0.04	spoiled	1.19^{ns}
t- value	0.00^{ns}	0.04^{ns}	0.48^{ns}	0.93^{ns}	1.72^{ns}	-	

Numerical Comparison

Results and Discussion

B	CHANGE IN ACIDITY DURING STORAGE (per cent LACTIC ACID)						
Atmospheric packaging	0.21 ± 0.008^{a}	0.22 ± 0.006^{a}	0.23 ± 0.008^{a}	0.24 ± 0.006^{ab}	0.26 ± 0.006^{b}	spoiled	10.21*
Vacuum packaging	0.20 ± 0.003^{a}	0.20 ± 0.003^{ab}	0.21 ± 0.003^{a}	0.24 ± 0.018^{a}	0.27 ± 0.009^{b}	spoiled	88.86**
t- value	1.02^{ns}	2.68^{ns}	1.41^{ns}	1.20^{ns}	1.77^{ns}		
C	CHANGE IN TOTAL SOLIDS DURING STORAGE (per cent)						
Atmospheric packaging	41.21 ± 0.12	41.22 ± 0.11	41.35± 0.10	41.61 ± 0.20	41.79 ± 0.23	spoiled	2.30^{ns}
Vacuum packaging	41.21± 0.10	41.21 ± 0.11	41.27± 0.13	41.42± 0.04	41.42± 0.04	spoiled	1.19^{ns}
t- value	0.00^{ns}	0.04^{ns}	0.48^{ns}	0.93^{ns}	1.72^{ns}	-	
D	CHANGE IN MOISTURE CONTENT DURING STORAGE (per cent)						
Atmospheric packaging	58.79 ± 0.10	58.77 ± 0.11	58.65 ± 0.10	58.39± 0.20	58.20 ± 0.21	spoiled	2.30^{ns}
Vacuum packaging	58.79 ± 0.11	58.78 ± 0.11	58.73± 0.13	58.58 ± 0.03	58.58 ± 0.06	spoiled	1.19^{ns}
t- value	0.00^{ns}	-0.04^{ns}	-0.48^{ns}	-0.93^{ns}	-1.72^{ns}		
E	CHANGE IN TBA VALUE DURING STORAGE (mg MDA / Kg)						
Atmospheric packaging	0.015± 0.002	0.015± 0.003	0.0157± 0.002	0.0203± 0.005	0.024± 0.003	spoiled	2.16^{ns}
Vacuum packaging	0.015 ± 0.002	0.015 ± 0.025	0.015± 0.002	0.015 ± 0.002	0.020 ± 0.004	spoiled	4.83^{ns}

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN SPC (log_{10} cfu/g)						
Atmospheric packaging	2.20 ± 0.10^{a}	2.36± 0.058^{a}	2.63± 0.032^{b}	3.10± 0.10^{c}	3.72± 0.026^{d}	spoiled	161.39**
Vacuum packaging	2.10 ± 0.10^{a}	2.40 ± 0.099^{b}	2.89 ± 0.29^{abcd}	3.00 ± 0.00^{c}	3.66 ± 0.032^{d}	spoiled	22.67**
t- value	0.71^{ns}	-0.35^{ns}	-0.89^{ns}	1.00^{ns}	1.05^{ns}		
B	CHANGE IN COLIFROM (log_{10} cfu/g)						
Atmospheric packaging	nil	nil	nil	2.18 ± 0.066^{a}	2.63 ± 0.047^{b}	spoiled	319.74**
Vacuum packaging	nil	nil	nil	nil	nil	spoiled	-
t- value	-	-	-	-	-	-	-
C	CHANGE IN YEAST AND MOLD (log_{10} cfu/g)						
Atmospheric packaging	2.100 ± 0.10	2.10 ± 0.10	2.2± 0.10	2.3± 0.00	2.42± 0.058	spoiled	2.52^{ns}
Vacuum packaging	2.1 ± 0.10	2.0 ± 0.00	2.10± 0.10	2.100 ± 0.10	2.30 ± 0.00	spoiled	2.00^{ns}

Table 1: Changes in physico-chemical attributes of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN pH DURING STORAGE						
Atmospheric packaging	5.95± 0.008^{a}	5.94 ± 0.006^{a}	5.94 ± 0.006^{a}	5.87 ± 0.008^{b}	5.78 ± 0.006^{c}	spoiled	105.05**
Vacuum packaging	5.95 ± 0.003^{a}	5.95 ± 0.003^{a}	5.94 ± 0.003^{a}	5.88 ± 0.01^{b}	5.79 ± 0.005^{b}	spoiled	179.62**
t- value	0.00^{ns}	-1.34^{ns}	-1.00^{ns}	-0.66^{ns}	-0.38^{ns}	-	
B	CHANGE IN ACIDITY DURING STORAGE (per cent LACTIC ACID)						
Atmospheric packaging	0.21 ± 0.008^{a}	0.22 ± 0.006^{a}	0.23 ± 0.008^{a}	0.24 ± 0.006^{ab}	0.26 ± 0.006^{b}	spoiled	10.21*
Vacuum packaging	0.20 ± 0.003^{a}	0.20 ± 0.003^{ab}	0.21 ± 0.003^{a}	0.24 ± 0.018^{a}	0.27 ± 0.009^{b}	spoiled	88.86**
t- value	1.02^{ns}	2.68^{ns}	1.41^{ns}	1.20^{ns}	1.77^{ns}		
C	CHANGE IN TOTAL SOLIDS DURING STORAGE (per cent)						
Atmospheric packaging	41.21 ± 0.12	41.22 ± 0.11	41.35± 0.10	41.61 ± 0.20	41.79 ± 0.23	spoiled	2.30^{ns}
Vacuum packaging	41.21± 0.10	41.21 ± 0.11	41.27± 0.13	41.42± 0.04	41.42± 0.04	spoiled	1.19^{ns}
t- value	0.00^{ns}	0.04^{ns}	0.48^{ns}	0.93^{ns}	1.72^{ns}	-	

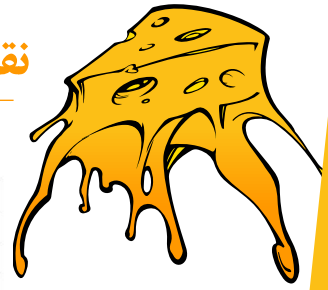
D	CHANGE IN MOISTURE CONTENT DURING STORAGE (per cent)						
Atmospheric packaging	58.79 ± 0.10	58.77 ± 0.11	58.65 ± 0.10	58.39± 0.20	58.20 ± 0.21	spoiled	2.30^{ns}
Vacuum packaging	58.79 ± 0.11	58.78 ± 0.11	58.73± 0.13	58.58 ± 0.03	58.58 ± 0.06	spoiled	1.19^{ns}
t- value	0.00^{ns}	-0.04^{ns}	-0.48^{ns}	-0.93^{ns}	-1.72^{ns}		
E	CHANGE IN TBA VALUE DURING STORAGE (mg MDA / Kg)						
Atmospheric packaging	0.015± 0.002	0.015± 0.003	0.0157± 0.002	0.0203± 0.005	0.024± 0.003	spoiled	2.16^{ns}
Vacuum packaging	0.015 ± 0.002	0.015 ± 0.025	0.015± 0.002	0.015 ± 0.002	0.020 ± 0.004	spoiled	4.83^{ns}
t- value	0.00^{ns}	-0.09^{ns}	0.00^{ns}	0.85^{ns}	0.60^{ns}	-	
F	CHANGE IN TYROSINE DURING STORAGE (mg/100g)						
Atmospheric packaging	20.74 ± 0.07^{a}	20.97 ± 0.200^{a}	21.72 ± 0.233^{ab}	22.93 ± 0.29^{b}	24.35 ± 0.003^{c}	spoiled	59.51**
Vacuum packaging	20.74 ± 0.07^{a}	20.896 ± 0.11^{ab}	21.27± 0.133^{b}	22.10 ± 0.055^{c}	23.40 ± 0.005^{d}	spoiled	128.47**
t- value	0.00^{ns}	0.32^{ns}	1.69^{ns}	2.80^{ns}	142.00^{ns}		

^{ns}non significant ** significant at one percent level ($p \leq 0.01$)

*significant at five percent level ($p \leq 0.05$)

Figures are mean ± standard error of three replicates.

Means with different superscript (a, b, c and d) vary significantly within a row



مرکز آموزش عالی علوم پزشکی وارستگان

Changes in Free Fatty Acids value (FFA)

Lipolysis associated with the product during storage was measured by using FFA values. The FFA values showed an increase from initial mean value of 1.433 to 1.87µeq/g for atmospheric packaged samples and an increase from 1.43 to 1.77µeq/g for vacuum packaged samples during its storage period of four days at room temperature. Significant difference ($p \leq 0.05$) for atmospheric packaged samples was noticed. F value vacuum packaged samples also showed significant difference ($p \leq 0.01$). There was no significant difference between the atmospheric packaged and vacuum packaged samples on analysis using independent t test. Similar observations were made Bukhari *et al*. (2012) in Kaladhi.

Table 1: Changes in physico-chemical attributes of coated paneer stored at room temperature

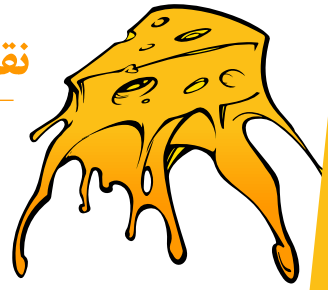
Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN pH DURING STORAGE						
Atmospheric packaging	5.95± 0.008^{a}	5.94 ± 0.006^{a}	5.94 ± 0.006^{a}	5.87 ± 0.008^{b}	5.78 ± 0.006^{c}	spoiled	105.05**
Vacuum packaging	5.95 ± 0.003^{a}	5.95 ± 0.003^{a}	5.94 ± 0.003^{a}	5.88 ± 0.01^{b}	5.79 ± 0.005^{b}	spoiled	179.62**
t- value	0.00^{ns}	-1.34^{ns}	-1.00^{ns}	-0.66^{ns}	-0.38^{ns}	-	
B	CHANGE IN ACIDITY DURING STORAGE (per cent LACTIC ACID)						
Atmospheric packaging	0.21 ± 0.008^{a}	0.22 ± 0.006^{a}	0.23 ± 0.008^{a}	0.24 ± 0.006^{ab}	0.26 ± 0.006^{b}	spoiled	10.21*
Vacuum packaging	0.20 ± 0.003^{a}	0.20 ± 0.003^{ab}	0.21 ± 0.003^{a}	0.24 ± 0.018^{a}	0.27 ± 0.009^{b}	spoiled	88.86**
t- value	1.02^{ns}	2.68^{ns}	1.41^{ns}	1.20^{ns}	1.77^{ns}		
C	CHANGE IN TOTAL SOLIDS DURING STORAGE (per cent)						
Atmospheric packaging	41.21 ± 0.12	41.22 ± 0.11	41.35± 0.10	41.61 ± 0.20	41.79 ± 0.23	spoiled	2.30^{ns}
Vacuum packaging	41.21± 0.10	41.21 ± 0.11	41.27± 0.13	41.42± 0.04	41.42± 0.04	spoiled	1.19^{ns}
t- value	0.00^{ns}	0.04^{ns}	0.48^{ns}	0.93^{ns}	1.72^{ns}	-	
D	CHANGE IN MOISTURE CONTENT DURING STORAGE (per cent)						
Atmospheric packaging	58.79 ± 0.10	58.77 ± 0.11	58.65 ± 0.10	58.39± 0.20	58.20 ± 0.21	spoiled	2.30^{ns}
Vacuum packaging	58.79 ± 0.11	58.78 ± 0.11	58.73± 0.13	58.58 ± 0.03	58.58 ± 0.06	spoiled	1.19^{ns}
t- value	0.00^{ns}	-0.04^{ns}	-0.48^{ns}	-0.93^{ns}	-1.72^{ns}		
E	CHANGE IN TBA VALUE DURING STORAGE (mg MDA / Kg)						
Atmospheric packaging	0.015± 0.002	0.015± 0.003	0.0157± 0.002	0.0203± 0.005	0.024± 0.003	spoiled	2.16^{ns}
Vacuum packaging	0.015 ± 0.002	0.015 ± 0.025	0.015± 0.002	0.015 ± 0.002	0.020 ± 0.004	spoiled	4.83^{ns}
t- value	0.00^{ns}	-0.09^{ns}	0.00^{ns}	0.85^{ns}	0.60^{ns}	-	
F	CHANGE IN TYROSINE DURING STORAGE (mg/100g)						
Atmospheric packaging	20.74 ± 0.07^{a}	20.97 ± 0.200^{a}	21.72 ± 0.233^{ab}	22.93 ± 0.29^{b}	24.35 ± 0.003^{c}	spoiled	59.51**
Vacuum packaging	20.74 ± 0.07^{a}	20.896 ± 0.11^{ab}	21.27± 0.133^{b}	22.10 ± 0.055^{c}	23.40 ± 0.005^{d}	spoiled	128.47**
t- value	0.00^{ns}	0.32^{ns}	1.69^{ns}	2.80^{ns}	142.00^{ns}		

^{ns}non significant ** significant at one percent level ($p \leq 0.01$)

*significant at five percent level ($p \leq 0.05$)

Figures are mean ± standard error of three replicates.

Means with different superscript (a, b, c and d) vary significantly within a row



مرکز آموزش عالی علوم پزشکی وارستگان

Table 2: Changes in microbial attributes of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	F value
A	CHANGE IN SPC (log_{10} cfu/g)						
Atmospheric packaging	2.20 ± 0.10^{a}	2.36± 0.058^{a}	2.63± 0.032^{b}	3.10± 0.10^{c}	3.72± 0.026^{d}	spoiled	161.39**
Vacuum packaging	2.10 ± 0.10^{a}	2.40 ± 0.099^{b}	2.89 ± 0.29^{abcd}	3.00 ± 0.00^{c}	3.66 ± 0.032^{d}	spoiled	22.67**
t- value	0.71^{ns}	-0.35^{ns}	-0.89^{ns}	1.00^{ns}	1.05^{ns}		
B	CHANGE IN COLIFROM (log_{10} cfu/g)						
Atmospheric packaging	nil	nil	nil	2.18 ± 0.066^{a}	2.63 ± 0.047^{b}	spoiled	319.74**
Vacuum packaging	nil	nil	nil	nil	nil	spoiled	-
t- value	-	-	-	-	-	-	-
C	CHANGE IN YEAST AND MOLD (log_{10} cfu/g)						
Atmospheric packaging	2.100 ± 0.10	2.10 ± 0.10	2.2± 0.10	2.3± 0.00	2.42± 0.058	spoiled	2.52^{ns}
Vacuum packaging	2.1 ± 0.10	2.0 ± 0.00	2.10± 0.10	2.100 ± 0.10	2.30 ± 0.00	spoiled	2.00^{ns}
t- value	0.00^{ns}	1.00^{ns}	0.71^{ns}	2.00^{ns}	2.00^{ns}		

^{ns} non significant ** significant at one percent level ($p \leq 0.01$) *significant at five percent level ($p \leq 0.05$)

Figures are mean±standard error of three replicates.

Means with different superscript (a, b, c and d) vary significantly within a row

nil :
no growth of microorganisms

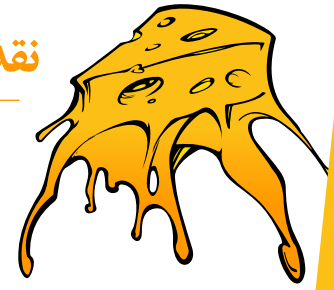


Table 3: Changes in sensory characteristics of coated paneer stored at room temperature

Sample	DAYS OF STORAGE						
	0	1	2	3	4	5	Chi square value
A	CHANGE IN FLAVOUR						
Atmospheric packaging	8.33 ± 0.166^{a}	8.33± 0.166^{abc}	7.916 ± 0.08^{abc}	7.50 ± 0.38^{bc}	7.166 ± 0.166^{c}	spoiled	10.32*
Vacuum packaging	8.583± 0.08^{a}	8.583 ± 0.083^{abc}	8.08± 0.22^{abc}	7.75 ± 0.144^{bc}	7.33± 0.166^{c}	spoiled	11.09*
Z- value	-1.29^{ns}	-1.29^{ns}	-0.48^{ns}	-0.23^{ns}	-0.75^{ns}		
B	CHANGE IN BODY AND TEXTURE						
Atmospheric packaging	8.25± 0.26^{a}	8.25 ± 0.25^{a}	7.91 ± 0.08^{ab}	7.58± 0.08a^{b}	7.166 ± 0.166^{b}	spoiled	10.44*
Vacuum packaging	8.33 ± 0.166^{a}	8.33 ± 0.17^{a}	7.92 ± 0.08^{ab}	7.66 ± 0.08^{b}	7.33± 0.166^{b}	spoiled	11.21*
Z- value	-0.26^{ns}	-0.25^{ns}	0.00^{ns}	-0.75^{ns}	-0.75^{ns}		
C	CHANGE IN COLOUR AND APPEARANCE						
Atmospheric packaging	8.16± 0.166^{a}	8.16± 0.166^{a}	7.916 ± 0.08^{ab}	7.416 ± 0.33^{ab}	6.58 ± 0.08^{b}	spoiled	11.25*
Vacuum packaging	8.33 ± 0.166 ^{a}	8.17± 0.17^{a}	8.08± 0.22^{ab}	7.66 ± 0.08^{ab}	6.75 ± 0.144^{b}	spoiled	10.94*
Z- value	-0.75^{ns}	0.00^{ns}	-0.47^{ns}	-0.26^{ns}	-0.94^{ns}		
D	CHANGE IN OVERALL ACCEPTABILITY						
Atmospheric packaging	8.25 ± 0.25^{a}	7.91± 0.36^{a}	7.66± 0.33^{a}	7.50 ± 0.25^{a}	7.25 ± 0.25^{a}	spoiled	7.93^{ns}
Vacuum packaging	8.33 ± 0.17^{a}	8.17 ± 0.17^{a}	7.92± 0.08^{ab}	7.67 ± 0.08^{ab}	7.33 ± 0.30^{b}	spoiled	10.50*
Z- value	-0.26^{ns}	-0.47^{ns}	-0.26^{ns}	-0.26^{ns}	-0.47^{ns}		

^{ns} non significant ** significant at one percent level (p≤0.01)

*significant at five percent level (p≤0.05)

Figures are mean±standard error of three replicates.

Means with different superscript (a, b, c) vary significantly within a row

Average

Conclusion

Microbiological analysis revealed that paneer coated with the optimized coating maintained satisfactory microbial counts (total viable count, coliforms, yeast, and mold) within FSSAI guidelines for four days at room temperature. Subsequently, the coated paneer samples were packaged under atmospheric and vacuum conditions and stored at room temperature. Storage studies included monitoring changes in physicochemical characteristics (pH, moisture content, total solids, TBA value, free fatty acids, and tyrosine), microbiological attributes (total viable count, coliforms, yeast, and mold), and sensory characteristics (flavor, body and texture, color and appearance, and overall acceptability). Based on the observed changes in physicochemical, microbiological, and sensory attributes during storage at room temperature, it was concluded that the coated paneer samples were well preserved for four days. By the fifth day, microbial counts exceeded FSSAI limits, and a slightly objectionable odor developed. Therefore, applying whey-based edible coatings to freshly prepared paneer samples is recommended to significantly extend their shelf life. Although samples packaged under vacuum conditions showed lower microbial counts compared to those packaged atmospherically, this packaging technique did not extend the product's shelf life beyond four days at room temperature.

Study limitations

Excessive assertiveness

References

Ahuja, K. K. and Goyal, G. K. 2013. Combined effect of vacuum packaging and refrigerated storage on the chemical quality of paneer tikka. *J. Food Sci. Technol.* **50**(3): 620-623.

Anbarasu, K., and Vijayalakshmi, G. 2007. Improved shelf life of protein-rich tofu using Ocimum sanctum (tulsi) extracts to benefit Indian rural population. *J. Food Sci.* . **72**(8): M300-M305.

AOAC. 1990. *Official methods of analysis.* (15th Ed.). Association Official Agriculture Chemists, Washington D.C,USA.

Archana, S., Divya, K.B., Warrier, A.S., Arshath, M. and Rajakumar, S.N. 2023. Optimization of casein based edible coating for paneer using Response Surface Methodology. *J. Vet. Anim. Sci.***54**(2):552-561

Bureau of Indian Standards. New Delhi.

Juffs, H. S. 1973. Proteolysis detection in milk: Interpretation of tyrosine value data for raw milk supplies in relation to natural variation, bacterial counts and other factors.*J. Dairy Res.***40**(3):371-381.

Kanawjia, S.K. and Singh, S. 1996. Sensory and textural changes in paneer during storage. *Buffalo J.***12**(3):329–334.

Khatkar, A. B., Ray, A. and Kaur, A. 2017. Effect of addition of clove essential oil on the storage stability of paneer. *The Pharma Innovation.* 6(9, Part A): 39.

Khwaldia, K.; Ferez, C.; Banon, S.; Desobry, S.; Hardy, J. 2004. Milk proteins for edible films and coatings. *Crit. Rev. Food Sci. Nutr.* **44:** 239–251.

Ozdemir, M. and Floros, J. D. 2008. Optimization of edible whey protein films containing preservatives for mechanical and optical properties.*J. Food Eng.***84**(1): 116-123.

Mishra, D.; Rao, K.J.; Bhardwaj, R.; Sutariya, H.; Kavitkar, R.S.; Subhash, W.S. 2016. Effect of pH on Sensory,Textural, Microbial Quality and Shelf-life of Paneer. Int. J. *Food. Ferment. Technol.* **6:** 405–414.

Mortan, D.R. 2001. Aerobic plate count. In: Downes, F.P. and Ito, K. (ed.), *Compendium of methods for the microbial examination of foods.* (4th Ed.). American Public Health Association, Washington DC, pp. 63-68.

O' Keeffee, B.R., Fox, F.P. and Daly, C. 1976. Contribution of rennet and starter proteases to proteolysis in cheddar cheese. *J. Dairy Res* .**43**: 97-102.

Ramos, Oscar L., J. O. Pereira, Sara I. Silva, Joao C. Fernandes, M. I. Franco, J. A. Lopes-da-Silva, M. E. Pintado, and F. Xavier Malcata. 2012. Evaluation of antimicrobial edible coatings from a whey protein isolate base to improve the shelf life of cheese.*J. Dairy Sci.* **95**(11): 6282-6292.

مرکز آموزش عالی
علوم پزشکی
وارستگان

ممنون از توجهتون