DEVELOPMENT OF READY-TO-SERVE SPICED PANEER

By

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CERTIFICATE I

*This is to certify that the project report entitled, "**Development of ready-to-serve spiced paneer**", submitted for the degree of Master of Science in the subject of **Food Science and Technology** of Chaudhary Charan Singh Haryana Agricultural University, Hisar, is a bonafide research work carried out by **Ms. Neha Gupta** (Admn. No. 2005FS178M) under my guidance and supervision and that no part of this project report has been submitted for any other degree.*

The assistance and help received during the course of investigation has been fully acknowledged.

Dr. R.S. Dabur

Major Advisor

CERTIFICATE II

*This is to certify that the project report entitled, "**Development of ready-to-serve spiced paneer**" submitted by Ms. **Neha Gupta** to Chaudhary Charan Singh Haryana Agricultural University, Hisar, in partial fulfillment of the requirement for the degree of Master of Science, in the subject Food Science and Technology has been approved by the student's advisory committee after an oral examination on the same.*

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HISAR

NEHA GUPTA

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CHAPTER - 1

INTRODUCTION

India is the largest milk producing country with approximately 100 million tones per annum (Economic Survey 2006-07). A significant portion of the milk produced is traditionally converted into a variety of heat and/or acid coagulated, heat dessicated and fermented intermediaries and products. It has been estimated that about 7% of total milk production, in India is converted into paneer.

According to Prevention of Food Adulteration Act, 1957; Paneer means the product obtained from cow or buffalo milk or a combination thereof, by precipitation with sour milk, lactic acid or citric acid. It shall not contain more than 70 per cent moisture and the milk fat content shall not be less than 50 per cent of the dry matter. Paneer contains entire milk casein, part of denatured whey proteins, almost all fat, colloidal salts and soluble milk solids in proportion to the moisture content retained. Paneer is characterized by typical mild acidic flavour with slightly sweet taste. It has firm, close, cohesive and spongy body and a smooth texture (Kanawjia et al., 1990).

The production of paneer has many advantages over the other dairy products. It provides one of the methods of conserving and preserving milk solids in concentrated forms. Paneer manufacturing and its handling requires equipments which are relatively less sophisticated and could easily be put to use for the manufacture of other allied products. The manufacturing process of paneer is so less time consuming, that considerable amount of milk could be handled at a time.

People's lifestyle influences food choice. The contemporary lifestyle of working families has moved convenience from pleasant luxury to a necessity. Healthy eating is important but so are diversity, variety and convenience. For this reason, the value addition to the produce is considered to be the aptest approach for making food production more lucrative and at the same time conserving regional and seasonal surpluses into a myriad range of nutritionally rich dairy products. This has led to a great demand for Indian style processed foods in ready-to-serve forms.

Spices have various effects when used in foods. Not only they impart – flavour, pungency and color characteristics; they also have antioxidant, antimicrobial, pharmaceutical and nutritional properties. In addition to these direct effects of spices, complex or secondary effects can be achieved during cooking i.e. using spices

for cooking causes salt reduction, sugar reduction and improved texture for certain foods. However, the use of spices is often limited by individuals likes and dislikes for certain flavours.

The shelf life of paneer improved significantly by application of various surface treatments at the refrigeration temperatures. However, the keeping quality of paneer did not improve at room temperature noticeably. The keeping quality of paneer could be improved markedly at room temperature by application of heat sterilization.

In view of the spices having desirable health benefits and flavour, increasing palatability of the product; development of ready-to-serve spiced paneer, will certainly improve the nutritional quality and acceptance of paneer. The present study was aimed at contemplating the below given objectives:

1. To standardize the technology for manufacture of ready-to-serve spiced paneer.
2. To monitor the physico-chemical, microbiological and sensory changes brought about during storage.

CHAPTER - 2

REVIEW OF LITERATURE

The present chapter deals with the review of literature under following headings:

2.1 Status of ready to Serve foods

2.2 Manufacturing Methods

2.3 Preservation

2.4 Packaging

2.5 Changes during storage

2.5 Effect of Spices

2.1 Status of ready to serve foods

Kapoor (1989) revealed that processed foods, ready-to-serve in particular, were very popular and briskly sold in super markets in grocery store.

Rangarao (1992) concluded that the so-called ready-to-eat revolution has become possible owing to the quality and cost advantages offered by the retort pouch technology compared to the age-old canning.

Deniau (1998) published that Amul Paneer frozen in cubes was launched by India's Gujrat Co-operative Milk Marketing federation Ltd. (GCMMI) in May 1997.

Rao and Patil (1999) formulated a Ready-To-Eat paneer curry and preserved it with the application of Hurdle Technology applying more than one preservation parameters such as water activity (a_w), pH, Redox potential (Eh) and heat treatment. They reported that the product could be accepted satisfactorily up to 30 days at room temperature (30˚c). Such paneer based convenience food was prepared by heat treatment, acidification and small reduction in water activity (a_w) with the suitable combinations of 0.8, 0.97 and 5.0 or 0.4, 0.96 and 5.0 for F value, a_w and pH respectively (Rao et al., 1992).

2.2 Manufacturing method

Vishweshwaraiah (1987) concluded that paneer cut into cubes and hot-air dried at 75°c for up to 4 hr had a moisture content of 15-18%; paneer extruded to increase the surface area and dried to for up to 2 hr retained less moisture (5-9%) and had a shelf-life of up to 2 months; paneer frozen at -9 or -15°c had a shelf-life of up to 8 days, although surface drying was observed.

Rao and Mathur (1990) developed a process for the manufacture of paneer involving concentration of standardized milk (2% fat, 9.2% SNF) to 27% TS by ultrafiltration, then subjection to a texturization process at 118°c for 5 minutes, which also inactivated microbial spores and yielded a long shelf-life product. This product had a greater proportion of whey proteins bound to the casein network than was found in traditional paneer, TS recovery was 95%, shelf-life was 3 months at 35°c and overall acceptability score was 8.5.

Rao *et al.* (1992) applied hurdle technology to the manufacture of paneer stable for 14 days at 30°c by mild heat treatment, a small reduction in aw and acidification; suitable combinations are – F value 0.8/a_w 0.97/pH 5.0 or F value 0.4/a_w 0.96/pH 5.0.

Kanawjia and Singh (2000) discussed following types of paneer: conventional (buffalo milk); low fat; cow milk; recombined and reconstituted; filled; protein-enriched filled; vegetable; soya; groundnut; ultrafiltration and long-life paneer and paneer curry. The application of brine, H_2O_2 and pimaricin or use of heat sterilization, to improve the shelf-life of paneer.

Makhal *et al.* (2002) revealed that mechanization of paneer-making using the centrifugal process, ultrafiltered milk and in-package texturization concept have been developed. Process innovations in paneer manufacture such as use of buttermilk, caseinate-enriched milk, buffalo milk blended with whey solids, low fat milk, recombined milk, reconstituted milk, soya milk, coconut milk, milk fortified with vegetable fat, among others, have been discussed.

Sreedhara and Balasubramanyam (2003) revealed that use of turmeric powder and garam masala significantly improved the flavour of the product. The use of maize flour had direct influence on body and texture. Addition of paneer cubes after frying improved the acceptability. The use of one part of paneer to five parts of gravy was found to be optimum to produce a good quality paneer curry.

Singh and Rai (2004) carried out hot and cold diffusion of paneer cubes with sodium chloride and potassium sorbate solution and subsequent microwave drying to extend the shelf-life of paneer. Microwave drying of paneer cubes at 70, 80 and 90% power level had significant effect ($p<0.01$) on moisture, fat and FDM level. Maximum rehydration ratio was achieved in cold (1.03) and hot

(1.09) diffused microwave dried paneer cubes at 30 degrees C for 10 minutes.

Yellamanda *et al.* (2006) subjected paneer cubes to oven drying and oil frying, pickled using a base consisting of tomato, tamarind, cooking oil and spices at a ratio of 1:3 (w/w). They reported that moisture content decreased; acidity increased; flavour and overall acceptability scores decreased and chewiness scores increased during storage period of 3 months at room temperature.

2.3 Preservation

Singh *et al.* (1988) reported that flavour of paneer was acceptable up to 16 days of storage at 8±1°c in brine and 12 days in chilled or acidified water with continuous dipping.

Singh and Kanawjia (1990) reported that dipping paneer blocks in solutions of H_2O_2 + Delvocid at 8°c for 2 hr increased the shelf-life of paneer packaged without vaccum to 35 days and 50 days (if, vacuum packaged).

Thakral *et al.* (1990) found out that keeping quality of paneer containing 0.1% potassium sorbate was extended by 13, 3-4 and 1 day at 7, 22 and 37°c respectively.

Kumar and Bector (1991) declared that titrable acidity, FFA level, soluble N content and microbial counts increased at a slower rate in paneer containing TBHQ and/or BHA than in control paneer; TBHQ tending to have greatest effect and rates of change increasing with increase in storage temperature. They increase shelf life of paneer to about 20, 7 days and 90 hr at 5, 15 and 25°c resp. of temperatures.

Singh *et al.* (1991) concluded that combination treatment of 0.10% sorbic acid in milk and irradiation of the product at 2.5 KGy preserved the paneer for 30 days at ambient temperature (25-35°c) giving good acceptance scores.

Sachdeva and Singh (1995) discussed innovative approaches in the manufacture – optimum processing conditions; coagulants; incorporation of certain hydrocolloids and preservation – chilling; brining; vaccum packaging; heat sterilization of paneer.

Nayak and Bector (2001) observed significantly lower pH and higher titrable acidity, water soluble N and free acidity contents in urea-added paneer samples. However, urea had no marked influence on gross chemical composition except for total protein and FFA of paneer. Chemical changes in paneer during storage were less pronounced as compared to that of control paneer.

Uprit and Mishra (2003) concluded that a hot air temperature of 53.5°c and microwave power of 111.5 W gave good-quality dried SFP cubes of uniform texture and surface, unblemished and with clear colour. The dried SFP cubes rehydrated well and had a shelf-life of 118 days under accelerated storage conditions (38±2°c, 90% RH).

Nanda *et al.* (2004) developed models capable of predicting the quality and yield of processed paneer using response surface methodology to determine the optimum processing conditions.

2.4 Packaging

Kumar and Srinivasan (1983) found laminates of poster paper/Al foil/low-density polyethylene and of moisture-proof, transparent, heat-sealable cellulose film/low-density polyethylene suitable for packaging milk products with high fat content and polyethylenes, polyvinylchloride and regenerated cellulose films suitable for milk products with low fat contents.

Shukla and Vaid (2004) reported significant decrease in moisture, fat and protein content and increase in acidity, FFA and peroxide value at both room temperature and refrigeration temperatures in all the packaging materials during storage of oil-based paneer pickle. The pickle remained microbiologically safe

and was acceptable up to 2 months of storage at both storage temperatures.

Stevanovic and Vujkovic (2005) reported that polypropylene compound packaging has much better characteristics, and particularly the one made of co-extruded multi-layer ribbon ensuring the conditions of sterilization at temperatures upto 121°c.

2.5 Storage study

Sachdeva (1983) investigated that heat sterilization of paneer was the only effective way of improving the keeping quality of paneer at room temperature. Paneer cubes packed in tin cans and sterilized in an autoclave at 15psi for 15 minutes were stored well over a period of 50 days at ambient temperature. Thereafter, perception of a mouldy character rendered the samples unacceptable. Slight browning coupled with a cooked flavour affected the organoleptic quality of paneer but this antagonism was overcome to a great extent during frying and cooking. He also suggested that sterilization along with small amount of water in tin cans was effective in reducing the degree of defects caused by heat sterilization. Frying of paneer cubes prior to heat sterilization was also investigated but the product deteriorated earlier due to the development of pronounced oxidized flavour within 40 days of storage.

Zanjad and Mathur (1990) concluded that 'in-package' sterilized paneer prepared from ultrafiltered milk (27% TS) and in-package texturized at 118°c/5 min. remained acceptable for 2 months at 35°c and 45 days at 45°c.

Zanjad and Mathur (1992) found out that levels of HMF (µmol) in paneer from ultrafiltered (27% TS) and vaccum-conc. (30% TS) milk that was in-package texturized at 118°c/5min. and stored at 35 and 45°c resp. increased from 11.76 and 17.34 initially to 15.05 and 25.16 after 30 days and 16.91 and 33.15 after 60 days at 35°c, or to 20.89 and 31.07 after 30 days, and 35.36 and 49.77 after 60 days at 45°c. The increase in HMF accelerated towards the end of storage at 45°c.

Zanzad and Mathur (1994) filled pasteurized, concentrated buffalo milk (5% fat, 25% SNF) at a pH of 5.8 into metallized polyster pouches, texturized at 118°c/5 min., air-cooled and stored at 35 and 45°c. During storage, increase in hardness, gumminess and chewiness were greater at 45 than 35°c, whilst cohesiveness decreased up to 45 days, then increased.

Pal (1998) found out that during storage of paneer at 82°c total counts of mesophilic bacteria, yeast and moulds as well as coliforms increased ($P<0.05$) during 15 days of storage. There was a highly positive correlation between these counts and thiobarbituric

acid (TBA), titratable acidity and tyrosine values (r=0.80 to 0.94), whilst a highly negative correlation was found to exist between microbial counts, residual lactose and pH (r=-0.90 to -0.98).

2.6 Effect of spices

Meena (1992) carried out studies on different concentrations of spice powder and salt (8, 16%) to find out the relative effectiveness of these food additives in inhibiting the growth of yeast, moulds and bacteria. It was observed that effect of spices as preservatives varied with the amount of salt added in test medium.

Madsen and Bertelsen (1995) reviewed antioxidant properties of spices: antioxidant components, quantification of antioxidative activity, synergism of spices, and effect of heat treatment and industrial application of spices as antioxidants.

Meena and Sethi (1996) studied antimicrobial activity of some common spices. Clove was most effective followed by cinnamon, mustard, ajowain and cumin at lower concentration at ambient temperature (25-30°c) and at 37°c. In the presence of salt (8%) the concentration of spice powder was reduced for checking the microbial growth.

Sethi and Meena (1997) used essential oils of some spices at very low concentration to check the food spoilage. In spicy products such as pickles, chutneys, sauces and spiced beverages,

condiments and spices will not only increase the palatability of food but they will also check their spoilage better along with small quantity of salt without using any chemical preservatives.

Hassan *et al.* (2001) found out that clove prevents the mould growth and mycotoxin production, while black pepper stimulated the mould growth but prevented mycotoxin production. Several spices and herbs were found to encourage the mould and production of mycotoxins.

Jasinka and Wasik (2005) reported that the effect of 1%, 2% and 3% spices added (i.e. savory, garlic, dill and chives) did not caused a decrease in lipolysis and oxidation of butter's lipids under cold storage. The highest acidity was in butter lipids with 2% and 3% savory and 3% of dill added. Only garlic was found to limit lipolysis and oxidation in butter.

CHAPTER - 3

MATERIAL & METHODS

This chapter deals with material used and methods adopted in the preparation of ready to serve spiced paneer, together with standard analytical procedures used in the present study are discussed under the following heads and subheads:

3.1 Procurement of raw material

3.1.1 Milk

3.1.2 Citric acid

3.1.3 Salt

3.1.4 Spices and additives

3.1.5 Curd

3.1.6 Media

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3.2 Methods

3.2.1 Manufacture of paneer

3.2.2 Standardization of technology of ready to serve spiced paneer.

3.2.2.1 Marination preparation

3.2.2.2 Marination application

3.2.2.3 Marination time

3.2.2.4 Packaging

3.2.2.5 Heat treatment

3.2.3 Shelf life study

3.2.4 Sampling

3.2.4.1 Sensory evaluation

3.2.4.2 Physico-chemical analysis

3.2.4.3 Bacteriological analysis

3.2.5 Analysis

3.2.5.1 Sensory evaluation

3.2.5.2 Physico-chemical analysis

3.2.5.2.1 pH

3.2.5.2.2 Titratable acidity

3.2.5.2.3 Moisture content

3.2.5.2.4 Free fatty acids (FFA)

3.2.5.3 Microbiological analysis

3.2.5.3.1 Standard plate count

3.2.5.3.2 Spore former count

2.6.6 Statistical analysis

3.1 Procurement of raw materials:

3.1.1 Milk

Standardized milk (4.5% fat and 8.5% SNF) was procured from the Department of Animal Product Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

3.1.2 Citric Acid

Citric acid monohydrate of SRL (Sisco Research Lab.), Mumbai was procured.

3.1.3 Salt

Commercial grade fine salt of M/S Tata Chemicals, Mumbai was procured from local market.

3.1.4 Spices and additives

Cumin, coriander, red pepper and black pepper (MDH), sugar, ginger and garlic were procured from local market.

2.6.5 Curd

Curd of Vita (Hisar-Jind Dairy Cooperative Milk Plant, Jind) was procured from local market.

3.1.6 Media

Plate count agar (Hi-Media) was procured.

2.2 Methods

2.2.1 Manufacture of Paneer

Paneer was prepared as per the method suggested by Sachdeva and Singh (1988).

3.2.2 Standardization of technology of ready to serve spiced paneer

Spiced paneer was prepared by marinating the paneer cubes using thick curd with spices.

3.2.2.1 Marination preparation

Curd was hanged in a muslin cloth for about 30 minutes, to drain off water and thick curd was obtained. In 100 gm thick curd weighed amount of spices were added and mixed thoroughly. Six formulations of marination were prepared which are as follows:

Ingredients	**Formulations**					
	Category I			**Category II**		
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**
Cumin	2.5	2.5	2.5	2.5	2.5	2.5
Coriander	2.5	2.5	2.5	2.5	2.5	2.5
Salt	2.0	2.0	2.0	2.0	2.0	2.0
Sugar	2.0	2.0	2.0	2.0	2.0	2.0
Ginger	20.0	10.0	5.0	-	-	-
Garlic	10.0	5.0	2.5	-	-	-
Red-pepper	-	-	-	2.50	1.25	0.62
Black -pepper	-	-	-	0.50	0.25	0.12

2.2.1.2 Marination application

Paneer was cut into 1cmx1cmx1cm cubes and all the above marination formulations were applied to 300 gm paneer cubes.

2.2.1.3 Marination time

Marinated paneer cubes were left for 60, 120 and 180 minutes, for maturation. The one best marination time was selected from each category of spiced paneer formulations based on sensory attributes and used for further studies.

3.2.2.4 Packaging

300 gm marinated paneer cubes were packaged in polyster pouches and sealed properly.

3.2.2.5 Heat treatment

Packaged spiced paneer samples were given heat treatment in heat sterilizer at 15 psi for 10, 15 and 20 minutes.

Best time for heat treatment was selected on the basis of texture attributes of spiced paneer cubes.

3.2.3 Shelf life study

The selected ready-to-serve (RTS) spiced paneer formulations were stored at room temperature (16-25°c) and samples were drawn for analysis on 0^{th} day, 15^{th} day, 30^{th} day, 45^{th} day and 60^{th} days respectively for sensory, physico-chemical and bacteriological analysis.

3.2.4 Sampling

3.2.4.1 Sensory evaluation

Stored samples of RTS spiced paneer were offered as such for sensory evaluation.

2.2.1.2 Physico-chemical analysis

Paneer cubes were drawn using a clean and sterilized stainless steel spatula. Spices were removed from the surface of paneer cubes and grounded with the help of porcelain pestle and mortar and then sample were drawn for analysis.

2.2.1.3 Bacteriological analysis

Stored paneer cubes were drawn out from package using a sterilized stainless steel spatula. 1 gram of paneer sample was aseptically weighed and transferred to a pre-sterilized pestle and mortar and grounded. The sample dilutions were made using 9 ml of peptone water.

3.2.5 Analysis

3.2.5.1 Sensory evaluation

Stored samples of RTS spiced paneer were evaluated organoleptically for their acceptability by a panel of semi-trained judges using 9-point Hedonic scale (Lawless and Haymann, 1998).

3.2.5.2 Physico-chemical analysis

Samples of selected RTS formulations were analysed for pH, acidity, moisture content and free fatty acids (FFA).

3.2.5.2.1 pH

The electrodes of Eutech pocket pH scan1 were dipped in the thoroughly mixed sample and readings were recorded. The process was repeated 2-3 times by dipping the electrodes.

2.2.1.3.2 Titratable acidity

The titratable acidity of RTS Spiced Paneer was determined as per the procedure given in AOAC (1984).

$$\% \text{ Acidity} = \frac{\text{Volume of 0.1 N NaOH used X 0.9}}{\text{Weight of sample taken}}$$

2.2.1.3.3 Moisture content

Per cent moisture in RTS Spiced paneer was determined as per method described in BIS Handbook for cheese (1989). Moisture percentage was calculated as follows:

$$\% \text{ Moisture} = 100 \times \frac{\text{Wt. of (Dish+Sample) Before drying} - \text{Wt. of (Dish+Sample) After drying}}{}$$

Weight of Sample

2.2.1.3.4 Free fatty acids (FFA)

FFA was determined by the method given by Koniecko (1979).

5 grams of sample was blended with 30 ml of chloroform for about 2 minutes, in the presence of about 5 grams of anhydrous sodium sulphate. Contents were filtered into a 250 ml conical flask by using Whatman Filter Paper No. 1. Titrate the filterate against 0.1N alcoholic KOH (0.1gm KOH in 100ml of alcohol), using phenolphthalein as indicator. % FFA was calculated as follows:

$$\%FFA = \frac{\text{Volume of 0.1N KOH used X 28.2 X 0.1}}{\text{Weight of Sample}}$$

2.2.1.3 Microbiological analysis

RTS spiced paneer samples were evaluated for Standard Plate Count (SPC) and Spore Former Count as per procedures given in American Public Health Association (2001).

3.2.5.3.1 Standard plate count

23.5 g of media was suspended in 1000 ml of distilled water and boiled. Media was sterilized by autoclaving at 15 psi for 15

minutes. After plating, the plates were incubated at 37±1°C for 48 hours. Plates with 30 to 300 colonies were selected for counting.

2.2.1.3.2 Spore former count

In this, sample dilutions are heated to 80°C for 30 minutes and then cooled down to 50°C for 5 minutes, before pouring to the plates, rest of the procedure was same as mentioned above for SPC.

2.2.6 Statistical analysis

The data obtained from various experiments during were analyzed statistically by two way analysis of variance (ANOVA) technique as described by Snedlcor and Cochran (1980).

CHAPTER 4

RESULTS & DISCUSSIONS

The present study was undertaken for two different types of ready-to-serve (RTS) spiced paneer and their evaluation for sensory acceptability, physico-chemical properties and microbiological count during storage study at room temperature; discussed under the following heads and subheads:

4.1 Selection of marination formulation

4.2 Selection of marination time

4.3 Selection of time for heat treatment

4.4 Shelf life study of developed RTS spiced paneer

4.4.1 Sensory acceptability

4.4.2 Effect of storage on physico-chemical properties

4.4.2.1 pH & acidity

4.4.2.1.1 pH

4.4.2.1.2 Acidity

4.4.2.2 Moisture content & free fatty acid (FFA)

4.4.2.2.1 Moisture content

4.4.2.2.2 Free fatty acid

4.4.3 Effect of storage on microbiological properties

4.4.3.1 Standard plate count

4.4.3.2 Spore former count

With the objective to add variety to daily diet, following formulations of ready-to-serve spiced paneer were developed. Results are discussed as under:

2.1 Selection of marination formulation

A total number of six formulations were evaluated for their organoleptic acceptability. These six formulations were divided into two categories (3.2.2.1). Mean scores obtained for different sensory attributes for different formulations in the two categories of ready-to-serve spiced paneer are presented in Table 1 (Plate 1).

In case of category I, flavour ranges from 5.67 to 8.07. It was observed from the table that T_2 had significantly ($P \leq 0.05$) higher sensory scores for all the attributes, except texture than T_1 and T_3; whereas T_1 and T_3 scores were found to differ non-significantly, whereas texture scores were at par for all the formulations. Sensory scores revealed that, judges 'liked very much' T_2 in comparison to T_1 and T_3 RTS spiced paneer for all the sensory attributes. Hence, it was selected for further studies.

Treatment	Sensory attributes		
	Flavour	Texture	Overall
	Category I		

T_1	5.67±0.13	7.90±0.19	6.27±0.15
T_2	8.07±0.18	8.40±0.19	8.20±0.20
T_3	5.93±0.21	7.97±0.23	6.27±0.18
C.D.(P≤0.05)	**0.50**	**N.S.**	**0.51**
	Category II		
T_4	6.27±0.32	8.03±0.18	6.80±0.22
T_5	7.73±0.18	8.27±0.18	7.87±0.19
T_6	6.13±0.21	8.00±0.23	6.60±0.16
C.D.(P≤0.05)	**0.70**	**N.S.**	**0.55**

Table 1: Selection of spice combination for ready-to-serve spiced paneer.

Values are Mean±SEM of scores of six judges and 3 replications.
100gm of curd (with 2.5gm cumin powder, 2.5gm coriander powder, 2gm salt and 2gm sugar) was used for 300gm of paneer.

Category I – Ginger + Garlic formulation
Category II – Red-pepper + Black-pepper formulation

T_1 = 20gm ginger and 10 gm garlic in curd.
T_2 = 10 gm ginger and 5 gm garlic in curd.
T_3 = 5 gm ginger and 2.5 gm garlic in curd.
T_4 = 2.5 gm red and 0.5 gm black pepper in curd.
T_5 = 1.25 gm red and 0.25 gm black pepper in curd.
T_6 = 0.625 gm red and 0.125 gm black pepper in curd.

Plate 1. Spiced paneer with different spice levels.
T1, T2, T3 - Ginger + garlic formulation
T4, T5, T6 - Red pepper + Black pepper formulation

Plate 2. Spiced paneer kept for different marination time
1-3h; 2-2h; 3-1h (Red pepper + black pepper formulation)
A-3h; B-2h; C-1h (Ginger + garlic formulation)

In case of category II, mean scores for flavour, texture and overall acceptability varied from 6.13 to 7.73, 8.00 to 8.27 and 6.60 to 7.87, respectively. There was a significant (P≤0.05) difference in mean scores for flavour and overall acceptability among T_4 & T_5 and T_5 & T_6 whereas T_4 and T_6 were differed non-significantly. The T_5 RTS spiced paneer was 'like moderately' in comparison to other two RTS spiced paneer i.e. T_4 & T_6, which were 'liked slightly'; therefore T_5 was selected for further studies.

It was concluded from the results, that T_2 & T_5 were found highly acceptable by judges and these treatments were selected for further studies.

2.2 Selection of marination time

Mean scores obtained for different sensory attributes for formulations with different time of marination in the two categories of RTS spiced paneer are presented in Table 2 (Plate 2).

In category I, sensory acceptability of RTS spiced paneer, kept for different time of marination for different attributes were in the range of 'liked moderately' to 'liked very much'. It is evident from the table that judges found all the marination times acceptable.

Statistical analysis of data revealed that sensory scores for different marination times had not shown any significant difference. However,

Table 2: Selection of marination time for ready-to-serve spiced paneer.

Marination Time (hr.)	Sensory attributes		
	Flavour	**Texture**	**Overall**
	Category I (T_2)		
3	7.20±0.22	7.60±0.21	7.50±0.22
2	7.60±0.13	8.00±0.14	7.80±0.14
1	7.80±0.24	8.10±0.24	8.00±0.21
C.D. (P≤0.05)	**N.S.**	**N.S.**	**N.S.**
	Category II (T_5)		
3	7.40±0.19	7.60±0.16	7.50±0.20
2	7.90±0.12	8.20±0.11	8.10±0.12
1	7.80±0.24	8.00±0.24	7.90±0.22
C.D. (P≤0.05)	**N.S.**	**N.S.**	**N.S.**

Values are Mean±SEM of scores of six judges and 3 replications.

Category I – Ginger + Garlic formulation
Category II – Red-pepper + Black-pepper formulation

1h marination time was selected for further studies to save the processing time and incidentally, it was scored maximum by the judges.

In category II, mean sensory scores for flavour, texture as well as overall acceptability for three hour, two hour and one hour as marination time varied non-significantly; ranging from 'liked moderately' to 'liked very much'. 1h was selected as the marination time for further investigations, to save the processing time involved.

It was concluded from the results that, one hour of marination time was selected for further investigations, in both the formulations to save the processing time.

2.3 Selection of time for heat treatment

Marinated packed paneer cubes (Plate 3) were subjected to heat treatment at 15 psi for different time i.e. 10, 15 and 20 minutes were studied. During heat treatment, it was found that packets used for packaging paneer cubes were not able to bear pressure applied for more than 10 minutes. Therefore, it was decided that heat treatment of 10 minutes will be used for further study.

2.4 Storage study of developed RTS spiced paneer

The two selected formulations one from each category of RTS spiced paneer was subjected to in-pack heat treatment at 15psi for

Plate 3. Packaged spiced paneer (before heat treatment)
A - Ginger + garlic formulation
1 - Red pepper + black pepper formulation

(after in-pack heat treatment at 15 psi for 10 min.)

A - Ginger + garlic formulation

1 - Red pepper + black pepper formulation

10 minutes and stored at room temperature (16-25°C) (Plate 4). Samples were drawn at an interval of 15 days to study the effect of storage on sensory attributes, physico-chemical properties and microbial count. The results are discussed below:

2.4.1 Effect of storage on sensory attributes of RTS spiced paneer

Mean sensory scores obtained for different sensory attributes during storage period are presented in Table 3.

Initially, T_2 formulation of RTS spiced paneer (without heat treatment) was 'liked moderately' by the judges in terms of all the sensory attributes. A significant ($P \leq 0.05$) decline was observed in flavour and overall acceptability of RTS spiced paneer after 15 days of storage whereas texture scores remained unchanged statistically.

Panel of judges 'liked very much' the flavour and overall acceptability of T_2 formulation of RTS spiced paneer (with heat treatment) at 0 day. A significant ($P \leq 0.05$) decrease in sensory scores was observed for flavour and overall acceptability on 15^{th} day while statistical analysis of texture scores revealed that there was non-significant effect of storage on texture of RTS spiced paneer samples.

T5 formulation of RTS spiced paneer (without heat treatment) ‘was liked very much’ by the judges at 0 day in terms of all the

Table 3: **Effect of storage on sensory attributes of ready-to-serve spiced paneer.**

Heat treatment (at 15 psi for 10 min.)	Sensory attributes											
	Flavour				Texture				Overall			
	Days											
	0th	15th	30th	C.D. (P≤0.05)	0th	15th	30th	C.D. (P≤0.05)	0th	15th	30th	C.D. (P≤0.05)
	Category I (T_2)											
Without heat treatment	7.33 ±0.31	5.33 ±0.21	*	0.41	7.07 ±0.33	6.98 ±0.27	*	N.S.	7.58 ±0.30	5.50 ±0.26	*	0.43
With heat treatment	8.00 ±0.26	6.83 ±0.31	*		7.27 ±0.49	6.88 ±0.42	*		7.92 ±0.35	6.58 ±0.35	*	
	Category II (T_5)											
Without heat treatment	7.92 ±0.20	4.25 ±0.36	*	0.58	7.55 ±0.31	6.92 ±0.45	*	N.S.	7.92 ±0.24	5.08 ±0.27	*	0.61
With heat treatment	8.33 ±0.21	6.58 ±0.37	*		8.00 ±0.36	7.27 ±0.40	*		8.17 ±0.28	5.92 ±0.35	*	
C.D. (P≤0.05)	N.S.	0.95	*		N.S.	N.S.	*		N.S.	0.92	*	

Values are Mean±SEM of scores of six judges.

Category I – Ginger + garlic formulation

Category II – Red pepper + black pepper formulation

* Product spoil, not offered for sensory evaluation

sensory attributes. After 15 days of storage, judges perceived a significant (P≤0.05) decline in flavour and overall acceptability of RTS spiced paneer. However, judges did not observe any significant change in texture of paneer samples.

Flavour and overall acceptability of T_5 formulation of RTS spiced paneer (with heat treatment) was 'like very much' by the judges at 0 day. At 15^{th} day of storage, similar changes in flavour, texture and overall acceptability were observed as in case of same formulation without heat treatment.

T_2 formulation was found to be scored better than T_5 formulation by the judges, with or without heat treatment, in terms of all the sensory attributes. Flavour, texture and overall acceptability of both formulations at 0 day had shown a non-significant difference, as heat treatment improved the samples sensory attributes marginally.

At 15^{th} day of storage, table data revealed that significant (P≤0.05) difference were found in flavour and overall acceptability of heat treated and without heat treated RTS spiced paneer samples within same category, while texture had not shown any significant effect of heat treatment in both the category of samples. Heat treated samples were found acceptable in both the categories at

15th day of storage. While samples without heat treatment were 'neither liked nor disliked' by the judges in both the category of samples on the basis of flavour and overall acceptability. However, texture was found to show non-significant difference among heat treated and without heat treated samples after 15 day of storage.

It was concluded from sensory evaluation results that RTS spiced paneer in both the categories with heat treatment could be stored up to 15 days at room temperature and thereafter judges perceived an off-flavour and samples were rejected without doing sensory. While in case of control (without heat treatment), samples were scored in the range of 'neither liked nor disliked' and rejected at 15th day of storage.

4.4.2 Effect of storage on physico-chemical properties of ready-to-serve spiced paneer.

The physico-chemical properties studied during storage were: pH, acidity, free fatty acids, moisture and the results are presented here under.

4.4.2.1 pH and acidity

Effect of storage on pH and acidity of RTS spiced paneer are presented in Figure 1 (Annexure 2).

2.4.1.31 pH

pH values of freshly prepared T_2 formulation were 5.06 & 5.33, without heat treatment and with heat treatment respectively.

Fig. 1 : Effect of storage on pH and acidity (% lactic acid) of RTS spiced paneer

The pH had shown decreasing trend during storage and it was decreased to the level of 3.83 & 4.76, without heat treatment and with heat treatment respectively, after 30 days of storage.

T_5 formulation had pH values as 4.93 & 5.36, without heat treatment and with heat treatment respectively. A decreasing trend was shown by pH during storage and it decreased to 4.13 & 4.56 without heat treatment and with heat treatment respectively, after 30 days of storage.

As it is evident from the data that during storage pH sharply decreased; could be due to the production of acid by acid-producing bacteria, bacteriological analysis also confirmed the same as microbial population increased to the level of 10^9 & 10^5 (Table 4), without and with heat treatment respectively, on 30^{th} day of storage.

It was concluded from the results that, decrease in pH values also correlated with the results of sensory attributes as formulation were found unacceptable at 15^{th} day of storage without heat treatment while with heat treatment samples were found acceptable up to 15^{th} day of storage.

4.4.2.1.2 Acidity

The per cent titratable acidity of freshly prepared T_2 formulation was 0.55 & 0.54, without and with heat treatment respectively. Acidity had shown an increasing trend during storage and it increased to the level of 1.42 & 0.98, without and with heat treatment respectively, after 30 days of storage.

In case of, T_5 formulation when freshly prepared, values of acidity were found out to be 0.56 & 0.52, without and with heat treatment respectively. It increased up to the level of 1.00 & 0.93, without and with heat treatment respectively after 30 days of storage.

It is clearly visible from the figures that per cent acidity increased in all types of RTS spiced paneer during storage. The increase in acidity may be due to formation of lactic acid as a result of lactose fermentation and diffusion of acid into the paneer cubes; as evident from an increased microbial growth to the levels of 10^9 & 10^5, without and with heat treatment respectively, on 30 days of storage. Sensory evaluation showed that these samples with heat treatment were acceptable up to 15 days of storage. At 30^{th} day, judges noticed distinct acidic flavour, while without heat treated samples had very sharp increase in acidity right at 15^{th} day of

storage and judges had noticed very high distinct acidic flavour and rejected the samples.

4.4.2.3 Moisture content and free fatty acid

Effect of storage on moisture content and free fatty acid (% oleic acid) of RTS spiced paneer are presented in Table 4.

4.4.2.3.1 Moisture content

Moisture per cent of freshly prepared T_2 formulation was found to be 56.29 & 54.25, without and with heat treatment respectively. With storage, moisture content decreased up to the levels of 47.34 & 44.21, without and with heat treatment respectively, during 30 days of storage.

T_5 formulation showed moisture content of 53.71 & 48.47, without and with heat treatment respectively, in freshly prepared paneer samples. Moisture content showed a decline up to the level of 45.83 & 44.11, without and with heat treatment respectively, during 30 days of storage.

This decrease in per cent moisture content was attributed to two reasons. First is the diffusion of various ingredients of spice marination into the paneer cubes, which caused increase in % total

solids. Rao and Patil (1999) also reported diffusion of NaCl and citric acid into paneer cubes and molecular size of the particle affected its rate of diffusion. Second reason for loss of moisture from RTS spiced paneer was possibly due to movement of water

Table 4 Effect of storage period on moisture content (%) and free fatty acid (% oleic acid) of ready-to-serve spiced paneer.

Treatment (at 15 psi for 10 min.)	Moisture				Free fatty acid			
	Days							
	0th	15th	30th	Mean	0th	15th	30th	Mean
	Category I							
Without heat treatment	56.29± 0.46	50.17± 0.47	47.34± 0.84	**51.26± 4.57**	0.20± 0.00	1.80± 0.02	2.30± 0.55	**1.43± 1.10**
With heat treatment	54.25± 0.76	49.17± 0.81	44.21± 0.41	**49.21± 5.02**	0.30± 0.03	2.00± 0.03	2.42± 0.19	**1.57± 1.12**
Mean	**55.27 ±1.44**	**49.67± 0.71**	**45.77± 2.21**		**0.25± 0.07**	**1.90± 0.14**	**2.36± 0.08**	
	Category II							
Without heat treatment	53.71± 0.53	51.23± 0.59	45.83± 0.88	**50.26± 4.03**	0.20± 0.01	1.90± 0.02	2.55± 0.25	**1.55± 1.21**
With heat treatment	48.47± 0.45	46.83± 0.35	44.11± 0.37	**46.47± 2.20**	0.30± 0.03	2.00± 0.01	2.91± 0.10	**1.74± 1.32**
Mean	**51.09± 3.70**	**49.03± 3.11**	**44.97± 1.22**		**0.25± 0.07**	**1.95± 0.07**	**2.73± 0.25**	

Values are Mean±SD of three replications.

Category I = Ginger + garlic formulation

Category II = Red pepper + black pepper formulation

molecules from paneer cubes into the medium along a concentration gradient.

However, loss of moisture was higher in T_2 formulation, as compared to T_5 formulation. It was concluded that moisture content showed a decreasing trend during entire period of storage.

4.4.2.4 Free fatty acid

Changes in FFA content in all types of RTS spiced paneer increased with time during storage and are presented in Table 4. Variation in the increase in FFA content was observed throughout the storage period and also among all 4 types of RTS spiced paneer. FFA content of all the formulations were found out to be 0.20 & 0.30, without and with heat treatment respectively; in freshly prepared samples. And it increased up to the levels of 2.30 & 2.42, without and with heat treatment respectively after 30 days of storage in T_2 formulation, whereas in T_5 formulation, the increase was to the level of 2.55 & 2.91 after 30 days of storage, without and with heat treatment respectively.

It was concluded from the results that FFA content increased during storage, without heat treatment, contributed by increase in the population of lipolytic bacteria as there was almost 4 log cycle increase in the microorganism population during storage.

2.4.3 Effect of storage on microbiological properties

Effect of storage on standard plate count and spore former count of RTS spiced paneer formulations are presented in Figure 2 (Annexure 3).

2.4.3.1 Standard plate count

In case of freshly prepared T_2 formulation, standard plate count was found to be $62x10^4$ & $42x10^1$, without and with heat treatment respectively; which increased up to the level of $78x10^9$ & $11.2x10^5$, without and with heat treatment respectively, during 30 days of storage.

In case of T_5 formulation, standard plate count was found to be $12.5x10^4$ & $80x10^1$, without and with heat treatment respectively, when freshly prepared. And it was found to increase up to the levels of $92x10^9$ & $5.6x10^5$, during 30 days of storage.

2.4.3.2 Spore former count

In case of freshly prepared T_2 formulation, spore former count was found to be $2.5x10^1$ & $1.8x10^1$, without and with heat treatment respectively; which increased up to the level of $18x10^2$ &

$5x10^2$, without and with heat treatment respectively, during 30 days of storage.

In case of T_5 formulation, spore former count was found to be $2.4x10^1$ & $1.4x10^1$, without and with heat treatment respectively,

Fig. 2 : Effect of storage on standard plate count and spore former count in RTS spiced paneer

when freshly prepared. And it was found to increase up to the levels of $16x10^2$ & $2x10^2$, during 30 days of storage.

From the results, it was concluded that increase in microbial population during storage, also correlated with the results of physico-chemical properties and sensory attributes of RTS spiced paneer samples.

CHAPTER - 5

SUMMARY & CONCLUSION

The present study was conducted to standardize and evaluate the technology for two types of ready-to-serve spiced paneer. The study was conducted on a laboratory scale. To develop RTS spiced paneer, paneer was cut into small cubes and marination was prepared by drainage of moisture from curd and adding salt, sugar, cumin, coriander. In addition to that, ginger & garlic were added in first formulation, whereas red pepper & black pepper were added in second formulation. RTS spiced paneer prepared, were analysed for physico-chemical properties, sensory attributes and bacteriological count. The results obtained in the course of investigation are summarized below:

- Out of 6 spiced paneer formulations tried, on the basis of organoleptic evaluation, one from each category was selected for further study, viz. T_2 - 10% ginger & 5% garlic from category I and T_5 - 1.25% red pepper & 0.25% black pepper from category II.
- One hour marination time for spiced paneer was found organoleptically at par with two hour and three hour

marination time. One hour marination time was selected to save processing time.

- Heat treatment improved sensory scores of RTS spiced paneer samples marginally in both the selected formulations but it was non-significant.
- After 15 days of storage at room temperature, heat treated formulations were found to have better scores of flavour, texture and overall acceptability.
- At 15^{th} day of storage, significant decline in sensory scores of taste and overall acceptability were observed. However, texture scores had non-significant change.
- pH of RTS spiced paneer samples had shown decreasing trend during the storage, while there was not much difference in pH values between the two selected formulations.
- Per cent acidity of RTS spiced paneer showed an increasing trend during storage. Acidity of heat treated T_2 and T_5 formulations, had acidity values as 0.54 and 0.52, respectively after 15 days of storage.
- Decrease in moisture content of ready-to-serve spiced paneer at each storage interval was observed.

- FFA (% oleic acid) values increased during storage in both formulations till the end of storage study.
- SPC (Standard Plate Count) of freshly prepared heat treated ready-to-serve spiced paneer was found to be $42x10^1$ and $80x10^1$ in T_2 and T_5 formulations respectively. The SPC increased to the level of $11.2x10^5$ and $5.6x10^5$ in T_2 and T_5 formulations at 30^{th} day of storage.
- SFC (Spore Former Count) of ready-to-serve spiced paneer at 0 day was observed as 18 and 14 for heat treated T_2 and T_5 formulations respectively, which had shown increasing trend throughout the storage period.

On the basis of present study, it was concluded that RTS spiced paneer could be prepared and preserved for 15 days at room temperature, as also indicated by the sensory score and physico-chemical changes in the product.

RTS spiced paneer is commercially viable and had commercially useful shelf-life at room temperature. The technologies generated could be explored further for value addition to the milk for producing a safe and quality product with

convenience to the consumers. Bacteriological analysis of RTS spiced paneer revealed that there is scope for further improvement in heat treatment and shelf life extension.

BIBLIOGRAPHY

Anonymous 2006-07. *Economic survey*. Ministry of Finance. Economic Division, Govt. of India. p. 164.

A.O.A.C. 1984. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D.C.

BIS. 1989. Handbook of Food Analysis Part-XI dairy Products. Bureau of Indian Standards, New Delhi.

Deniane, 1998. Paneer Amul-Industrial scale processing of a traditional Indian Products. Process-*Rennes*, **1135**: 38-39.

Hassan, M.N.A., El-Aassar, M.A. and Dawood, S.A.A. 2001. Antimycotic and antimycotoxigenic activity of some spices and herbs. *8th Egyptian Conference for Dairy Science and Technology*. **V-II**: 609-623

Jasinska, M. and Wasik, K. 2005. Effect of spices added on lipids changes in butter during cold storage. Alimentaria, **246(4)**: 183-192

Kanawjia, S.K. and Singh, S. 2000. Technological advances in Paneer making. *Indian Dairyman*. **52(10)**: 45-50

Kanawjia, S.K., Roy, S.K. and Singh, S. 1990. Paneer technology and its diversification. *Indian Dairyman*. **42(9)**: 390-393

Kapoor, P.P. 1989. Export market for ready-to-serve Indian foods. *Indian Food Packer*. **43(4)**: 21-23.

Koniecko, E.S. 1979. Handbook of meat chemistry. Avery publishing Group, Inc. Wayne, New Jersey, pp. 53-55.

Kumar, G and Srinivasan, M.R. 1983. Physio-chemical properties of selected flexible packaging materials for dairy products. *Indian J. of Dairy Sci.* **36(3)**: 255-261.

Kumar, P. and Bector, B.S. 1991. Enhancement of shelf life of paneer with food additives. *Indian J. of Dairy Sci.* **44**: 577-584

Lawless, H.T. and Hymann, H. 1998. Consumer Field Tests and Questionnaire Design. In:Sensory Evaluation of food (H.T. Lawless & H. Hymann, eds.) Chapmann and Hall, New York, pp. 480-518.

Madsen, H.L. and Bertelsen, G. 1995. Spices as antioxidants. *Trends in Food Sci. & Tech.* **6(8)**: 271-277.

Makhal, S., Vashishtha, B., Prabha, S., Sen, D.C. 2002. Mechanization and process innovation of paneer making – A Review. *Indian J. of Dairy & BioSci.* **13(2)**: 10-17.

Meena, M.R. 1992. Studies on antimicrobial activity of various spices and their oils. MSc. Thesis, IARI, Delhi.

Meena, M.R. and Sethi, V. 1996. Antimicrobial activity of some common spices. *Food Microbiology*.

Nanda, V., Singh, S., Raina, C.S., Jindal, N., Singh, K. and Saxena, D.C. 2004. Optimization of the process variables for the preparation of processed paneer using response surface methodology. *European Food Research & Tech*. **218(6)**: 529-534.

Nayak, S.K. and Bector, B.S. 2004. Evaluation of chemical quality of paneer prepared from milk preserved with hydrogen peroxide. *J. of Food Sci. & Tech*. **41(1)**: 86-88.

Pal, M. A. 1998. Microbiologically related biochemical transformation in paneer during storage. *Indian J. of Microbiology*. **38(1)**: 21-23.

Rangarao, G.C.P., Satish, H.S., Shwetha, M.A., Ashiwini, B. 2004. Shelf stable ready-to-eat foods as home meal replacement: A pilot survey on consumer perception and preferences. *Indian Food Ind*. **23**: 21-24.

Rao, K.V.S.S. and Mathur, B.N. 1990. Process upgradation in the manufacture of a traditional Indian dairy product (Paneer). *International Dairy Federation*. **V-II**: 459-872.

Rao, J.K., Dresel, J. And Leistner, L. 1992. Application of hurdle technology in developing countries, considering paneer as an example. *Mitteilungsblatt-der-Bundesanstalt-fur-Fleischforschung-Kulmbach*. **31(117)**: 293-297.

Rao, K.J. and Patil, G.R. 1999. Development of ready-to-eat paneer curry by hurdle technology. *J. of Food Sci. & Tech.* **36(1)**: 37-41.

Sachdeva, S. 1983. Production, packaging and preservation of paneer. Ph.D. Thesis, Kurukshetra Universuty, Kurukshetra.

Sachdeva, S and Singh, S. 1988. Optimisation of processing parameters in the manufacture of paneer. *J. of Food Sci. & Tech*. **25(3)**: 142-145.

Sachdeva, S. and Singh, S. 1995. Industrial production of paneer. Innovative approaches. *Indian Dairyman*. **47(4)**: 11-14.

Sethi, V. and Meena, M.R. 1997. Role of spices and their essential oils as preservatives and antimicrobial agents – A Review. *Indian Food Packer*. **5-6**: 25-43.

Shukla, F.C. and Vaid, J. 2004. Studies on the storage stability of oil-based paneer pickle. *International J. of Dairy Tech*. **57(1)**: 15-18.

Singh, L., Murali, H.S. and Sankaran, R. 1991. Extension of shelf life of paneer by sorbic acid and irradiation. *J. of Food Sci. & Tech*. **28(6)**: 386-388.

Singh, S., Kanawjia, S.K. and Sachdeva, S. 1988. Extension of shelf life of paneer. *Asian J. Dairy Research*. **7**: 147.

Singh, S. and Kanawjia, S.K. 1990. Effect of hydrogen peroxide and delvocid on enhancement of shelf life of recombined milk paneer. *International Dairy Federation*. **V-II:** 537.

Singh, S and Rai, T. 2004. Process optimization for diffusion process and microwave drying of paneer. *J. of Food Sci. & Tech. – Mysore*. **41(5)**: 487-491.

Snedecor, G.W. and Cochran, W.G. 1972. *Statistical Methods*. Oxford and IBH Publishing Co., New Delhi.

Sreedhara, N.S. and Balasubramanyam, B.V. 2003. Optimization of ingredients and process conditions for production of paneer curry. *Indian J. of Dairy and Biosci*. **14(2)**: 55-57.

Stevanovic, P. and Vujkovic, I. 2005. Thermoformed polypropylene packaging for sterilized dairy products. *Acta-Alimentaria*. **34(4)**: 367-372.

Stevenson, K.E. and Segner, W.P. 2001. Mesophilic aerobic sporeformers. In F.P. Downes and K.Ito (Eds.), *Compendium of methods for the microbiological examination*

of foods, 4th ed. (pp.223-228). American Public Health Association, Washington, D.C.

Thakral, S., Prasad, M.M. and Ghodeker, D.R. 1990. Effect of incorporation of potassium sorbate and Nisin for improvement in shelf life of paneer. *International Dairy Federation*. **V-I,** 150(275).

Uprit, S., Mishra, H.N. 2003. Microwave convective drying and soy-fortified paneer. *Food and Bioproducts Processing*. **81(C2)**: 89-96.

Vashista, S. 2000. A study on development and evaluation of paneer pickles. Ph.D Thesis. HAU, Hisar.

Vishweshwariah, L. 1987. Studies on dehydration and deep freezing of paneer. *J. of Food Sci. & Tech.* **24(2)**: 95-96.

http://recipes.tajonline.com/75/panee-tikka-masala.html

Yellamanda, S., Reddy, K.K. and Devi, N.L. 2006. A study on pickling of low fat paneer. *Indian J. of Dairy Sci.* **59(2)**: 125-127.

Zanzad, P.N. and Mathur, B.N. 1990. Storage behaviour of 'in-package' sterilized paneer: Sensory quality and texture profile analysis. *International Dairy Federation*. **V-II,** 471(896).

Zanzad, P.N. and Mathuir, B.N. 1990. Storage behaviour of 'in-package' sterilized paneer formation of hydroxyl methyl furfural. *International Dairy Federation*. **V-II, 471(897).**

Zanzad, P.N. and Mathur, B.N. 1994. Kinectics of storage related textural changes in simulated sterilized paneer system. *Indian J. of Dairy Sci.* **47(1)**: 65-67.

ANNEXURE –I

(HEDONIC RATING SCALE)

Name……. Date…….

Product…… Time…….

INSTRUCTIONS : Taste the given samples and check how much you like or dislike each one. Use appropriate scale to who your attitude by assigning points that best describe your feelings about the sample. An honest expression of your's will help us. Evaluate on the basis of the following scale.

Score Preference	**Code**
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Sample Code	**Flavour**	**Texture**	**Overall**	**Remarks**

Signature

ANNEXURE - II

Effect of storage period on pH and acidity (% lactic acid) of ready-to-serve spiced paneer.

Heat treatment (at 15 psi for 10 min.)	pH				Acidity			
	Days							
	0^{th}	**15^{th}**	**30^{th}**	**Mean**	**0^{th}**	**15^{th}**	**30^{th}**	**Mean**
	Category I (T_2)							
Without heat treatment	5.06± 0.06	4.46± 0.06	3.83± 0.06	**4.45± 0.61**	0.55± 0.01	1.03± 0.03	1.42± 0.01	**1.00± 0.43**
With heat treatment	5.33± 0.11	4.96± 0.06	4.76± 0.06	**5.02± 0.29**	0.54± 0.02	0.75± 0.01	0.98± 0.02	**0.76± 0.22**
Mean	**5.19± 0.19**	**4.71± 0.35**	**4.29± 0.66**		**0.54± 0.01**	**0.89± 0.20**	**1.20± 0.31**	
	Category II (T_5)							
Without heat treatment	4.93± 0.06	4.43± 0.06	4.13± 0.06	**4.50± 0.40**	0.56± 0.02	1.02± 0.02	1.18± 0.02	**0.92± 0.32**
With heat treatment	5.36± 0.06	4.80± 0.00	4.56± 0.11	**4.91± 0.41**	0.52± 0.02	0.86± 0.03	0.93± 0.02	**0.77± 0.22**
Mean	**5.14± 0.30**	**4.61± 0.26**	**4.34± 0.30**		**0.54± 0.03**	**0.94± 0.11**	**1.05± 0.18**	

Values are Mean±SD of three replications.

Category I = Ginger + garlic formulation

Category II = Red pepper + black pepper formulation

ANNEXURE - III

Changes in Total Plate Count (TPC) and Spore Former Count (SFC) during storage of ready-to-serve spiced paneer. (cfu/gm)

Treatment (at 15 psi for 10 min.)	Standard Plate Count			Spore Former Count		
	Days					
	0th	15th	30th	0th	15th	30th
	Category I					
Without heat treatment	$62x10^4$	$14.7x10^6$	$78x10^9$	$2.5x10^1$	$9x10^1$	$18x10^2$
With heat treatment	$42x10^1$	$27.4x10^3$	$11.2x10^5$	$1.8x10^1$	$5x10^1$	$5x10^2$
	Category II					
Without heat treatment	$12.5x10^4$	$27.2x10^6$	$92x10^9$	$2.4x10^1$	$7x10^1$	$16x10^2$
With heat treatment	$80x10^1$	$46x10^3$	$5.6x10^5$	$1.4x10^1$	$4x10^1$	$2x10^2$

Category I = Ginger + garlic formulation

Category II = Red pepper + black pepper formulation

ABSTRACT

TITLE OF RESEARCH PROJECT	:	Development of ready-to-serve spiced paneer.
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TITLE OF DEGREE	:	Master of Science
NAME OF DISCIPLINE	:	Food Science & Technology
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The present investigation was carried out to standardize the technology of ready-to-serve (RTS) spiced paneer and monitor the sensory, physico-chemical and microbiological changes during storage. Two categories of spiced paneer were prepared by marinating the paneer cubes with different levels of ginger+garlic and red pepper+black pepper separately in thick curd with cumin, coriander, salt and sugar. Selected two formulations were left for 60, 120 and 180 minutes for maturation. Marinated paneer samples were packed in multilayer polyethylene pouches and given heat treatment at 15 psi for 10, 15 and 20 minutes. The RTS spiced paneer formulations were stored at room temperature (16-25°c) and samples were drawn for analysis on 0^{th} day, 15^{th} day and 30^{th} day respectively to observe the sensory, physico-chemical and microbiological changes during storage. On the basis of sensory attributes two best formulations i.e. 10 per cent ginger + 5 per cent garlic and 1.25 per cent red pepper + 0.25 per cent black pepper, 60 minutes as maturation time and 10 minutes heat treatment time were selected.

Sensory evaluation revealed that RTS spiced paneer, when freshly prepared was ‘liked very much’ by the judges in both the categories (with and without heat treatment). After 15 days of storage, scores were around 6.0 and above, which means the samples were ‘liked slightly’ by the judges and thereafter scores decreased and judges found the samples to have an off-flavour and were therefore rejected. Moisture content and pH had shown a decreasing trend while free fatty acid (% oleic acid) and acidity (% lactic acid) had shown an increasing trend during entire period of storage for all the paneer samples. During storage period, standard plate count increased to the level of almost 4 log cycle whereas spore former count increased at the rate of one log cycle in all the paneer samples. It was concluded from the results that both the formulations of RTS spiced paneer had 15 days shelf life at room temperature.

Key words: Paneer, spice marination, heat treatment, sensory attributes, shelf life

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