STANDARDISATION AND QUALITY EVALUATION OF COCONUT BASED FILLED PANEER

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled "Standardisation and quality evaluation of coconut based filled paneer" is a bonafide record of research work done by me during the course of research and the thesis has not been previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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Certified that the thesis entitled "Standardisation and quality evaluation of coconut based filled paneer" is a bonafide record of research work done independently by **Mrs. Suvarna Mohan** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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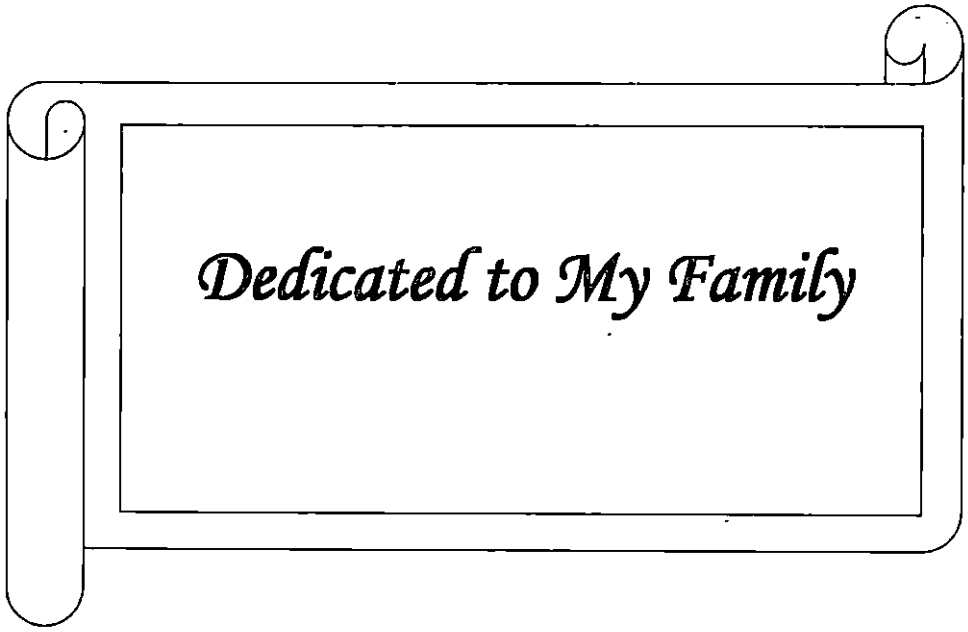

Dedicated to My Family

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE NO.
1.	INTRODUCTION	1 - 3
2.	REVIEW OF LITERATURE	4 – 24
3.	MATERIALS AND METHODS	25 – 36
4.	RESULTS	37 – 84
5.	DISCUSSION	85 – 101
6.	SUMMARY	102 - 107
	REFERENCES	i-xix
	APPENDICES	
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1	Proximate composition of paneer	14
2	Treatments for the standardisation of coconut based filled paneer	28
3	Acidity (%) of fruit juices used as natural coagulant	31
4	Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut milk in comparison with control	38
5	Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut slurry in comparison with control	39
6	Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut milk in comparison with control	40
7	Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut slurry in comparison with control	41
8	Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut milk/soy milk in comparison with control	42
9	Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut milk/soy milk in comparison with control	43
10	Yield of filled paneer (%) from different combination of cow milk, coconut milk and soy milk in comparison with control	44
11	Mean scores for the organoleptic qualities of milk paneer prepared using natural coagulants.	47
12	Yield of milk paneer (%) prepared by natural coagulants in comparison with control	48
13	Yield of coconut based filled paneer and its weight loss in comparison with control during storage	50

14	Mean score for appearance and colour of coconut based filled paneer in comparison with control during storage	51
15	Moisture (%) content of coconut based filled paneer in comparison with control during storage	54
16	Titrable acidity (%) of coconut based filled paneer in comparison with control during storage	55
17	pH of coconut based filled paneer in comparison with control during storage	57
18	Total solid (%) content of coconut based filled paneer in comparison with control during storage	58
19	Protein (%) content of coconut based filled paneer in comparison with control during storage	60
20	Fat (%) content of coconut based filled paneer in comparison with control during storage	62
21	Free fatty acids (%) content of coconut based filled paneer in comparison with control during storage	64
22	Ash (%) content of coconut based filled paneer in comparison with control during storage	65
23	Calcium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage	67
24	Phosphorus (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage	69
25	Sodium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage	71
26	Potassium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage	72
27	Mean scores for organoleptic qualities of coconut based filled paneer prepared using citric acid during storage	75
28	Mean scores for organoleptic qualities of selected coconut based filled paneer prepared using bilimbi juice during storage	77

29	Total bacterial count ($\times 10^4$ cfu g^{-1}) in coconut based filled paneer during storage	79
30	Total yeast count ($\times 10^2$ cfu g^{-1}) in coconut based filled paneer during storage	80
31	Total mold count ($\times 10^2$ cfu g^{-1}) in coconut based filled paneer during storage	81
32	Total coliform count ($\times 10^2$ cfg^{-1}) in coconut based filled paneer during storage	82

LIST OF FIGURES

Figure No.	Title	Page in between
1	Flow diagram for preparation of coconut based filled paneer	29 - 30
2	Effect of storage on weight of coconut based filled paneer	90 – 91
3	Effect of storage on moisture content of coconut based filled paneer	92 – 93
4	Effect of storage on titrable acidity of coconut based filled paneer	92 – 93
5	Effect of storage on pH of coconut based filled paneer	93 – 94
6	Effect of storage on total solid content of coconut based filled paneer	93 – 94
7	Effect of storage on protien content of coconut based filled paneer	94 – 95
8	Effect of storage on fat content of coconut based filled paneer	95 – 96
9	Effect of storage on free fatty acid content of coconut based filled paneer	97 -98
10	Effect of storage on ash content of coconut based filled paneer	97 -98
11	Effect of storage on calcium content of coconut based filled paneer	98 -99
12	Effect of storage on phosphorous content of coconut based filled paneer	98- 99
13	Effect of storage on sodium content of coconut based filled paneer	98- 99
14	Effect of storage on potassium content of coconut based filled paneer	98- 99
15	Mean scores for overall acceptability of coconut based filled paneer during storage	99 -100

LIST OF PLATES

Plate No.	Title	Page in between
1	Preparation of coconut based filled paneer	29 – 30
2	Coconut based filled paneer selected for storage study	46 – 47
3	Coconut based filled paneer selected for storage study	46 – 47

LIST OF APPENDICES

Appendix No.	Title
I	Score card for organoleptic evaluation of coconut based filled paneer
II	Cost of production of coconut based filled paneer

Introduction

1. INTRODUCTION

Milk and milk products form an essential component of the human diet. A variety of dairy products is indigenous to India and form an important part of Indian cuisine. Among various dairy products, paneer is a well-known heat and acid coagulated milk product. Approximately five per cent of milk produced in India is converted into paneer (Chandan, 2007). Paneer is similar to soft cheese, and is not only very popular in Indian subcontinent, but has also made appearance in Western and Middle East markets.

Paneer is a rich source of high quality proteins, fat, minerals and vitamins (Shrivastava and Goyal, 2007). The unique feature of paneer is that it not only includes casein but also contains most of the whey proteins which get recovered during its manufacture, while they are mostly lost in whey in the case of other types of cheese. It forms base for a variety of culinary dishes, stuffing material for various vegetable dishes, snacks and sweetmeats (Aneja, 2007). Different types of coagulants at different concentrations including natural coagulants are used for its preparation, which have profound effect on the compositional, functional, physico-chemical and sensory characteristics of paneer (Kumar *et al.*, 2008).

Paneer, traditionally prepared from full fat buffalo milk is characterised by marble white colour, nutty flavour, and closely knit smooth texture with 23 per cent fat and 13.4 per cent protein. Paneer is highly nutritious and has the wholesomeness of milk. The main drawback of paneer is its high fat content. Higher dietary fat is known to increase the chances for arterial hypertension, coronary heart disease and obesity. The high fat content in paneer not only contributes to its cost but also makes it less acceptable to health conscious consumers. To meet the ever growing demand of paneer by the health conscious consumers, researchers are developing new varieties of paneer.

Coconut is ideal for incorporation in the development of paneer as it is widely grown in Kerala. The potential for a paneer like product from coconut and cow milk blend is always an alternative as coconut milk is rich in emulsifiers and it is a natural oil-in-water emulsion just like cow milk, hence both can mix readily. The blend also has pH of about 6.5 similar to that of milk.

Some published reports have indicated that coconut fat could be used to prepare highly acceptable and relatively inexpensive new types of dairy-like foods such as custard-like products, various types of cheeses, yogurt and drinks. Davide *et al.* (1987) investigated the potential of water-extracted coconut milk as a less expensive substitute for butterfat in the manufacture of fresh soft cheese. Furthermore, Davide *et al.* (1988) developed a fresh soft cheese spiced with garlic (Queso de Ajo) starter and blue-type cheese, from a blend of skim milk powder and coconut milk.

Coconut is highly nutritious and rich in fibre, vitamins, and minerals. The saturated fat content in coconut milk has been shown to be a good saturated fat, easily metabolized to give the body quick energy. The principal fatty acid in coconut milk is lauric acid, which is the same fatty acid found in abundance in mothers' milk and is known to promote normal brain development and contribute to healthy bones. Coconut also has important anti-carcinogenic and anti-pathogenic properties (Ishiaq and Odeyemi, 2012). It is classified as a functional food because of its health benefits and nutritional content.

Replacing a part of milk used in making paneer with soy milk could give economical and nutritional product. Addition of the soy solids in milk influences textural and sensory characteristics of paneer. Many researchers have recommended blending of soy milk with buffalo milk for the preparation of paneer and cheese. Soy milk is highly nutritious, inexpensive, conventional, and convenient and one of the richest sources of vegetable protein. Addition of soy milk to cow milk up to 20 per cent had no adverse effect on quality of paneer.

In the rapidly changing socio-economic scenario, novel ways of value addition are essential. Incorporation of functional ingredients like fibres, proteins, hydrocolloids, herbs and vegetable oils will help to increase the yield and decrease the calorific value of paneer making it attractive to consumers. It also leads to formation of innovative varieties which further will increase its marketability. Technologies involving incorporation of native food ingredients will help to diversify processing operations and to achieve value addition in a different dimension. In this context, a study on standardisation of coconut based filled paneer was proposed with the following objectives.

1. To standardise the preparation of paneer incorporating coconut milk and coconut slurry in different proportions

2. To assess the practical feasibility of using natural coagulants in the preparation of paneer.

3. To evaluate the physical, chemical, nutritional, organoleptic and keeping qualities of the developed paneer.

Review of literature

2. REVIEW OF LITERATURE

Paneer is a popular Indian dairy product obtained by acid coagulation of whole milk and subsequent drainage of whey and is widely used for culinary purposes in the Northern and Western parts of India. During past two decades, paneer has enjoyed the status of national culinary dish in India. Paneer is highly nutritious and a wholesome food product. It is of great value in diet because; it is a concentrated form of almost all the proteins and usually most of the fat as well as essential minerals, vitamins and other nutrients of milk.

In this chapter, the literature pertaining to the study on "standardisation and quality evaluation of coconut based filled paneer" has been reviewed under the following headings.

2.1. Paneer – the Indian cheese

2.2. Physico-chemical, nutritional, sensory and shelf life qualities of paneer

2.3. Composition and health benefits of coconut

2.4. Diversification in paneer

2.1. Paneer - the Indian cheese

Milk plays an important role in the diet of Indians as a source of animal proteins. India is the largest producer of milk in the world with a production of 112 million metric tonnes (Anonymous, 2013). About 55 per cent of total production is buffalo milk. Approximately half of the milk produced is consumed in liquid form and the remaining is used to prepare products such as ghee, curd, butter, *khoa,* paneer, cheese, *channa,* ice cream and milk powders (Kumar *et al.*, 2011).

An estimated five per cent of milk produced in India is converted to paneer (Chandan, 2007); production figure being 3,959 metric tonnes in the year 2002-03, which increased to 4,496 metric tonnes in the year 2003-04 exhibiting a growth of 13 per cent (Joshi, 2007 and Shrivastava and Goyal, 2007)

Paneer is a South Asian variety of soft cheese obtained by acid and heat coagulation of milk. It is a non fermentative, non renneted and unripened type of cheese. It is popular through out South Asia, used in raw form or in preparation of several varieties of culinary dishes and snacks. The ability of paneer to be deep fried is one feature that has lead to its wide acceptance and a favourite for making snacks, *pakoras* or fried paneer chunks (Aneja, 2007). Paneer is formed from heat-cum-acid coagulation of casein component of milk, entrapped through complex physio-chemical interactions involving almost all the fat, a part of denatured whey proteins and colloidal salts, as well as a part of soluble milk solids (Karadbhajne and Bhoyarkar, 2010).

The nomads of the South West Asia were the first to develop distinctive acid/ heat coagulated varieties of cheese (Mathur *et al*., 1986). The earliest reference to the present paneer is attributed to the people of Kusana and Saka Satavahana periods (AD 75 to 300). They used to consume a solid mass prepared from mixture of warm milk and curd resembling paneer (Mathur, 1991). Paneer was probably first introduced to India by Persian and Afghan invaders. This could be the reason for its wide popularity in the North and Western parts of India and Southern regions of Jammu and Kashmir. It was only during last five decades that paneer has spread to other parts of India probably due to wide spread migration of people from one region to another (Kumar *et al*., 2011).

According to FSSAI (2011), *channa* or paneer means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid or citric acid. It should not contain more than 70.0 per cent moisture and the fat content should not be less than 50.0 per cent of the dry matter.

The main raw material for the preparation of paneer is milk. Now a days certain additives are used to improve the quality characteristics of paneer. Various types of milk have been used for the manufacture of paneer. According to Nayak and Bector (1998) the quality of the milk is the most important one, determining the quality of paneer.

For the manufacture of good quality paneer, buffalo milk is considered more ideal than cow milk (Singh and Kanawjia, 1988). Ghodekar (1989) and

Sindhu (1996) reported that higher amount of casein, fat and minerals (Ca and P) were responsible for imparting firm rubbery body and spongy character to buffalo milk paneer. Ramasamya *et al.* (1999) and Masud (2002) advocated use of buffalo milk having six per cent fat for preparation of best quality paneer. According to Kumar *et al.* (2011) the superior quality of paneer from buffalo milk is due to its unique physico chemical properties compared to cow milk.

Chawla *et al.* (1985) and Vishweshwaraiah and Anantakrishnan (1986) noticed that homogenisation of milk improved the yield and organoleptic scores of paneer. Good quality paneer can be obtained from cow milk using certain modifications in manufacturing process or through use of additives (Vishweshwaraiah and Anantakrishnan, 1986, Singh and Kanawjia, 1988, Sachdeva *et al.*, 1991, Arya and Bhaik, 1992 and Jadhavar *et al.*, 2009a). According to Kumar *et al.* (2011), among different constituents of milk, the fat primarily influences the quality of paneer and five per cent fat in milk is required for making paneer, conforming to FSSAI standards.

Vishweshwaraiah and Anantakrishnan (1986) reported that paneer obtained from cow milk standardised to 4.5 per cent fat conformed to the PFA standards. Sindhu (1996) pointed out that paneer from cow milk is of inferior quality especially in sensory characteristics compared to buffalo milk and such effect could be ascribed to different make up of casein micelles and lower protein and calcium contents in cow milk. Chavan *et al.* (2007) recommended addition of 20 parts of buffalo skim milk to 80 parts of cow whole milk for the production of better quality paneer. Kale *et al.* (2008) opined that sheep milk could be used for manufacturing paneer resembling buffalo milk paneer. According to Kandeepan and Sangama (2011) yak milk which is creamy white in colour with thick consistency is ideal for making paneer.

Heat treatment of milk is a highly essential step in the manufacture of paneer and it has profound effect on physico chemical, sensory and microbiological properties of paneer. It also affects total solid recovery and thus yield of paneer. Heat treatment is essential to destroy the pathogenic as well as spoilage microorganisms (Ghodekar, 1989 and Khan and Pal, 2011).

Heat treatment at 90°C for 10 to 15 minutes is necessary to achieve desired yield in paneer. (Muller *et al.*,1967). The coagulation is a complex process influenced by many different factors like temperature, pH and calcium content. Coagulation temperature of 70 °C has been widely practiced and reported to give desired frying quality in terms of shape retention, softness as well as integrity (Rao *et al.*, 1984 and Chawla *et al.*, 1985) But Vishweshwaraiah and Anantakrishnan (1985) reported that satisfactory quality paneer can be obtained by employing coagulation temperature of 80°C from both buffalo and cow milk. Low coagulation temperature of 60°C has been used by Sanyal and Yadav (2000a) for preparing reduced fat paneer. Coagulation temperature influences the moisture content, fat and total solid recovery and there by yield of paneer. According to Kumar *et al.* (2011), an increase in the temperature from 60 to 86°C decreased the moisture content of paneer from 59 to 49 per cent.

De (1980) reported that the moisture retention in paneer decreased with fall in pH, which consequently decreased the yield. Paneer made by coagulating cow milk at coagulation pH 5.0 was sensorily scored superior to the one coagulated at pH 5.5. (Vishweshwaraiah and Anantakrishnan, 1985) Sachdeva and Singh (1988) reported optimum coagulation pH of 5.35 for paneer to be prepared from buffalo milk and Sachdeva *et al.* (1991) advocated optimum coagulation pH of 5.2 to 5.25 for paneer to be prepared from cow milk. Decreasing the pH and increasing the temperature will decrease the coagulation time (Malossini *et al.*, 1996, Chiofalo *et al.*, 2000, Auldist *et al.*, 2004)

Paneer manufacture involves coagulation of milk proteins using an acidic medium to form curd. During this process large lumps of proteins are formed in which fat and other colloids and dissolved solids get entrapped. The complete coagulation of milk occurs when pH of milk reaches 4.6 which is the isoelectric point of its major protein, casein. The type, concentration of the acid and the mode of delivery into the hot milk influences the moisture level and product yield (Khan and Pal, 2011).

Several coagulants have been tried over the years namely lemon juice and citric acid (Vishweshwaraiah and Anantakrishnan, 1985), whey cultured with *Lactobacillus acidophilus* (Sachdeva *et al.*, 1985) hydrochloric acid, phosphoric acid and tartaric acid (Sachdeva and Singh, 1987), acetic acid (Grover *et al.*, 1989) malic acid (Kumar *et al.*, 1998), lactic acid (Kumar *et al.*, 2008), alum (Kumar *et al.*, 2008) and calcium lactate (Deshmukh *et al.*, 2009) to prepare paneer. The concentration of coagulant has a profound effect on the body and texture of paneer. Low acid strength result in soft body and smooth texture, while high acid strength results in hard body. The amount of coagulant required for coagulation depends on the type of milk, buffering capacity of milk, type of coagulant and the coagulation temperature (Khan and Pal, 2011)

Citric acid as one per cent solution is the most widely used coagulant for making good quality paneer (Singh and kanawjia, 1988, Sachdev and Singh, 1988). Rao *et al.* (1984) made paneer from standardised buffalo milk (6 per cent fat) using three different strength of acidic solutions (0.3, 0.4, and 0.5 per cent) and indicated a decreased yield with increased strength of citric acid solution.

Vishweshwaraiah and Anantakrishnan (1985) advocated use of 2 per cent citric acid solution for making paneer from cow milk and the acid requirement was 2.34 g for coagulating one kg of milk whereas Chawla *et al.* (1987) recommended 1.95g citric acid for making paneer from one kg of cow milk regardless of its fat content.

During paneer production various types of additives can be incorporated into milk to improve yield, sensory characteristics and shelf life as well as to reduce the cost of production. Cow milk paneer has softer body than buffalo milk paneer since cow milk is lower in calcium content. In order to produce good quality cow milk paneer, calcium chloride at the rate of 0.08 to 1.5 per cent was used by Sachdeva *et al.* (1991) and Arya and Bhaik (1992).

Singh and Kanawjia (1988) and Arya and Bhaik (1992) suggested that addition of 0.1 per cent $CaCl_2$ to milk prior to coagulation increased the total solid recovery, yield and sensory characteristics. Use of 0.5 per cent common salt in milk also improved the body, texture, yield and shelf life of low-fat buffalo milk

paneer (Yadav *et al.*, 1994). Calcium phosphate addition to milk can help in the coagulation of whey proteins there by increasing yield of curd (Dybin and Smith, 1998). Khan and Pal (2011) suggested that for improving the quality of paneer from reconstituted milk, calcium phosphate can be incorporated at different levels with a view to aid coagulation and to improve the texture, cohesiveness and over all acceptability. In a study conducted by Rajakumar *et al.* (2010), tricalcium citrate was added to buffalo milk to achieve the calcium fortification at 25, 50 and 75 mg per 100 ml.

Hill *et al.* (1982) recommended use of high temperature and $CaCl_2$ for getting better yield through co-precipitation of casein and whey proteins. Arora *et al.* (1996) observed that addition of $CaCl_2$ increased fat, protein, pH, TS recovery and thus yield of paneer made from diluted milk. Kanawjia and Rizvi (2003) recommended use of 0.15 per cent $CaCl_2$ to micro filtered milk prior to acidification in paneer manufacture.

The water binding capacity, consistency, yield and recovery of total solids of paneer can be improved by the addition of sodium alginate, carrageenan, pre-gelatinized potato starch and Carboxymethyl celllose (CMC) (Sachdeva and Singh, 1988). A study conducted by Nalkar *et al.* (2009) reported usage of bhendi or lady's finger gum for better hydrocolloidal properties in paneer.

After curd formation and whey drainage coagulum is transferred to hoops lined with muslin cloth and subjected to pressing to obtain compact block of paneer. Kulsheshtha *et al.* (1987) suggested applying a pressure of 1 kg/cm^2 and found moisture level in paneer was inversely related to the pressure applied. Sachdeva *et al.* (1991) applied pressure of 40 to 45 kg for 10-15 minutes for paneer hoops sized 35 x 28 x 10 cm for buffalo milk paneer with moisture content around 56 per cent. Kumari and Singh (1992) used 0.08kg $/cm^2$ for paneer from cow and buffalo milk which resulted in paneer with 47.9 and 42.7 per cent moisture respectively. Aneja *et al.* (2002) recommended higher weights of 70 to 100 kg on hoops for 10 to 15 minutes for the preparation of paneer.

Paneer is a highly perishable product. It was reported that the freshness of paneer remain intact only for 3 days at refrigeration temperature (Bhattacharya *et*

al., 1971). At ambient temperature paneer does not keep good for more than one day. Singh *et al.* (1988) dipped paneer blocks in 5 per cent brine, chilled water and acidified water (pH 5.0) to enhance their shelf life up to 12 days at refrigerated storage. Singh *et al.* (1989) found that addition of 0.15 per cent sorbic acid to milk for paneer preparation or wrapping the paneer in sorbic acid coated butter paper extended the shelf life to 30 days at ambient temperature. Rao *et al.* (1992) utilized hurdle technology involving mild heat treatment, minor reduction in water activity and acidification (pH 5.0) to extend the shelf life of paneer to 14 days at 30^0C. Pal *et al.* (1993) observed that applying paraffin wax on low-fat paneer cubes increased the shelf life by over 10 days compared to unparaffined one. Rao and Patil (1999) used 1 per cent each of sodium chloride, sucrose and glycerol to decrease the water activity of paneer which also extended the shelf life. FSSAI (2011) allows use of sorbic acid and its sodium, potassium or calcium salts at the rate of 2000 ppm and nisin at the rate of 12.5 ppm for preserving paneer.

Kankhare *et al.* (2007) conducted a study to utilise the potential of microwave technology (425 watts for 5 min) with chemical preservative (sorbic acid 0.1%) and bio-preservative (Nisin 100 RU/g) in combination and alone, in order to extent shelf life of paneer under refrigerated condition ($7 \pm 10\ ^0$C). The antimicrobial effect of spices like ginger, garlic and chemical preservatives (KMS) and sodium chloride was also studied by Balijeet *et al.* 2007 on storage life of paneer. Garlic extract was found to have the maximum preservative effect and the product remained microbially safe for 4 days and 8 days at room temperature and refrigerated temperature respectively.

The type of packaging material also plays an important role in enhancement of shelf life. Goyal and Shrivastava (2006) were of the opinion that the common types of chemical spoilage in paneer could be significantly delayed or altogether prevented by using suitable packing technique. Modified atmosphere packing (MAP) reduces, oxidative deterioration and microbial growth by changing the gas that surrounds the product. MAP is a process by which the shelf life of food products is significaly increased. Normally, paneer blocks of required size are packaged in polyethylene pouches, heat sealed and stored under refrigeration conditions. Paneer packed in tins along with water/ brine and sterilized in

autoclave at 1 kg/cm^2 for 15 min could stay well for 4 months at room temperature (Kanawjia and Singh, 2000).

2.2. Physico-chemical, nutritional, sensory and shelf life qualities of paneer

Paneer is of great value in diet, especially in the Indian vegetarian context, because it contains a fairly high level of protein and fat as well as certain minerals, especially calcium and phosphorus. It is also a good source of fat soluble vitamins A and D.

The good quality paneer is marble white in appearance, having a slight spongy body, lose knit texture possessing a sweetish acidic nutty flavour (Prince *et al.*, 2007). The coagulation process in paneer is considered to be a consequence of the chemical and physical changes in casein brought about by the combined influence of heat and acid. This phenomenon involves the formation of large structural aggregates of casein from the normal colloidal dispersion of discrete casein micelles, in which milk fat and coagulated serum proteins get entrapped along with some whey (Kumar *et al.*, 2011).

The yield of paneer mainly depends on the composition of milk used (type of milk, standardization for fat and SNF), heat treatment given to milk, type and strength of coagulant, losses incurred after coagulation (based on pH and temperature of coagulation) and moisture content of resultant paneer after pressing (Chawla *et al.*, 1987 and Sachdeva and Singh, 1988). Sharma *et al.* (2002) reported that the composition of milk, which changes with the seasons of the year, had profound effect on the yield of paneer. Milk obtained during winter season gave highest yield (15.5 per cent) while rainy season led to least yield (14.79 per cent).

According to Chandan (2007), the yield of paneer is dependent on the fat and SNF content of the milk used, fat and protein recovered in paneer and its moisture content. A yield of around 21 to 23 per cent for paneer containing 51 to 54 per cent moisture can be obtained from buffalo milk, while yield from cow milk is about 17 to 18 per cent (Khan and Pal, 2011).

Muller *et al.* (1967) recommended that adequate heat treatment to milk so as to have desired protein denaturation is necessary to enhance the yield of paneer.

Co-precipitation of casein and whey protein through acidification in presence of calcium chloride (0.15 per cent) enhanced the yield of paneer (Hill *et al.*, 1982; Singh and Kanawjia, 1988, Arora *et al.*, 1996 and Makhal and Kanawjia, 2005).

The yield of paneer from buffalo milk decreased with an increase in coagulation temperature (Sachdeva and Singh, 1988), while for cow milk it increased (Singh and Kanawjia, 1988). Higher fat levels in initial milk gave higher yield for paneer (Pal and Yadav, 1991). Jadhavar *et al.* (2009) obtained 14.2 per cent yield from cow milk, standardized to 4 per cent fat. Deshmukh *et al.* (2009) observed that use of acidified and cultured whey helped in increasing the yield of paneer.

Rao *et al.* (1984) suggested that higher yield of paneer could be obtained by heating milk to 85 °C and coagulating milk using 0.3 per cent citric acid solution at 70 °C. Sachdeva and Singh (1987) obtained 21.7 to 23.4 per cent yield by using different coagulants like citric acid, tartaric acid, lactic acid and phosphoric acid, HCl and sourced whey. Yield of paneer was found to be greater when malic acid was used instead of citric acid solution as coagulant (Pal *et al.*, 1999).

Homogenisation increased the yield of paneer significantly (Vishweshwaraiah and Anantakrishnan, 1985). Chawla *et al.* (1987) observed that the incorporation of sodium chloride (0.5 per cent) and NFDM dramatically improved the yield of paneer. Sanyal and Yadav (2000b) found that addition of 0.25 per cent common salt along with 2.5 per cent cultured skim milk increased the yield of reduced-fat paneer. Sanyal *et al.* (2004) observed that the addition of common salt at the rate of 0.75 per cent to milk increased the yield of reduced-fat paneer by 19.59 per cent above that of control.

Incorporation of hydrocolloids like 0.10 per cent sodium-alginate, 0.15 per cent carrageenan or 0.15 per cent pre-gelatinized starch helped in increasing the yield of paneer by retaining more moisture (Sachdeva and Singh, 1988). Addition of 7.5 per cent of whey solids to milk increased yield by about 21.0 per cent (Singh *et al.*, 1991). Gupta and Pal (1995) observed that paneer made from reverse osmosis retentate (25 and 33 TS per cent) resulted in higher moisture retention, culminating in higher yield by 2 to 3 per cent. Kaur and Bajwa (2003) found that

reduction of the size of leaves by chopping or grinding and stage of incorporation significantly affected the yield and moisture content of herb impregnated paneer. Kantha and Kanawjia (2007) observed that both fat level in milk and incorporation of soy fibre had a significant effect on the yield of paneer; fat level of 2.5 per cent and soy fibre level of 0.56 per cent was found to be optimal.

The chemical composition of paneer reported by earlier workers showed a significant variation. According to Khan and Pal (2011) the initial composition of milk, method of manufacture and losses of milk solids in whey influences the composition of paneer. The chemical composition of paneer reported by different workers is furnished in Table 1.

The moisture content of paneer decreased progressively with the increase in the strength of coagulant and the concentration of coagulant was inversely related to moisture in paneer (Sachdeva and Singh 1988). The moisture and ash contents were significantly high in low fat paneer compared to full fat paneer prepared from yak milk (Kandeepan and Sangma, 2011).

The pH of fresh milk is 6.6 at 25 ^{0}C. When milk is heated, its pH decreases because hydrogen ions are liberated when calcium phosphate precipitates (Sherbon, 1988). In freshly prepared goat milk paneer the pH varied from 5.69 to 6.13 (Agnihotri and Pal, 1996). Biradar *et al.* (2012) reported a pH of 5.78 to 6.0 in paneer prepared by blending soy milk and bufallo milk at different levels. Archana *et al.* (2012) reported pH and acidity in freshly prepared milk paneer as 5.780 and 0.185 per cent respectively.

Sreeja and Jaya (2007) reported an acidity of 0.44 per cent in pineapple flavoured cultured paneer made from buffalo milk. The titrable acidity in soy paneer was found to be 0.43 per cent (Khodke *et al.*, 2010). Goyal *et al.* (2007) evaluated the acidity of paneer available in the market and reported that it varied from 0.30 to 0.72 per cent. The maximum acidity allowed in paneer is 0.50 per cent (Anon, 2013).

Table 1. Proximate composition of paneer

Milk fat (%)	Constituents in Paneer (%)					References
	Moisture	Fat	Protein	Lactose	Ash	
Buffalo milk						
3.5	56.99	18.10	18.43	–	–	Chawla *et al.* (1987)
5.0	56.77	22.30	–	–	–	Bhattacharya *et al.* (1971)
5.0	56.43	22.50	-	-	-	Shukla *et al.* (1984)
5.5	55.19	23.80	17.99			Chawla *et al.* (1987)
5.8	50.72	27.13	17.99	2.29	1.87	Rajorhia *et al.* (1984)
5.8	54.10	23.50	18.20	2.40	1.80	Sachdeva and Singh (1987)
5.9	51.12	26.86	17.38	-	2.00	Pal and Garg (1989)
5.9	55.10	23.47	19.92	3.09	2.43	Pal *et al.* (1999)
6.0	54.76	25.98	-	-	-	Bhattacharya *et al.* (1971)
6.0	53.51	24.12	16.44	2.60	1.88	Pal and Kapoor (2000)
6.0	47.05	23.00	19.77	-	2.75	Masud *et al.* (2007)
7.57	51.93	26.17	15.74	2.71	1.80	Pal and Yadav (1991)
Cow milk						
3.5	55.97	18.98	20.93	2.01	1.45	Mistry *et al.* (1992)
4.4	56.0	22.0	18.5	2.1	1.4	Sachdeva *et al.* (1991)
4.5	55.26	24.15	18.43	-	-	Syed *et al.* (1992)
4.57	59.31	17.9	17.34	2.43	1.38	Pal and Yadav (1991)
5.0	53.90	24.80	17.60	-	-	Sachdeva and Singh (1988)
-	53.80	24.85	17.75	-	1.45	Shashikumar and Puranik (2011)
Mixed cow and buffalo						
3.5	55.06	18.40	20.75	2.43	1.90	Pal *et al.* (1991)
5.0	57.14	22.32	-	-	-	Shukla *et al.* (1984)
Skim milk						
0.1	62.14	4.0	27.48	-	-	Syed *et al.* (1992)
-	62.47	1.96	28.64	–	2.55	Sivakumar *et al.* (2005)
Goat milk 4.86	46.94	26.95	19.99	-	1.93	Agnihotri and Pal (1996)
Ewe milk 6.94	55.08	23.50	15.75	2.73	2.93	Pal *et al.* (2008)
Reconstituted WMP 15	57.30	17.40	22.80	-	-	Singh and Kanawjia (1992)
Recombined cow milk	57.40	22.92	16.16	-	-	Singh and Kanawjia (1991)

According to Masud *et al.* (1992) the paneer prepared from buffalo milk had higher total solids as compared to paneer from cow milk. Moreover, there is no significant difference in the lactose and ash content of paneer prepared from both types of milk.

Agnihotri and Pal (1996) reported a total solid content of 48.20 to 57.78 per cent in goat milk paneer. Sharma *et al.* (2002) observed a total solid content of 13.31 percent in cow milk paneer. Biradar *et al.* (2012) reported a total solid content of 45 to 50 per cent in paneer prepared by blending soy milk and bufallo milk at different levels.

Milk paneer is nutritionally superior and it is attributed to the presence of whey proteins rich in essential amino acids. Due to its high nutritive value, paneer is an ideal food for expectant mothers, infants, growing children, adolescents and adults. Paneer is also recommended by the clinicians for diabetic and coronary heart disease patients (Chopra and Mamtani, 1995). Shrivastava and Goyal (2007) indicated a protein efficiency ratio (PER) of 3.4 and 2.3 in paneer prepared from buffalo milk and cow milk while the biological value (BV) was found to be 86.56 and 81.88 respectively, digestibility coefficient was found to be same in both. The authors also indicated high net protein utilization of 83.10 in buffalo milk paneer when compared t0 78.28 in cow milk paneer.

Paneer is a rich source of animal protein, fat, vitamins and minerals like calcium and phosphorus. Paneer contains 53 to 55 per cent moisture, 23 to 25 per cent fat, 17-18 per cent proteins, 2 -2.5 per cent lactose, and 1.5- 2 per cent minerals (Kanawjia and Singh, 1996). According to Mathare *et al.* (2009), paneer is a good source of calcium and its consumption is helpful in preventing ostioorosis and the authors reported thet paneer contribute around 40 to 50 per cent of daily requirement of calcium.

The quality of paneer depends upon the quality of milk from which it was made. Milk fat exerts significant effect on the organoleptic qualities of paneer. According to Arora and Gupta (1980) the sensory score of paneer increased with increasing fat levels. Chawla *et al.* (1985) reported that acceptable quality paneer could be obtained from milk possessing 3.5 to 6.0 per cent fat. Low fat paneer with

acceptable organoleptic quality was made from cow milk with 3.5 per cent fat (Vishweshwaraiah and Anantakrishnan (1986). Singh and Kanawjia (1988) observed that the sensory score of cow milk paneer improved with increase in coagulation temperatures (i.e. 75 to 90 °C).

Kanawjia *et al.* (1990) reported a shelf life of 6 days for paneer stored at refrigerated temperature. Sachdeva *et al.* (1991) observed that incorporation of 0.08 per cent $CaCl_2$ in manufacture of cow milk paneer helped in improving the sensory score for appearance, flavour, body and texture compared to milk without added calcium salt. The authors reported maximal sensory score when the pH of coagulation was in the range 5.20 to 5.25. Citric acid yielded sensorily superior paneer compared to malic acid; the body and texture of paneer obtained using malic acid was quite poor (Pal *et al.* 1999). Kaur and Bajwa (2003) found that paneer dipped in 3 per cent brine had a good sensory score. They also reported that the addition of mint (*Mentha spicata*) and coriander (*Coriandrum sativum*) improved the flavour of paneer.

Sanyal *et al.* (2004) observed that desired sensory quality of reduced fat paneer could be obtained through the use of 0.25 per cent sodium chloride in milk. Bajwa *et al.* (2005) advised heating temperature of 85 °C and coagulation temperature of 72 °C with immediate straining for yielding highly acceptable paneer incorporated with all the levels of herbs. The overall acceptability score was the highest for paneer incorporated with 10.0 per cent of coriander and mint leaves. Paneer made from buffalo milk heated at 85 °C yielded sensorily superior product than when heated at 80 or 90 °C (Masud *et al.*, 2007). Kantha and Kanawjia (2007) reported that acceptable paneer could be obtained from milk having 3.0 per cent fat and 0.25 per cent soy fibre. Chavan *et al.* (2007) found that paneer made from blend of buffalo skim milk and cow milk (20:80) was comparable to the paneer made using standard buffalo milk containing 5.5 per cent fat. Kumar *et al.* (2007) found that the sensory score of paneer decreased with an increase in the level of incorporation of the coagulant i.e. from 0.2 to 0.6 per cent. Pal *et al.* (2008) found that acceptable paneer could be obtained from ewes' milk by coagulating the milk at 90 °C using 2.0 per cent citric acid solution. Rajakumar *et al.* (2010) prepared acceptable paneer from buffalo milk fortified with tricalcium citrate and found

better sensory characteristics such as flavour, body and texture, colour and appearance and overall acceptability in comparison with control paneer

Agnihotri and Pal (1996) conducted a study to determine the quality and shelf-life of goat milk paneer in refrigerated storage and reported change in colour from white to yellowish white especially on the surface. Sreeja and Jaya (2007) observed that the paneer stored under refrigeration temperature remained acceptable up to 15 days with negligible change in sensory evaluation score. Bhargave *et al.* (2007) revealed that the fat content plays an important role in determining the hardness and softness of the outer surface of paneer.

The microbiological quality of paneer depends on the microbiological quality of milk and the hygiene exercised during manufacture of paneer and its subsequent handling, packaging and storage. Microorganisms such as coliform, yeast and mold that might be present in raw milk get destroyed completely, when milk is heated at 82°C for 5 minutes. But these microbes may contaminate the product through a number of sources like air, water, equipment, knife, muslin cloth and persons handling the products (Aggarwal and Shrinivasan, 1980). These microbes can cause proteolytic and lipolytic changes, discoloration and other defects in the product (Thakral *et al.*, 1986). Paneer is highly susceptible to spoilage by bacteria, yeast and mold does not keep good for more than a day at room temperature (Nath *et al.*, 2007).

Bureau of Indian Standards (BIS, 1983) set limits for microbial count viz., total plate count $<5\times10^5$/g, yeast and mold count <250/g, and coliform count of <90/g. FSSAI (2011) has given maximum permissible limits for microbial population in paneer as TPC not more than 50,000/g, coliform count not more than 90/g, yeast and mold count not more than 250/g without any E coli.

Singh *et al.* (1989) reported microbial profile of fresh paneer as SPC - 2.3×10^3, proteolytic bacteria - 7.4×10^2, lipolytic bacteria - 4.9×10^2 and fungi - 10/g. Pal *et al.*, (1993) observed the SPC, yeast, mold and coliform count of fresh paneer as 3.03, 1.90 and 0.86 log cfu/g respectively. Nath *et al.* (2007) observed SPC of 5.4×103 and yeast and mould count of 260/g in freshly prepared paneer.

Vaishnavi *et al.* (2001) obtained SPC in the range of 3×10^2 to 9.7×10^{10} cfu/g in paneer samples sold in Chandigarh. A few workers noticed (*Bacillus cereus* and *Pseudomonas aeruginosa)* in paneer sold form Ranchi and Gwalior from markets (Kumari and Kalimuddin, 2002; Bharadwaj *et al.*, 2007). Aflatoxin contamination in market panner was also observed by Choudhary *et al.* (2007). Chhabra (2008) observed yeast count in the range of 24–180 cfu/g in paneer.

Vishweshwaraiah and Anantakrishnan (1985) reported that the fresh samples prepared under hygienic conditions contain only a few organisms. The coliform, yeast and molds are completely destroyed during heating of milk at 80°C for 5 minutes, but these micro organisms reappear in the product in the absence of strict sanitary conditions.

According to Sachdeva *et al.* (1991) quality of paneer deteriorates due to the growth of organisms on the surface of paneer during storage. The total counts as well as yeast and mold counts increased during storage of paneer up to 10 days at 5°C. Gupta (1985), Thakral *et al.* (1986), Parashar (1987) reported about the increasing trend of the total viable count of paneer treated with 2 per cent potassium sorbate.

A study conducted by Agnihotri and Pal (1996) on quality and shelf-life of goat milk Paneer under refrigerated storage revealed marked increase in microbial population after three days of storage. Change in organoleptic traits such as odour, colour, sliminess and overall appearance were also noticed after three days of storage. The results indicate that good quality Paneer from goat milk can be prepared and stored safely only for 3 days under refrigeration before it is marketed.

Normal paneer without any preservatives can be kept for only two days at ambient temperature and six days at refrigerated temperature (Sachdeva *et al.*, 1991). Psychrotrophic bacteria which were initially low in numbers increased by two log cycles on seven days of storage. Arora and Mittal (1991) did not find the presence of yeast and mold in freshly prepared soy milk Paneer and soy milk and skim milk blended Paneer.

Yadav *et al.* (2010) studied the effect of brine treatment on sensory, chemical and microbiological quality of paneer and indicated the presence of small

number of viable organisms (31 to 38 cfu/g) and absence of coliform in the product. However, during storage, the total viable counts (TPC) and yeast and mold increased at a slow pace due to the brine treatment of the product. Even after 21 days of storage the TPC, yeast and mold counts of paneer were well within the prescribed limits. In case of lactoferrin incorporated paneer, there was no increase in the total bacterial count, coliform count and yeast and mold counts during storage (Shashikumar and Puranik, 2011).

Khodke *et al.* (2010) indicated the yeast and mold count of fresh soy paneer as 28 cfu/g. They also observed that aerobic packed soy paneer (9062 cfu/g) samples recorded more counts as compared to vacuum packed soy paneer samples (4378 cfu/g) during storage. Gandhi (2009) had quoted the critical limit of yeast and mould counts as 250 cfu/gm in soy paneer. Archana *et al.* (2012) studied the effects of edible coating and different packaging treatments on microbial quality of paneer and indicated maximum shelf life of 40 days with a total viable count of 1.6 $\times$ 10^3 and 2.75 $\times$ 10^3 cfu/g in coated paneer samples packed in LDPE and laminates respectively.

2.3. Composition and health benefits of coconut

The importance of the coconut palm lies in the fact that not only does it supply food, drink and shelter but also provides raw materials for a number of industries intimately connected with domestic as well as economic life (Shanmughavelu *et al.*, 2002). India is one among the largest producers of coconut in the world with annual production of 12536 millions nuts from an area of 1.75 million hectares (Rethinam, 2003).

It is pertinent to mention that all the parts of the wonder palm are useful to mankind in one way or other. Coconut trees are permanent crops that bear fruit continuously up to 60 to 70 years. According to Banzon *et al.* (1996) coconut provides coconut water, coconut meat, coconut milk and coconut oil. Batugal *et al.* (1998) stated that coconut provides a source of food with high nutritive value. Romulo (1999) is of the opinion that coconut is to be projected in the world market not as an oil yielding units but as a dietary fruit endowed with considerable health benefits.

The health effects of coconut were recognized about 4000 years ago in ayurvedic medicine (Kabara, 2002). The medium chain fatty acids in coconut fat are similar to the fat in mother's milk and have similar nutraceutical effects. It does not contain cholesterol and helps to reduce fat accumulation in the body. It is rich in lauric acid, a source of disease fighting fatty acid derivative of monolaurin, increases HDL cholesterol, and does not elevate LDL cholesterol/ serum triglycerides (Rethinam, 2003). Coconut is an indispensible ingredient in many of the traditional cuisines of South East Asian countries including India. For thousands of years coconut products have held a respectable and valuable place in local folk medicine, one of such claims is that it is antiulcerogenic (Nneli and Woyike, 2008)

Coconut milk is a sweet, milky white cooking base extracted from the meat of mature coconut. The colour and rich taste of the milk can be attributed to the high oil content and sugars. Coconut milk contains a complex blend of nutritional constituents like carbohydrates, vitamins and minerals (Nair, 2009).

Sattyanarayana *et al.* (1991) reported the typical composition of coconut milk as 50 per cent moisture, 34 per cent fat, 7.3 per cent carbohydrates, 3.5 per cent protein, 3.0 per cent fibre and 2.2 per cent ash. Mini and Rajamohan (2003) analysed the coconut kernel protein and indicated that it contains very high amount of amino acid L-arginine (24.5 per cent) that is mainly responsible for the antioxidant effect of coconut protein. Ishiaq and Odeyemi (2012) reported the pH of coconut milk as 6.50 and its specific gravity as 1.008. They also reported the composition of coconut milk as glucose 2645.7 mg/l, Vitamin C 0.46 mg/l, Vitamin E 0.14 mg/l, Calcium 2130.6 mg/l, iron 24.56 mg/l, zinc 7.06 mg/l, potassium 1127 Meq/l and sodium 20.22 Meq/l.

According to Gonzalez (1991) coconut milk is an emulsion of oil, water and proteins. The emulsion separates on heating and coagulate the proteins. Ananth and Vasudevan (2003) opined that coconut oil has added advantage as a nutraceutical and posses therapeutic values, which could be tapped by the health conscious consumers.

Warrier (1995) narrated that the lauric acid component of coconut is an ideal dietary fat due to its anti-microbal benefits. Human body utilizes lauric acid obtained from the diet to make monolaurin, which is reported to possess antiviral, antibacterial and antiprotozoal properties (Enig, 1995 and Vidyaprakash, 1995).

In a study conducted by Sunethra (2003) among adolescent Srilankan boys subsequent increase in cholesterol level was not noticed with increased intake of coconut. This may be attributed to hypercholesterolemic effect of coconut fat, which was mitigated by a fibre rich diet with low animal fat.

Pandiyan and Geevarghese (2007) prepared coconut milk and milk products are prepared from mature coconuts. In this process the white coconut kernel is ground into slurry from which coconut milk was separated by pressing. The coconut milk was then centrifuged and further processed to get milk concentrate, coconut cream and milk powder.

Efforts have been made to develop novel dairy products using a combination of skim milk and coconut milk. Likewise, coconut fat is an excellent fat source for the preparation of filled milk, infant formula, margarine and imitation cheeses. The products like filled milk beverage, soft and blue cheeses, cheese analogues and low fat fruit yoghurt prepared with coconut cream showed good commercial potential (Gwee and Seow, 1997).

Agarwal *et al.* (1991) prepared filled milk by blending skim milk powder with coconut milk of freshy grated coconut could be utilised as coconut flavoured milk by food industry.

2.4. Diversification in paneer

The high cost of paneer has restricted its popularity particularly among the middle class and the poor. Hence there is a considerable interest to reduce or replace the milk fat in paneer. This requires the manufacture of paneer like products utilising low fat milk from non conventional food solids, which are not only cheap but can also be converted to a product closely similar to the nutritional and textural qualities of paneer. Preparation of paneer using incorporation of different types of milk and varied techniques resulted in wide variation in phycico-

chemical, nutritional, microbiological and sensory quality of the final product. In the last few decades, consistent efforts have been made for the manufacture of different types of paneer like low fat paneer, recombined and reconstituted milk paneer, dietary fibre enriched low fat paneer, soy paneer, filled paneer, vegetable impregnated paneer and UF paneer (Kumar *et al.*, 2011).

Good quality low fat paneer has been developed at National Dairy Research Institute, Karnal from milk having as low as 3.0 per cent fat (Kanawjia and Khuran, 2006). Chandan (2007) reported that skim milk paneer and low fat paneer having 13 per cent and 24 per cent fat, respectively on dry matter basis are available in the western countries. Out of these, former had a chewy, rubbery texture and hard body.

Paneer prepared from low fat milk result in hard body, coarse, rubbery and chewy texture, bland flavor, poor mouth feel as well as mottled colour and appearance (Chawla *et al.*, 1985): However, low fat paneer with an improved quality in terms of sensory, rheological and nutritional attributes has been developed using soy fiber and inulin (Kanawjia and Khuran, 2006). Kandeepan and Sangma (2011) developed a low fat yak milk paneer with incorporation of guargum at a level of 0.15 per cent, improved body and texture and juiciness of low fat yak milk paneer.

Babaje *et al.* (1992) studied the effect of blending soy milk with buffalo milk on the quality of paneer. The authors observed that coagulation of soy milk results in a white, soft gelatinous mass with bland taste, unique body and texture. Soy paneer is a cheaper source of good quality paneer. They also noticed that addition of soy milk up to 20 per cent to buffalo milk had no adverse effect on the quality of paneer and resembles almost that of milk paneer in colour, taste and springiness. Acceptability of soy paneer can be further enhanced by addition of sodium caseinate. Kanawjia and Singh (2000) reported that fortification of low fat milk with soya solids improved its rheological and sensory qualities along with reduction in the cost of production.

Kaur and Bajwa (2003) reported that incorporation of coriander and mint at level of 10 per cent by weight in paneer improved the overall acceptability score and yield of the product.

Low-cost, low-calorie, health promoting paneer can be made using skim milk added with vegetable oil. Hydrogenated vegetable oil and groundnut oil was proved to be better than soya oil; for the preparation of filled paneer. Higher fat level (i.e., 5.5 vs 3.5 per cent) resulted in better acceptability of the resulting filled-paneer (Roy and Singh, 1994). Kanawjia and Singh (2000) found that paneer obtained from skim milk and vanaspati (HVO) is quite acceptable paneer.

Coconut milk is low in protein but very rich in fat and emulsifiers and it is a natural oil-in-water emulsion just like cow milk hence both can mix readily (Davide *et al.*, 1987). As a carrier of vegetable fat to substitute butterfat, water-extracted coconut milk would be less expensive and much easier to blend with skimmed milk than coconut oil (Adedeji and Nwanekezi, 1987).

Sanchez and Rasco (1983) conducted a study to utilize coconut milk as a cow milk extender in processing white soft cheese using formulations of various combinations of coconut milk and skimmed milk. The potential of water-extracted coconut milk as a less expensive substitute for butterfat in the manufacture of fresh soft cheese manufacture was investigated by Davide *et al.* (1987). Davide *et al.* (1988) developed a fresh soft cheese spiced with garlic and blue-type cheese, from a blend of skimmed milk powder and coconut milk.

Venkateswarlu *et al.* (2003) opined that addition of 100 per cent of coconut milk (25 per cent fat) to skim milk resulted in highly acceptable quality paneer. David (2012) developed functional paneer from buffalo milk blended with coconut milk.

Impregnation of vegetables not only reduces the cost of paneer but also provides functional properties. Kaur and Bajwa (2003) incorporated green leafy vegetables in paneer to enhance nutritive value and flavour. Bajwa *et al.* (2005) manufactured vegetable impregnated paneer by incorporating coriander and mint leaves from 5 to 30 per cent in buffalo milk having 5 per cent fat. They reported that yield, ash, crude fibre, ascorbic acid, iron and calcium content of the paneer

increased with increase in the level of impregnation whereas fat content decreased. A decrease in the level of sensory scores was noticed with increase in the level of vegetable impregnation although all the samples were very well acceptable.

Gupta *et al.* (2001) standardised filled masal paneer and ready to serve spice paneer that could be equally good for the direct consumption and for preparation of culinary dishes.

Incorporation of whey solids raised the yield of paneer by 20.9 per cent with recovery of milk solids (Singh *et al.*, 1988). Kanawjia and Singh (2000) found that incorporation of low cost calcium salt of groundnut protein isolates to skim milk and vegetable fat mixture produced nutritionally superior paneer than the conventional paneer. Salve *et al.* (2007) advocated use of 2.0 per cent whey protein concentrate (72 per cent protein) to buffalo milk with only 4 per cent fat for improving the quality attributes of low fat paneer (<50 per cemt FDM). Sivakumar *et al.* (2007) found that the inclusion of 0.2 per cent soy protein isolate (SPI) as a fat replacer to buffalo milk containing 4 per cent fat increased the yield of low-fat paneer with improved texture, juiciness and overall acceptability when compared to paneer devoid of added SPI.

Sachdeva and Singh (1988) observed increase in moisture retention and thus yield of paneer when sodium alginate, carrageenan or pre-gelatinized starch at levels of 0.10 and 0.15 per cent respectively were used as hydrocolloids. Roy and Singh (1994) reported that addition of 0.1 per cent pre-gelatinized starch coupled with higher coagulation temperature (90 °C) improved the body and texture as well as yield of filled paneer. However, the authors did not notice any beneficial effect when 0.1 per cent sodium aligenate was used. Sharma *et al.* (1999) used Carboxymethyl cellulose (CMC) as an additive for oil reduction in deep-fat fried paneer and found that it appreciably reduced the oil uptake by paneer on frying.

Nakazawa *et al.* (1989) added fruit juices to reconstituted skim milk for obtaining 'fruit flavoured paneer' having desired sensory characteristics.

Materials and Methods

3. MATERIALS AND METHODS

The study entitled "Standardisation and quality evaluation of coconut based filled paneer" was undertaken to standardise the preparation of paneer incorporating coconut milk, coconut slurry and soymilk in different proportions and to evaluate the physical, chemical, nutritional, organoleptic and keeping qualities of the developed paneer. The feasibility of using natural coagulants in the preparation of paneer was also evaluated. The study was carried out in three experiments. The materials used and the methods followed in this study are given under the following headings.

3.1. Collection of raw ingredients

3.2. Pretreatments

3.3. Standardisation of coconut based filled paneer

3.4. Organoleptic evaluation of filled paneer and selection of the most acceptable products

3.5. Selection of natural coagulant for preparation of paneer

3.6. Preparation of selected filled paneer using natural coagulant

3.7. Quality evaluation of selected filled paneer and filled paneer prepared using natural coagulant

3.7.1. Physical qualities

3.7.2. Chemical qualities

3.7.3. Nutritional qualities

3.7.4. Organoleptic qualities

3.7.5. Microbial qualities

3.8. Cost of production of filled paneer

3.9. Statistical analysis of the data.

3.1. Collection of raw ingredients

The cow milk required for the preparation of coconut based filled paneer was procured from the dairy plant of Kerala Veterinary and Animal Sciences

University (KVASU), Mannuthy, Thrissur district. Skimmed milk and soymilk required for the study were parchersed from the local market. Fully matured coconut and natural coagulants like lemon, garcinia, tamarind, raw mango, bilimbi and carambola were collected from the orchard of College of Horticulture, Vellanikkara. All the other ingredients required for the study were purchased from the local market.

3.2. Pretreatments

3.2.1. Milk- The whole milk collected from the dairy plant of KVASU, Mannuthy was standardised to 3.5 per cent fat and 8.5 per cent SNF. UHT sterilized skimmed milk with 0.5 per cent fat and 8.7 per cent SNF and soya milk with approximately 16 per cent fat and 18 per cent carbohydrate available in tetra packs were used for the preparation of filled paneer.

3.2.2. Preparation of coconut milk and slurry

Fully matured fresh coconut after dehusking, were split opened into halves and scrapped using an electric coconut scraper. The grated coconut was ground to a fine paste by adding 20 per cent water using a mixer grinder and used as the slurry. Coconut milk was extracted by straining the slurry through a muslin cloth.

3.2.2.1. Standardisation of fat content in coconut milk and slurry

The fat content in coconut milk and coconut slurry was estimated to standardise the fat content in coconut milk and coconut slurry to be used for the preparation of filled paneer, so as to obtain the fat content in the final product conforming to the FSSAI specification of not less than 50 per cent of fat on dry matter basis for paneer. The fat content in the prepared coconut slurry and coconut milk was found to be 34.78 and 38.93 percent respectively. A trial was carried on preparation of filled paneer using coconut milk and coconut slurry and the fat content was estimated by the procedure suggested by A.O.A.C (1955). Since the fat content in filled paneer trialed out of coconut slurry and extracted coconut milk had fat content above 50 per cent on dry matter basis (ie, 56.0 to 58.4 per cent), it was decided to use coconut milk and coconut slurry prepared by adding 20 per cent water as such for further steps.

3.2.3. Citric acid

Citric acid at a concentration of one per cent, 1.5 per cent and two percent was tried for coagulation of milk. Maximum solid recovery was noticed when 1.5 per cent citric acid was used. Hence, citric acid solution having 1.5 percent concentration was selected for the coagulation of milk and its combinations.

3.2.4. Calcium chloride

Calcium chloride at 0.15 percent was used in all the treatment to improve the solid recovery as suggested by Singh and Kanawjia (1988).

3.3. Standardisation of coconut based filled paneer

Coconut based filled paneer was standardised by replacing whole milk and skimmed milk with coconut milk, coconut slurry and coconut milk + soy milk at various levels and the treatments are given in Table 2. Paneer prepared from whole cow milk using the procedure followed in KVASU dairy plant was taken as the control. The yield and the organoleptic qualities of the filled paneer and the control were evaluated.

3.3.1. Preparation of milk paneer

The cow milk was heated to 90^0 C for 15 minutes and 0.15 percent calcium chloride was added. After cooling to 70^0C, the milk was coagulated with citric acid solution (1.5 per cent). The citric acid was added slowly to the milk with continuous stirring until a curd and clear whey separated out. The mixture was allowed to settle down for 10 minutes and the whey was drained out through a muslin cloth. The coagulum was then transferred to a mould (7cm x 7cm x 4cm) lined with muslin cloth. A known weight was placed above it to remove the excess water for 15 to 20 minutes. The pressed paneer is removed from mould and immersed in pasteurized chilled water (4 to 6^0C) for 2 to 3 hours. The chilled paneer was then taken out and placed on wooden plank for 10-15 minutes to drain the occluded water. Afterwards the paneer pieces were packed in polythene covers and stored under refrigerated condition (4 ± 1^0C).

3.3.2. Preparation of filled paneer

Cow milk/ skim milk was replaced by coconut milk/ slurry and soy milk combinations in required quantities and the mixture was homogenised. The filled paneer was prepared following the procedure of milk paneer described in 3.3.1 and the flow chart and plate for the preparation of filled paneer is shown in Fig.1 and Plate.1 respectively. The filled paneer was packed in polythene covers and stored under refrigeration at 4 ± 1^{0}C. The yield of paneer from each treatment was also recorded.

Table 2. Treatments for the standardisation of coconut based filled paneer

Treatments	Whole milk (ml)	Skimmed milk(ml)	Coconut milk (ml)	Coconut slurry (ml)	Soy milk (ml)
T_0 (control)	100	-	-	-	-
T_1	80	-	20	-	-
T_2	70	-	30	-	-
T_3	60	-	40	-	-
T_4	80	-	-	20	-
T_5	70	-	-	30	-
T_6	60	-	-	40	-
T_7	-	80	20	-	-
T_8	-	70	30	-	-
T_9	-	60	40	-	-
T_{10}	-	80	-	20	-
T_{11}	-	70	-	30	-
T_{12}	-	60	-	40	
T_{13}	80	-	10	-	10
T_{14}	70	-	15	-	15
T_{15}	60	-	20	-	20
T_{16}	-	80	10	-	10
T_{17}	-	70	15	-	15
T_{18}	-	60	20	-	20

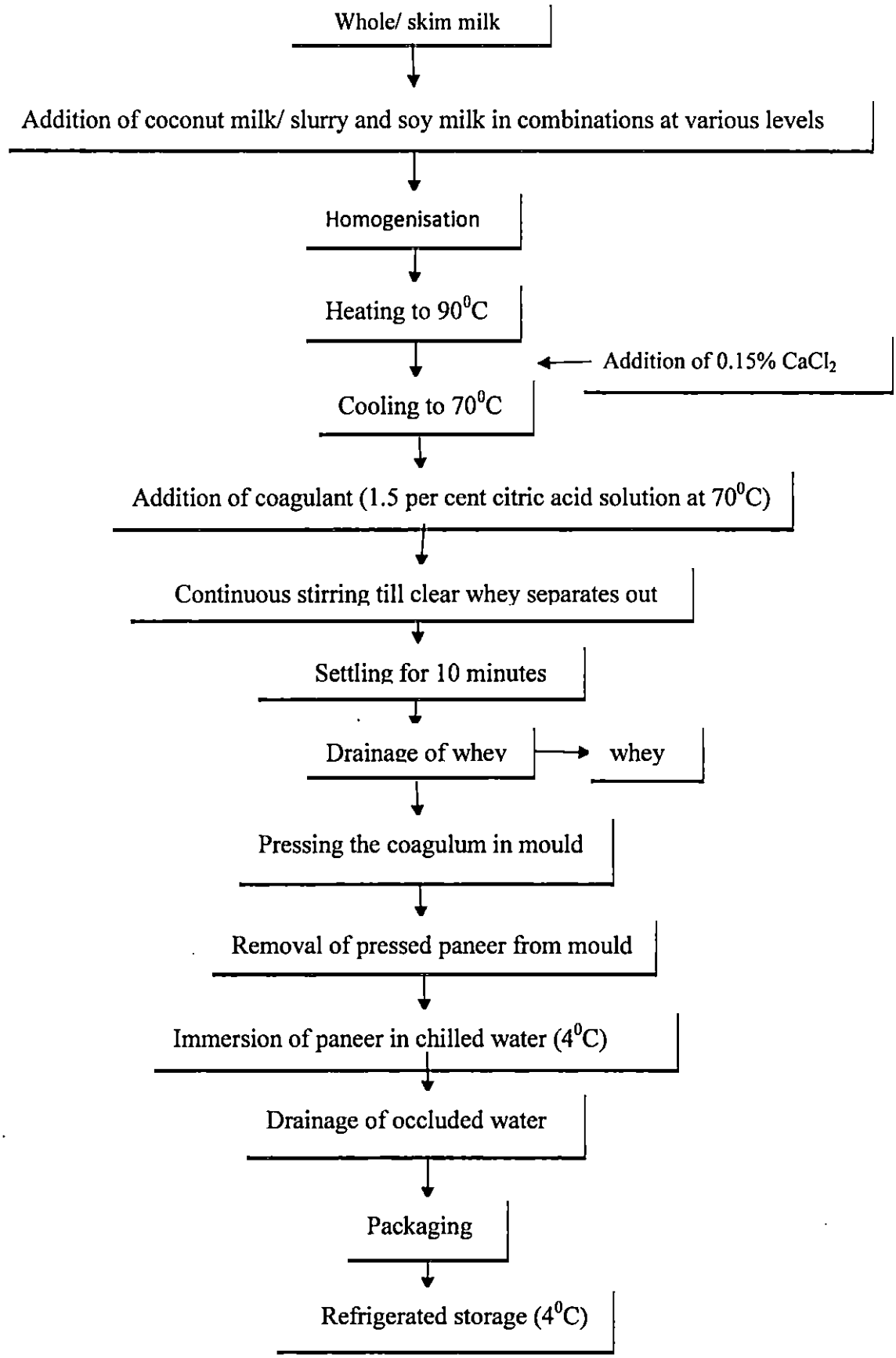


Fig. 1. Flow diagram for preparation of coconut based filled paneer

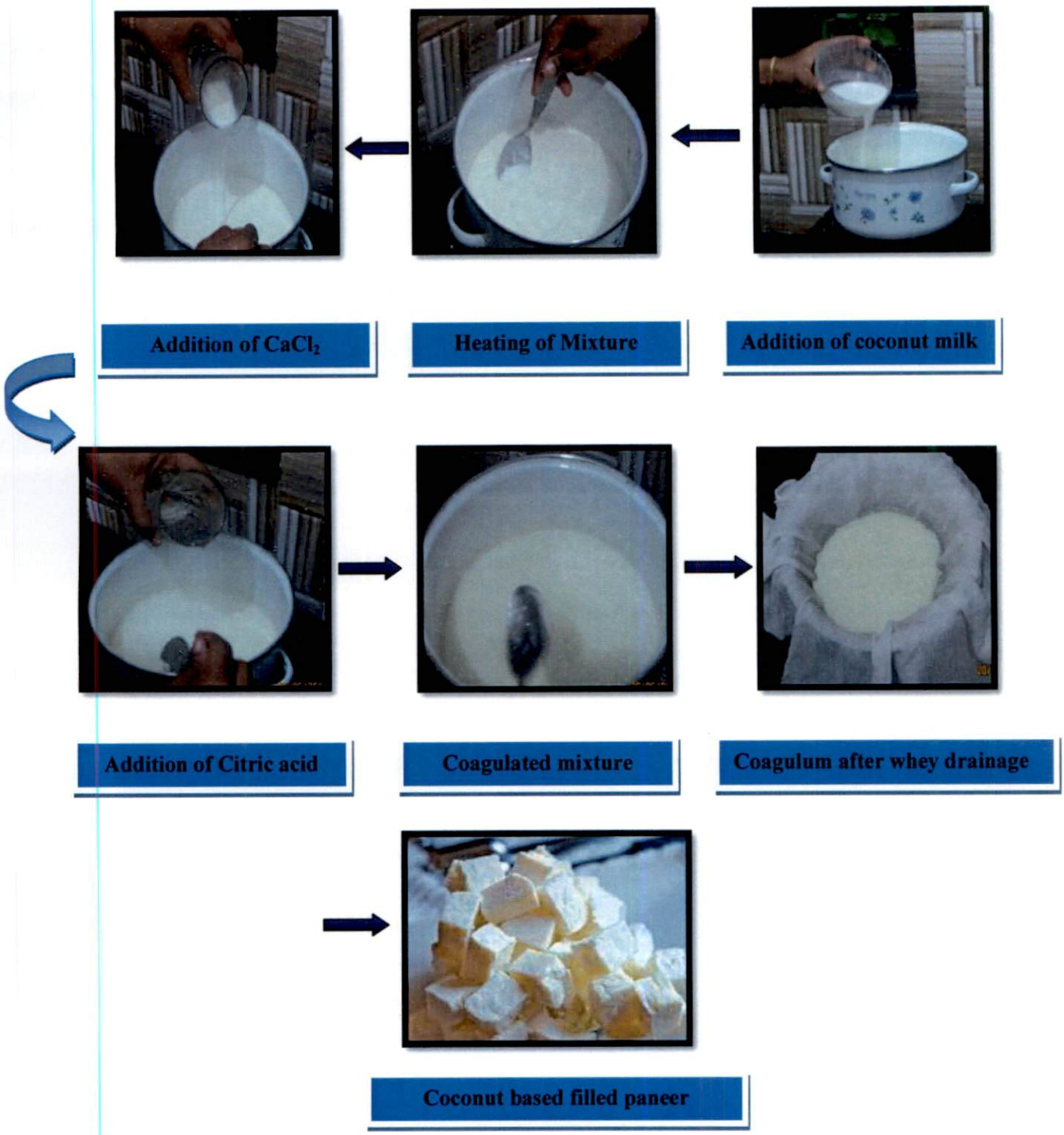


Plate 1. Preparation of coconut based filled paneer

3.4. Organoleptic evaluation of filled paneer and selection of the most acceptable products

Organoleptic evaluation of filled paneer was conducted in the morning using score card by a selected panel of ten judges.

3.4.1. Selection of judges

A series of organoleptic trials were carried out using simple triangle test at laboratory level to select a panel of ten judges between the age group of 18 to 35 years as suggested by Jellinek (1985).

3.4.2. Preparation of score card

Score card containing four attributes such as appearance and colour, flavour, body and texture and overall acceptability was prepared for the evaluation of coconut based filled paneer. Each of the above mentioned quality was assessed by a nine point hedonic scale. The score card used for the organoleptic evaluation of the products is given in Appendix I.

3.4.3. Selection of most acceptable products for the preparation of filled paneer

From the eighteen treatments (T_1 to T_{18}), highly acceptable paneer one each from whole milk and skimmed milk with coconut milk, coconut slurry and coconut milk + soymilk combinations, totalling six treatments were selected based on the acceptability scores obtained for different quality attributes by applying Kendall's coefficient of concordance. Paneer prepared using whole milk (control) was also selected for further studies.

3.5. Selection of natural coagulant for preparation of filled paneer

For selection of most suitable natural coagulant, whole cow milk paneer was prepared using juice of acidic fruits as coagulant. The acidity of juices were standardised to 1.5 per cent. The paneer coagulated using lemon juice was taken as the control. The fruits used as natural coagulant and their acidity and the dilution factor used are shown in Table 3.

The yield and the sensory qualities of the paneer were also assessed as described in 3.4 to select the most acceptable natural coagulant.

Table: 3 Acidity (%) of fruit juices used as natural coagulant

Sl No:	Fruits	Acidity of juice (%)	Dilution factor
1	Lemon (*Citrus limon*)	9	1: 5
2	Garcinia (*Garcinia cambogia*)	6	1: 3
3	Tamarind (*Tamarindus indicus*)	1.5	1: 0
4	Raw mango (*Mangifera indica*)	2.1	1: 0.4
5	Bilimbi (*Averrhoa bilimbi*)	1.5	1: 0
6	Carambola (*Averrhoa carambola*)	1.5	1: 0

3.6. Preparation of selected filled paneer using natural coagulant

The selected filled paneer were prepared using the selected natural coagulant following the procedure described in 3.3.2. The cow milk paneer coagulated with lemon juice was taken as the control.

3.7. Quality evaluation of selected filled paneer and filled paneer prepared using natural coagulant

The selected six coconut based filled paneer from T_1 to T_{18} and the selected paneer prepared with natural coagulant along with controls (2 Nos.) were packed in polythene covers and stored under refrigerated condition at 4 ± 1^0C for ten days. Various physical, chemical and nutritional qualities of the product were evaluated. All the analysis were carried out in triplicate samples.

3.7.1. Physical qualities

The physical qualities like yield, appearance and colour of the coconut based filled paneer were assessed initially, on 5^{th} and 10^{th} days of storage using standard procedures.

3.7.1.1. Yeild

Coconut based filled paneer was prepared from known quantity of milk and its combinations of coconut milk, coconut slurry and soya milk. The weight of the coagulum after complete drainage of whey was taken and expressed in percentage.

3.7.1.2. Appearance and colour

The appearance and colour of the filled paneer were rated with the help of a score card suggested by De (2003), by the selected panel of ten judges.

3.7.2. Chemical qualities

The chemical qualities of coconut based filled paneer and the control were evaluated initially, on 5^{th} and 10^{th} days of storage.

3.7.2.1. Moisture

Moisture content of coconut based filled paneer was estimated by the method of A.O.A.C (1980). To determine the moisture content, five gram of the sample was taken in a petri dish and dried at 60 to 70^0C in a hot air oven, cooled in a desiccator and weighed. The process of heating and cooling was repeated till constant weight was achieved. The moisture content of the sample was calculated from the loss in weight during drying.

3.7.2.2. Titrable acidity

Titrable acidity of coconut based filled paneer was estimated by the method suggested by Ranganna (1986). An aliquot of the sample was titrated against 0.1N sodium hydroxide using phenophthalein as an indicator. Acidity was expressed in terms of percentage of citric acid.

3.7.2.3. pH

pH of the coconut based filled paneer and control was determined using a pH meter.

3.7.2.3. Total solids

The total solids of coconut based filled paneer was estimated by the procedure of ISI (1981). Five gram of powdered sample was taken in a preweighed petri dish and the dish was placed uncovered on a boiling water bath for 30 minutes. Later the petri dish was transferred to an oven at 100 ^{0}C and kept for 3 hours. The petri dish was kept for cooling in a desiccator for 30 minutes and weighed. The process of heating and cooling was repeated till a constant weight was achieved. Total solid was expressed in percentage.

3.7.3. Nutritional qualities

The nutritional qualities of coconut based filled paneer and the control were evaluated initially and at the end of ten days of storage.

3.7.3.1. Protein

Protein was estimated by the method of A.O.A.C (1980). Sample (0.2g) was digested with six ml Conc.H_2SO_4 after adding 0.4 g of $CuSO_4$ and 3.5g K_2SO_4 in a digestion flask until the colour of sample was converted to green. After digestion, it was diluted with water and 25ml of 40 percent NaoH was pumped. The distillate was collected in two percent boric acid containing mixed indicators and then titrated with 0.2 N HCl to determine the nitrogen content. The nitrogen content thus estimated was multiplied with a factor 6.25 to get the protein content.

3.7.3.2. Fat

The fat content was estimated by Gerber method suggested by Aggrawal and Sharma (1961). The sample was heated at a temperature of 38 to 40^{0}C, mixed thoroughly and cooled to 20^{0}C. Ten ml of Gerber sulphuric acid was transferred to cheese butyrometer and the weighed sample was poured down the butyrometer and one ml of iso-amyl alcohol was added. Butyrometer was stopped and after placing in water bath (65^{0}C) for five minutes, the sample was centriauged in Gerber

centrifuge. The butyrometer was immersed again in a water bath and the reading was taken from the graduated scale. Difference was noted (upper level and lower level) which gave the percentage of fat in the sample.

3.7.3.3. Free fatty Acids

Free fatty acid content was estimated by the method suggested by Sadasivam and Manickam (1992). Ten gram of sample was dissolved in 50ml of neutral solvent (mixture of 25 ml of ether, 25 ml 0f 95% alcohol and 1ml of phenolphthalein solution, neutralised with N/10 alkali) in a 250ml conical flask. After adding two drops of phenolphthalein, an aliquot of the sample was titrated against 0.1N potassium hydroxide with continuous stirring until a pink colour was obtained. The free fatty acid was expressed as percentage of oleic acid.

3.7.3.4. Ash

The ash content was estimated by the method given by ISI (1980). To determine the ash content, five gram of sample was taken in a crucible and the sample was ignited at 550 to 600^{0}C in a muffle furnace for 5 to 6 hours. Cooled in a desiccator at room temperature and weighed. The ash content of sample was expressed in percentage.

3.7.3.5. Calcium and Iron

The calcium and iron contents of filled paneer were estimated by Atomic Absorption Spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer, 1982). A known weight of sample was predigested with 10ml of 9:4 mixtures of nitric acid and perchloric acid and made up to 50 ml and used directly in Atomic Absorption Spectrophotometric for the estimation of calcium and iron and expressed in mg per 100g of sample.

.3.7.3.6. Phosphorus

The phosphorous content was analysed colorimetrically as suggested by Jackson (1973). The sample produced yellow colour with nitric acid vandate molybdate reagent. To five ml of predigested aliquot, five ml of nitric acid

vandate molybdate reagent was added and made up to 50 ml with distilled water. After 10 minutes, the OD was read at 420nm.

A standard graph was prepared using serial dilution of standard phosphorus solution. The phosphorus content of the sample was estimated from the standard graph and expressed in mg per 100g of sample.

3.7.3.7. Sodium

The sodium content was estimated using flame photometer as suggested by Jackson (1973). The diacid extract prepared was directly read in the flame photometer and sodium content was expressed in mg per 100g of sample.

3.7.3.8. Potassium

The potassium content was estimated using flame photometer suggested by Jackson (1973). The diacid extract prepared was read directly in flame photometer and potassium content was expressed in mg per 100g of sample

3.7.4. Organoleptic qualities

Organoleptic evaluation of the selected coconut based filled paneer was conducted initially, on 5^{th} and 10^{th} day of storage as described in 3.4.

3.7.5. Microbial qualities

The microbial evaluation of paneer was conducted initially, on 5^{th} day and at the end of storage period using standard procedures.

3.7.5.1. Total viable count and coliform count

The total count of contaminating microbes in coconut based filled paneer was enumerated using serial dilution and plate count method as described by Agarwal and Hasija (1986). Ten gram of sample was added to 90 ml sterile water and shook well. One ml of this solution was transferred to a test tube containing 9 ml of sterile water to get 10^{-2} dilution and similarly 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} dilutions were also prepared.

Enumeration of total count was carried out using Nutrient Agar media for bacteria, Potato Dextrose Agar media for fungi, Sabouraud's Dextrose Agar media for yeast and Eosine methylene blue agar for coliforms, which were obtained from Himedia Lab, Mumbai. The dilution used for bacteria was 10^{-5} and for yeast and mold 10^{-2} dilutions were used.

3.8. Cost of production of paneer

Cost analysis of the filled paneer was done to assess the extent of expenses incurred for the preparation of the product. The cost of production was worked out based on the market rates of different ingredients used for the preparation of paneer. The cost was calculated for 100g of paneer and compared with the price of paneer product available in the market.

3.9. Statistical analysis

The data on quality evaluvation of coconut based filled paneer during storage was analysed statistically by two factor ANOVA. For this, the percentage variation was computed and analysed as two factor CRD for nutritional constituents and three factor CRD for physical and chemical constituents. Percentage variation was computed as

$$\frac{\text{Value in phase I- value in phase II}}{\text{Value in Phase I}} \times 100$$

Result

4. RESULT

The results of the study entitled "Standardisation and quality evaluation of coconut based filled paneer" are presented under the following headings.

4.1. Organoleptic qualities and yield of coconut based filled paneer and selection of most acceptable products.

4.2. Organoleptic qualities and yield of milk paneer prepared using natural coagulants and selection of most ideal natural coagulant for the preparation of filled paneer.

4.3. Physical, chemical, nutritional and shelf life qualities of coconut based filled paneer during storage.

4.4. Cost of production of coconut based filled paneer.

4.1. Organoleptic qualities and yield of coconut based filled paneer and selection of most acceptable products.

Coconut based filled paneer was prepared by replacing whole/ skim milk with coconut milk, coconut slurry and soy milk in combination at various levels. Nineteen different treatments including the control (T_0) were evaluated organoleptically for various quality attributes like colour and appearance, flavour, body and texture and overall acceptability. The different quality attributes were ranked based on their mean score using Kendall's (W) test. Yield of filled paneer was also recorded.

4.1.1. Organoleptic qualities of coconut based filled paneer

4.1.1.1. Organoleptic qualities of filled paneer prepared from whole milk and coconut milk.

The mean scores and the mean rank scores obtained for different quality attributes of filled paneer prepared using whole milk and coconut milk in different proportions are presented in Table 4.

The mean scores for colour and appearance of filled paneer (T_1 to T_3) varied from 7.5 to 8.1 with a mean rank score in the range of 1.15 to 2.55. The mean scores for flavour of filled paneer was in the range of 7.8 to 8.3 (1.15 to 2.80) and for body and texture, it varied from 7.4 to 8.2. (1.15 to 2.95). For overall acceptability the mean score for T_1, T_2 and T_3 was 8.3 (2.90), 8.2 (2.40) and 7.6 (1.15) respectively. Among different combinations tried for the preparation of filled paneer, the highest mean score for different quality attributes was noticed in paneer prepared using whole milk and coconut milk in the proportion of 80:20 (T_1). Compared to control, lower mean scores was noticed in filled paneer for different quality attributes.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer prepared using a combination of whole milk and coconut milk.

Table. 4. Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut milk in comparison with control.

Treatments	Whole milk: coconut milk	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (3.95)	8.7 (3.50)	8.7 (3.75)	8.6 (3.55)
T_1	80:20	8.1 (2.55)	8.3 (2.80)	8.2 (2.95)	8.3 (2.90)
T_2	70:30	7.9 (2.35)	8.2 (2.55)	7.9 (2.15)	8.2 (2.40)
T_3	60:40	7.5 (1.15)	7.8 (1.15)	7.4 (1.15)	7.6 (1.15)
Kendall's (W) value		0.840**	0.648**	0.815**	0.784**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.1.2. Organoleptic qualities of filled paneer prepared from whole milk and coconut slurry

The mean score and the mean rank score for different quality attributes of filled paneer prepared using whole milk and coconut slurry in different proportions are presented in Table 5.

Among different treatments tried with whole milk and coconut slurry the highest mean score for different quality attributes was noticed in T_4 (80:20) and the mean scores for colour and appearance, flavour, body and texture and overall acceptability were 7.3 (2.70), 7.6 (2.70), 7.2 (2.90) and 7.2 (2.70) respectively. Compared to control, the mean scores for different quality attributes of coconut slurry based filled paneer was lower.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer made out of a mixture whole milk and coconut slurry.

Table. 5. Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut slurry in comparison with control.

Treatments	Whole milk: coconut slurry	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (4.00)	8.7 (4.00)	8.7 (4.00)	8.6 (4.00)
T_4	80:20	7.3 (2.70)	7.6 (2.70)	7.2 (2.90)	7.2 (2.70)
T_5	70:30	6.9 (1.95)	7.4 (2.10)	6.8 (1.90)	6.9 (2.10)
T_6	60:40	6.7 (1.35)	7.0 (1.20)	6.5 (1.20)	6.6 (1.20)
Kendall's (W) value		0.842**	0.881**	0.949**	0.900**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.1.3. Organoleptic qualities of filled paneer prepared from skim milk and coconut milk

The mean and rank scores obtained for different quality attributes of filled paneer prepared with skim milk and coconut milk in comparison with control is shown in Table 6.

From the table, it is clear that the filled paneer prepared with skim milk and coconut milk in 80: 20 (T_7) proportion scored maximum for different organoleptic qualities. The mean scores for colour and appearance, flavour, body

and texture and overall acceptability were 7.8 (2.75), 8.3 (3.15), 7.9 (2.90) and 8.1 (3.20) respectively. The lowest mean score for different quality attributes was noticed in T_9 (60:40). Control paneer (T_0) had mean score above 8.0 for different quality attributes.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer prepared using a combination of skim milk and coconut milk.

Table. 6. Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut milk in comparison with control.

Treatments	Skim milk: coconut milk	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (4.00)	8.7 (3.70)	8.7 (4.00)	8.6 (3.80)
T_7	80:20	7.8 (2.75)	8.3 (3.15)	7.9 (2.90)	8.1 (3.20)
T_8	70:30	7.4 (1.90)	7.6 (2.05)	7.2 (1.85)	7.5 (1.95)
T_9	60:40	7.1 (1.35)	7.1 (1.10)	6.0 (1.25)	6.9 (1.05)
Kendall's (W) value		0.824**	0.813**	0.925**	0.945**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.1.4. Organoleptic qualities of filled paneer prepared from skim milk and coconut slurry

The mean scores and the mean rank scores for different quality attributes of filled paneer prepared using skim milk and coconut slurry in different proportion are presented in Table 7.

Among different treatments tried with skim milk and coconut slurry, the highest mean score for different quality attributes was noticed in T_{10} (80: 20) and the mean scores for colour and appearance, flavour, body and texture and overall acceptability were 6.9 (2.60), 6.3 (2.95), 6.9 (2.80) and 7.1 (2.95) respectively.

Compared to control, the mean scores for different quality attributes of skim milk and coconut slurry based filled paneer was lower.

Filled paneer prepared using skim milk and coconut milk in 60:40 ratio (T_9) scored minimum for different quality attributes.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer made out of a combination of skim milk and coconut slurry.

Table. 7. Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut slurry in comparison with control.

Treatments	Skim milk: coconut slurry	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (3.95)	8.7 (3.95)	8.7 (4.00)	8.6 (4.00)
T_{10}	80:20	6.9 (2.60)	6.3 (2.95)	6.9 (2.80)	7.1 (2.95)
T_{11}	70:30	6.3 (1.90)	6.2 (2.00)	6.1 (1.95)	6.1 (1.60)
T_{12}	60:40	6.1 (1.55)	5.5 (1.10)	5.6 (1.25)	6.0 (1.45)
Kendall's (W) value		0.703**	0.912**	0.849**	0.909**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.1.5. Organoleptic qualities of filled paneer prepared from whole milk and coconut milk/soy milk.

The mean scores and the mean rank scores obtained for different quality attributes of filled paneer prepared using a combination of whole milk, coconut milk and soy milk in different proportions are presented in Table 8.

The mean scores for colour and appearance of filled paneer T_{13} (80:10:10) and T_{15} (60:20:20) was 7.7 with a mean rank score of 2.70 and 1.30 respectively. For T_{14} (70:15:15), the mean score for colour and appearance was 7.4 (2.05). The mean scores for flavour of filled paneer was in the range of 6.6 to 8.1 (1.05 to 3.10)

and for body and texture, it varied from 6.4 to 7.5 (1.10 to 2.70). For overall acceptability, the mean score for T_{13}, T_{14} and T_{15} was 8.0 (3.10), 7.2 (2.0) and 6.4 (1.0) respectively. Among different combinations tried for the preparation of filled paneer, the highest mean score for different quality attributes was noticed in paneer prepared using whole milk and coconut milk and soy milk in the proportion of 80:10:10 (T_{13}). Compared to control, lower mean scores was noticed in filled paneer for different quality attributes.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer prepared using a combination of whole milk, coconut milk and soy milk.

Table. 8. Mean scores for the organoleptic qualities of filled paneer prepared with whole milk and coconut milk/soy milk in comparison with control.

Treatments	Whole milk: coconut milk: soy milk	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (3.95)	8.7 (3.90)	8.7 (4.00)	8.6 (3.90)
T_{13}	80:10:10	7.7 (2.70)	8.1 (3.10)	7.5 (2.70)	8.0 (3.10)
T_{14}	70:15:15	7.4 (2.05)	7.2 (1.95)	7.5 (2.20)	7.2 (2.00)
T_{15}	60:20:20	7.7 (1.30)	6.6 (1.05)	6.4 (1.10)	6.4 (1.00)
Kendall's (W) value		0.772**	0.974**	0.886**	0.984**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.1.6. Organoleptic qualities of filled paneer prepared from skim milk and coconut milk/soy milk.

The mean scores and the mean rank scores for different quality attributes of filled paneer prepared using skim milk, coconut milk and soy milk in different proportions are presented in Table 9.

Among different treatments tried with skim milk, coconut milk and soy milk the highest mean score for different quality attributes was noticed in T_{16}

(80:10:10) and the mean scores for colour and appearance, flavour, body and texture and overall acceptability were 7.5 (2.70), 7.6 (3.0), 7.5 (2.55) and 7.7 (3.05) respectively. The lowest mean score for flavour was noticed in T_{17} (70:15:15) and for other parameters the lowest mean score was observed in T_{18} (60:20:20). Compared to control, the mean scores for different quality attributes of skim, coconut and soy milk based filled paneer were lower.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer made out of a mixture of skim milk, coconut milk and soy milk in different proportion.

Table. 9. Mean scores for the organoleptic qualities of filled paneer prepared with skim milk and coconut milk/soy milk in comparison with control.

Treatments	Skim milk: coconut milk: soy milk	Colour and appearance	Flavour	Body and texture	Overall acceptability
T_0 (Control)	100:0	8.7 (3.95)	8.7 (4.00)	8.7 (4.00)	8.6 (3.85)
T_{16}	80:10:10	7.5 (2.70)	7.6 (3.00)	7.5 (2.55)	7.7 (3.05)
T_{17}	70:15:15	6.9 (1.95)	6.4 (1.60)	7.4 (2.35)	7.0 (2.05)
T_{18}	60:20:20	6.3 (1.40)	6.6 (1.40)	6.6 (1.10)	6.5 (1.05)
Kendall's (W) value		0.761**	0.942**	0.873**	0.904**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

4.1.2 Yield of coconut based filled paneer

The yield of coconut based filled paneer from each treatment was recorded and the data in comparison with control is presented in Table 10. Compared to control, the filled paneer had better yield. The yield of paneer prepared with 100 percent cow milk (T_0, Control) was 14.60 percent.

The yield of filled paneer prepared with whole milk and coconut milk combinations varied from 15.20 to 16.80 per cent with highest in T_3 (60:40) and lowest in T_1 (80:20). The whole milk and coconut slurry based filled paneer had a

yield of 22.34 to 23.80 percent. The highest was recorded in T_6 (60:40) and lowest in T_4 (80:20).

Table 10. Yield of filled paneer (%) from different combination of cow coconut milk and soy milk in comparison with control

Treatments	Combinations	Proportions	Yield (%)
T_0	Control	100	14.60
T_1	whole milk: coconut milk	80:20	15.20
T_2		70:30	15.82
T_3		60:40	16.80
T_4	whole milk: coconut slurry	80:20	22.34
T_5		70:30	22.57
T_6		60:40	23.80
T_7	skim milk: coconut milk	80:20	15.15
T_8		70:30	15.52
T_9		60:40	16.0
T_{10}	skim milk: coconut slurry	80:20	20.55
T_{11}		70:30	22.08
T_{12}		60:40	23.56
T_{13}	whole milk: coconut milk: soy milk	80:10:10	17.56
T_{14}		70:15:15	20.12
T_{15}		60:20:20	22.34
T_{16}	skim milk: cocnut milk: soy milk	80:10:10	15.03
T_{17}		70:15:15	15.78
T_{18}		60:20:20	16.30

The yield of filled paneer from combination of skim milk and coconut milk varied from 15.15 (T_7 – 80:20) to 16.0 (T_9 – 60:40) per cent. In case of skim milk and coconut slurry based filled paneer the highest yield was noticed in T_{12} (23.56 per cent, 60:40) and lowest in T_{10} (20.55 per cent, 80:20).

The filled paneer prepared by combination of whole milk, coconut milk and soy milk had a yield of 17.56 to 22.34 per cent. The highest was noticed in T_{15} (60:20:20) and lowest in T_{13} (80:10:10). In skim milk, coconut milk nd soy milk combination, the yield of filled paneer varied from 15.03 to 16.30 per cent. The maximum yield was observed in T_{18} (60:20:20) and minimum in T_{16} (80:10:10).

4.1.3. Selection of most acceptable treatments for the preparation of filled paneer

From the various treatments tried for the standardisation of coconut based filled paneer (T_1 to T_{18}) six highly acceptable paneer, one each from whole milk and skim milk with coconut milk, coconut slurry and coconut milk + soymilk combination were selected for further studies. The mean scores obtained for different organoleptic qualities were taken into account to select the most acceptable treatments.

Among different treatments tried for the preparation of filled paneer using whole milk and coconut milk in different proportions, the highest mean score for colour and appearance, flavour, body and texture and overall acceptability was noticed in T_1 prepared out of 80:20 proportions. The mean scores for the above mentioned quality attributes were 8.1, 8.3, 8.2 and 8.3 respectively.

In the case of filled paneer prepared from combinations of whole milk and coconut slurry, the highest mean scores of 7.3 for colour and appearance, 7.6 for flavour, 7.2 for body and texture and 7.2 for overall acceptability were noticed in T_4 prepared in 80:20 proportions. Hence T_4 was selected as the most acceptable treatment from whole milk and coconut slurry.

Among the combinations tried with skim milk and coconut milk, T_7 (80:20) had maximum mean scores for different quality attributes. The mean score for colour and appearance, flavour, body and texture and overall acceptability were 7.8, 8.3, 7.9 and 8.1 respectively. In filled paneer tried with skim milk and coconut slurry, the highest mean score for different quality attributes such as colour and appearance, flavour, body and texture and overall acceptability was noticed in T_{10} (80:20) and selected as the most acceptable treatment.

The most acceptable treatment for filled paneer from whole milk, coconut milk and soy milk combination was T_{13} (80:10:10). The mean scores for colour and appearance, flavour, body and texture and overall acceptability were 7.7, 8.1, 7.5 and 8.0 respectively. In the case the of skim milk, coconut milk and soymilk combinations the highest mean score for the above mentioned quality attributes were 7.5, 7.6, 7.5 and 7.7 and was noticed in T_{16}. Therefore T_{13} and T_{16} were

selected as the most ideal treatment from whole milk/ skim milk, coconut milk and soymilk combinations.

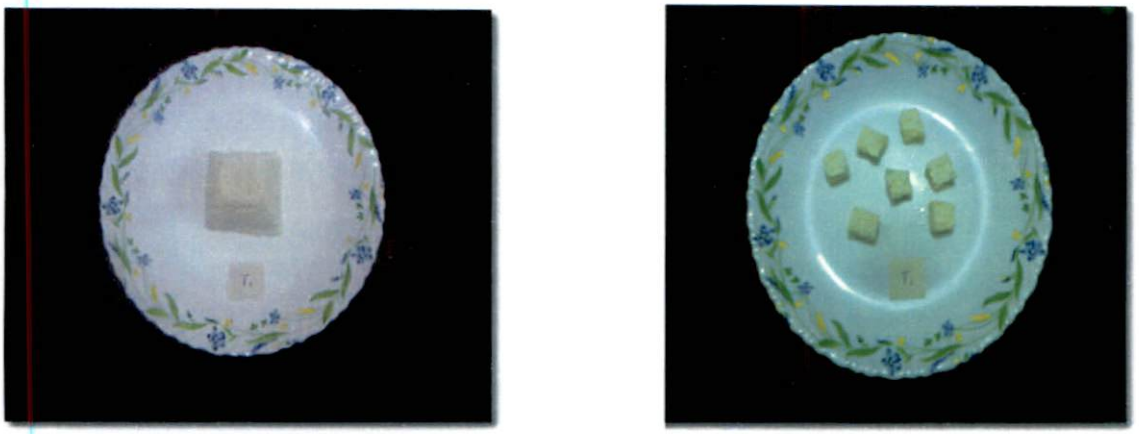
Hence, T_1, T_4, T_7, T_{10}, T_{13} and T_{16} along with control were selected for further studies (Plate 2 and 3).

4.2. Organoleptic qualities and yield of milk paneer prepared using natural coagulants and selection of most ideal natural coagulant for the preparation of filled paneer.

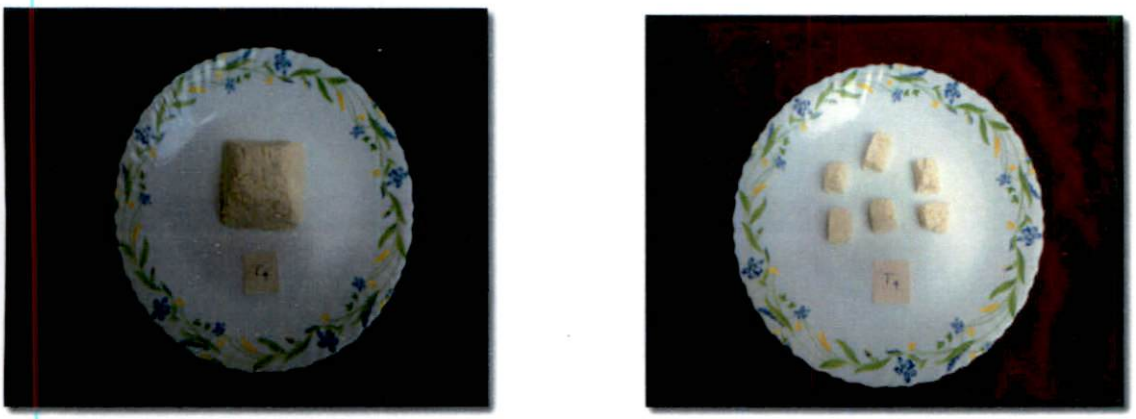
4.2.1. Organoleptic qualities of milk paneer prepared using different types of natural coagulants

The mean scores and the mean rank scores obtained for different quality attributes of cow milk paneer prepared using different natural coagulants like lemon (control), raw mango, bilimbi, garcinia, tamarind and carambola are presented in Table 11.

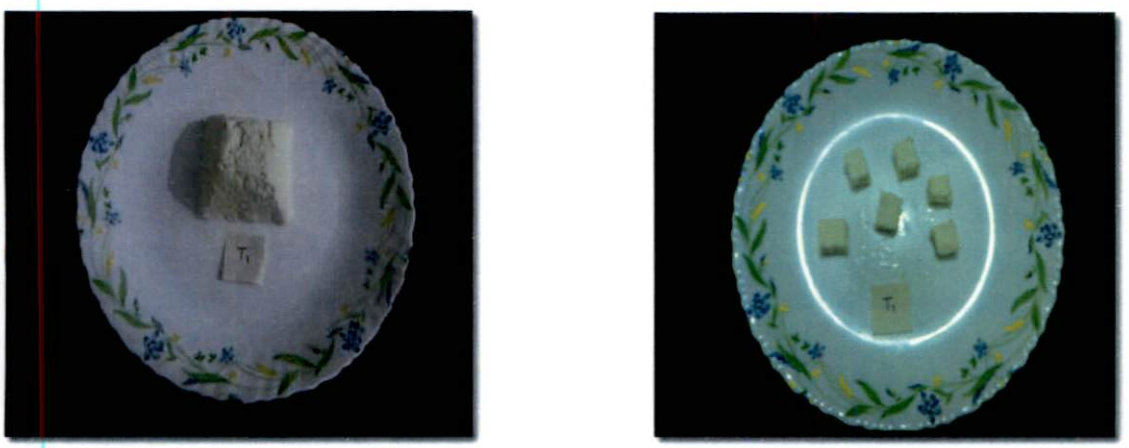
The mean scores for colour and appearance of milk paneer prepared using different natural coagulants varied from 6.5 to 9.0 with the mean rank score in the range of 1.2 to 5.8. The highest mean score for appearance and colour was obtained for milk paneer prepared with lemon juice (control) and lowest in milk paneer coagulated with tamarind juice. The mean scores for flavour of milk paneer prepared with different fruit juices were in the range of 6.5 to 9.0 (1.3 to 5.8) The highest and lowest mean score for body and texture was noticed in milk paneer prepared with lemon juice (9.0) and tamarind juice (7.0) respectively. For overall acceptability, the mean score of milk paneer coagulated with lemon, raw mango, bilimbi, garcinia, tamarind and carambola was 9.0 (5.8), 8.0 (3.8), 8.7 (5.2), 7.5 (1.9), 6.7 (1.2) and 7.7 (3.3) respectively. Compared to control (lemon), the mean scores for different quality attributes was lower in milk paneer coagulated using other fruit juices. Among different types of natural coagulants tried other than lemon juice (Control) for preparation of milk paneer, the highest mean and rank scores for different quality attributes was noticed in paneer coagulated with bilimbi.



T_1 – Whole milk + coconut milk (80:20)

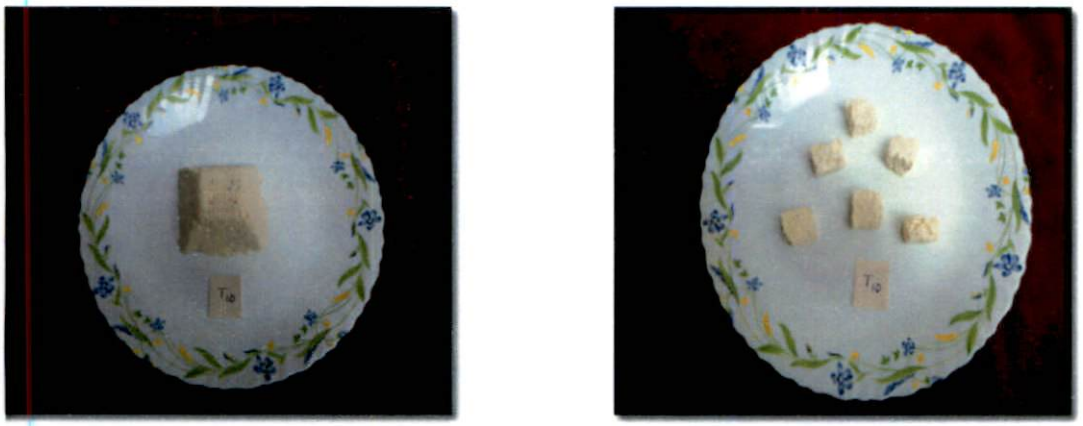


T_4 – Whole milk + coconut slurry (80:20)

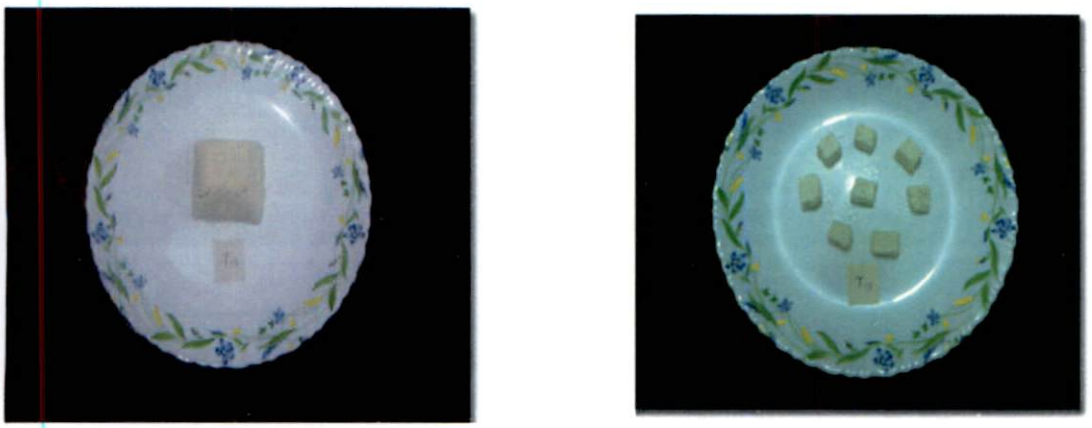


T_7 – Skim milk + coconut milk (80:20)

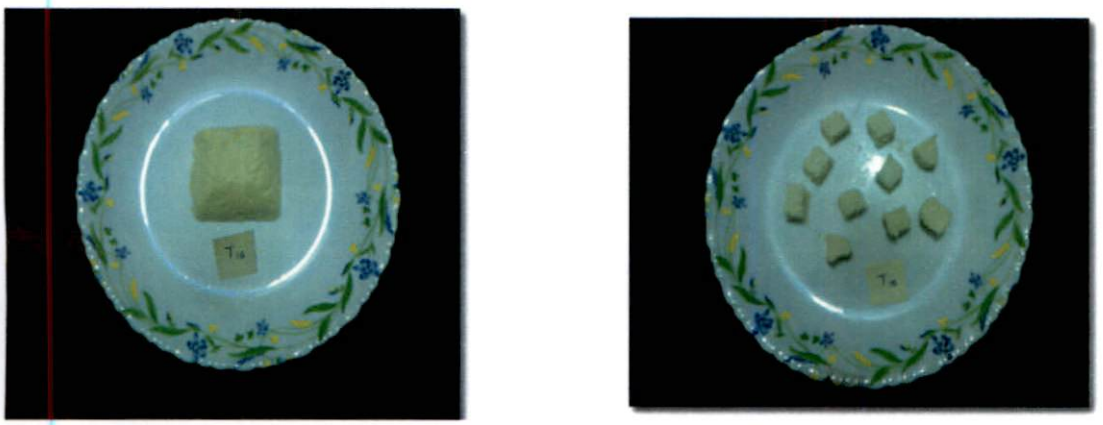
Plate 2. Coconut based filled paneer selected for storage study



T_{10} – Skim milk + coconut slurry (80:20)



T_{13} – Whole milk+ coconut milk : soy milk (80:20)



T_{16}- Skim milk+ coconut milk: soy milk (80:10:10)

Plate 3. Coconut based filled paneer selected for storage study

Table. 11. Mean scores for the organoleptic qualities of milk paneer prepared using natural coagulants.

Fruits used as Coagulant	Colour and appearance	Flavour	Body and texture	Overall acceptability
Lemon Control)	9.0 (5.8)	9.0 (5.8)	9.0 (5.8)	9.0 (5.8)
Raw mango	8.0 (4.1)	8.0 (3.2)	8.0 (4.0)	8.0 (3.8)
Bilimbi	8.6 (4.9)	8.6 (4.6)	8.5 (4.8)	8.7 (5.2)
Garcinia	7.1 (1.9)	6.5 (1.3)	7.3 (2.1)	7.5 (1.9)
Tamarind	6.5 (1.2)	6.7 (1.7)	7.0 (1.6)	6.7 (1.2)
Carambola	7.7 (2.9)	8.3 (4.3)	7.6 (2.5)	7.7 (3.0)
Kendall's (W) value	0.922**	0.921**	0.834**	0.944**

Figures in parenthesis indicate mean rank score. ** significant at 1% level.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of milk paneer prepared out of different natural coagulants.

4.2.2. Yield of milk paneer prepared using natural coagulants

The yield of milk paneer prepared using natural coagulant was also recorded and the data in comparison with control is presented in Table 12.

The yield of milk paneer prepared with lemon juice as a natural coagulant (Control) was 18.87 percent. The yield of milk paneer prepared using other fruit juices varied from 16.47 to 18.76 percent. Maximum yield was noticed for milk paneer coagulated with bilimbi juice and minimum was noticed for milk paneer prepared with juice of raw mango.

Table 12. Yield of milk paneer (%) prepared by natural coagulants in comparison with control

Sl.No.	Fruits used as coagulant	Yield (%)
1	Lemon (Control)	18.87
2	Raw mango	16.47
3	Bilimbi	18.76
4	Garcinia	17.01
5	Tamarind	17.05
6	Carambola	17.25

4.2.3. Selection of most ideal natural coagulant for the preparation of filled paneer

From the different fruit juices used as natural coagulants, the most ideal fruit juice for preparation of filled paneer was selected based on organoleptic scores and yield of milk paneer prepared with different natural coagulants. Lemon juice was also taken for further studies as control.

In case of mik paneer prepared with different natural coagulants, maximum yield and highest mean score for different quality attributes were noticed for paneer coagulated with lemon juice (control). Among other coagulants used, maximum yield of 18.76 was noticed for milk paneer coagulated with bilimbi juice. The highest organoleptic scores for different quality attributes was also noticed for milk paneer coagulated using bilimbi juice and the mean scores for colour and appearance, flavour, body and texture and overall acceptability were 8.6, 8.6, 8.5 and 8.7 respectively. Thus, bilimbi juice was selected as the most ideal natural coagulant for the preparation of filled paneer.

4.3 Physical, chemical, nutritional organoleptic and shelf life qualities of coconut based filled paneer during storage

The selected six coconut based filled paneer from T_1 to T_{18} and the selected paneer prepared using bilimbi juice as natural coagulant along with controls (Cow milk paneer coagulated using citric acid and lemon juice) were packed in polythene covers and stored under refrigerated condition at 4 ± 1^0C for ten days.

The products were evaluated for various physical, chemical, nutritional, organoleptic and microbiological qualities during storage. Physical, chemical, organoleptic and microbiological qualities of the product were assessed initially, on 5th day and 10th day of storage. Nutritional qualities of the product were evaluated initially and on 10th day of storage. The results are presented in this section.

4.3.1. Physical qualities of coconut based filled paneer

Physical qualities like yield, weight loss and appearance and colour of selected coconut based filled paneer prepared using citric acid and bilimbi juice in comparison with control paneer is as follows.

4.3.1.1. Yield and weight loss

The yield of coconut based filled paneer prepared using both coagulants and its weight loss during storage in comparison with milk paneer are given in Table 13. Compared to control, better yield was noticed for filled paneer coagulated using citric acid as well as bilimbi juice except in T_7 (only in paneer coagulated with citric acid), T_{13} (whole milk+coconut milk+soy milk) and T_{16} (skim milk+coconut milk+soy milk). Among treatments, the highest yield was noticed for filled paneer prepared out of whole milk and coconut slurry (T_4). Statistically the yield of paneer differed significantly with respect to coagulants only in T_1 and T_7. But among treatments, the yield of filled paneer differed significantly.

The weight of filled paneer decreased gradually with advancement in days of storage. Compared to milk paneer, the percentage loss in weight was lower in filled paneer coagulated with citric acid in both periods under study. In filled paneer coagulated with bilimbi juice, the weight loss percentage of T_1, T_7, T_{13} and T_{16} was higher than milk paneer up to fifth day of storage and on tenth day the percentage loss in weight was lower than the milk paneer in all the treatments.

Table 13. Yield of coconut based filled paneer and its weight loss in comparison with control during storage

Treatments / Coagulants	Yield (%)		Weight during storage (%)				Weight losss (%)			
	Days of storage						Phases of storage			
	Initial		5th Day		10th Day		0-5		5-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	18.53^{f}	18.51^{f}	17.86^{e}	17.86^{e}	17.07^{fg}	17.04^{g}	3.62	3.51	4.42	4.59
T_1– whole milk + coconut milk (80:20)	18.97^{d}	19.19^{c}	18.44^{d}	18.48^{d}	17.90^{e}	18.04^{d}	2.79	3.70	2.93	2.38
T_4 – whole milk + coconut slurry (80:20)	23.23^{a}	23.20^{a}	21.70^{c}	22.70^{a}	21.07^{bc}	22.00^{a}	6.59	2.16	2.90	3.08
T_7 – skim milk + coconut milk (80:20)	18.12^{g}	18.73^{e}	17.77^{ef}	17.93^{e}	18.01^{d}	17.16^{f}	1.93	4.27	1.35	4.29
T_{10}– skim milk + coconut slurry (80:20)	22.25^{b}	22.25^{b}	21.93^{b}	21.74^{c}	21.13^{b}	21.01^{c}	1.44	2.29	3.65	3.36
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	18.20^{g}	18.18^{g}	17.68^{fg}	17.52^{gh}	17.05^{g}	16.97^{g}	2.86	3.63	3.56	3.14
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	18.20^{g}	18.20^{g}	17.51^{gh}	17.44^{h}	16.80^{h}	16.98^{g}	3.79	4.18	4.05	2.64

F value	
Coagulants	251.84**
Phases of storage	0.433^{NS}
Treatments	15.66**

** 1% significant level, NS non significant

Statistically, the coagulants had a significant influence on weight loss of filled paneer during storage. However, irrespective of coagulants, the weight loss in filled paneer over ten days storage was statistically insignificant.

4.3.1.2. Appearance and colour

As revealed in Table 14, a decrease in mean scores for appearance and colour of coconut based filled paneer was observed in all the products with advancement in days of storage. The highest mean score for appearance and colour was noticed in filled paneer prepared using whole milk and coconut milk T_1 (80:20) in all periods under study. The mean scores were 8.8, 8.5 and 8.2 initially, on 5th day and 10th day respectively for filled paneer coagulated with citric acid. For filled paneer coagulated with bilimbi juice the mean scores were 8.8, 8.6 and 8.4 initially, on 5th day and 10th day respectively. The lowest mean scores for appearance and colour was noticed in filled paneer prepared out of skim milk and coconut slurry (80:20) coagulated with citric acid as well as bilimbi juice in all periods under study.

Table 14. Mean score for appearance and colour of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Days of storage					
	Initial		5th Day		10th Day	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	9	9	8.6	8.8	8.3	8.6
T_1– whole milk + coconut milk(80:20)	8.8	8.8	8.5	8.6	8.2	8.4
T_4 – whole milk + coconut slurry (80:20)	8.6	8.4	8.4	8.2	8	8
T_7 – skim milk + coconut milk (80:20)	8.4	8.3	8.1	8.2	7.7	8
T_{10}– skim milk + coconut slurry (80:20)	8.2	8.2	7.8	8	7.4	7.8
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	8.5	8.5	8.3	8.2	7.9	7.9
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	8.3	8.4	8	8.2	7.6	7.8

* Lemon juice as natural coagulant in control.

4.3.2. Chemical qualities of coconut based filled paneer

Chemical qualities such as moisture, titrable acidity, pH and total solids of the selected coconut based filled paneer were evaluated initially, on 5th day and 10th day of storage and compared with milk paneer. The results are presented in this section.

4.3.2.1. Moisture

The moisture content in coconut based filled paneer in comparison with control is given in Table 15. Initially, the moisture content in filled paneer prepared by coagulating with citric acid was significantly lower than the control (58.47%). In the case of filled paneer coagulated with bilimbi juice, only T_7- skim milk and coconut milk (58.57%) had moisture percentage above control paneer. Based on DMRT, moisture content in T_7 was on par with control and they differed from other treatments with respect to moisture level.

The moisture content in filled paneer prepared by coagulating with citric acid and bilimbi juice were compared and it was found that only in T_7 significant variation in moisture level was observed throughout the storage period.

The moisture content in all the products decreased gradually with advancement in days of storage. At the end of storage, the moisture content in filled paneer was significantly lower than the control.

The influence of two coagulants on the percentage decrease in moisture content of filled paneer over periods of storage was found to be statistically insignificant. However, the percentage decrease in moisture content in different treatments during ten days of storage was found to be statistically significant.

4.3.2.2. Titrable acidity

Effect of storage on the titrable acidity of coconut based filled paneer coagulated using citric acid and bilimbi juice in comparison with milk paneer is depicted in Table 16. Initially, coconut based filled paneer prepared using both coagulants had lower acid content than the milk paneer (0.24%) and statistically, it differed significantly from all treatments.

Titrable acidity in coconut based filled paneer prepared using citric acid, initially varied from 0.217 (T_{16}- skim milk + coconut milk + soy milk) to 0.223 (T_{13}- whole milk + coconut milk + soy milk) per cent where as in filled paneer coagulated with bilimbi juice, the acidity varied from 0.217(T_7- skim milk + coconut milk) to 0.230 (T_{13}- whole milk + coconut milk + soy milk) percent.

The titrable acidity in all the products increased gradually with advancement in days of storage. At the end of storage too the acidity of filled paneer prepared using citric acid had lower acidity than control. In filled paneer prepared using bilimbi juice, the control had lower acidity than filled paneer except T_{10} (skim milk + coconut slurry) in which the acidity was on par with control (0.280%).

The percentage increase in acidity of filled paneer was comparatively more pronounced in products coagulated with citric acid. However the effect of two coagulants on the percentage increase in acidity of filled paneer over periods of storage was found to be statistically insignificant. The percentage increase in acidity of different treatments during ten days of storage was also found to be statistically insignificant.

Table 15. Moisture (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period						% variation			
							Phases of storage			
	Initial		5th Day		10th Day		0-5		5-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	58.47^{a}	58.47^{a}	55.10^{c}	55.10^{c}	52.77^{a}	52.63^{ab}	5.76	5.76	4.23	4.48
T_1– whole milk + coconut milk (80:20)	58.00^{c}	57.63^{de}	55.31^{ab}	54.33^{e}	52.23^{cd}	52.40^{bc}	4.63	5.73	5.57	3.55
T_4 – whole milk + coconut slurry (80:20)	55.17^{h}	55.30^{h}	53.77^{f}	53.70^{f}	52.00^{def}	52.01^{def}	2.54	2.89	3.29	3.15
T_7 – skim milk + coconut milk (80:20)	58.17^{b}	58.57^{a}	55.30^{b}	55.47^{a}	52.57^{ab}	52.27^{cd}	4.93	5.29	4.94	5.77
T_{10}– skim milk + coconut slurry (80:20)	55.59^{g}	55.60^{g}	53.70^{f}	53.70^{f}	51.11^{g}	52.15^{cde}	3.40	3.42	4.82	2.89
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	57.03^{f}	57.47^{e}	54.19^{e}	54.23^{e}	51.85^{f}	51.87^{ef}	4.98	5.64	4.32	4.35
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	57.67^{d}	57.63^{de}	54.50^{d}	54.53^{d}	51.37^{g}	51.12^{g}	5.50	5.38	5.74	6.25

F value	
Coagulants	0.0425^{NS}
Phases of storage	6.6880*
Treatments	120.74**

** 1% significant level * 5% significant level NS non significant

* Lemon juice as natural coagulant in control.

Table 16.Titrable acidity (%) of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period						% variation			
							Phases of storage			
	Initial		5th Day		10th Day		0-5		5-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	0.240^{a}	0.240^{a}	0.263^{a}	0.257^{c}	0.303^{a}	0.280^{e}	9.58	7.08	15.21	8.95
T_1– whole milk + coconut milk (80:20)	0.220^{d}	0.220^{d}	0.240^{e}	0.260^{b}	0.290^{d}	0.290^{d}	9.09	18.18	20.83	11.54
T_4 – whole milk + coconut slurry (80:20)	0.220^{d}	0.217^{e}	0.260^{b}	0.250^{d}	0.290^{d}	0.290^{d}	18.18	15.21	11.54	16.00
T_7 – skim milk + coconut milk (80:20)	0.223^{c}	0.217^{e}	0.260^{b}	0.260^{b}	0.300^{b}	0.297^{c}	16.59	19.82	15.38	14.23
T_{10}– skim milk + coconut slurry (80:20)	0.220^{d}	0.220^{d}	0.260^{b}	0.250^{d}	0.300^{b}	0.280^{e}	18.18	13.64	15.38	12.00
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	0.223^{c}	0.230^{b}	0.263^{a}	0.250^{d}	0.300^{b}	0.300^{b}	17.93	8.70	14.07	20.00
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	0.217^{e}	0.220^{d}	0.250^{d}	0.250^{d}	0.300^{b}	0.300^{b}	15.20	13.64	20.00	20.00

F value	
Coagulants	2.479^{NS}
Phases of storage	0.177^{NS}
Treatments	1.307^{NS}

NS - non significant

* Lemon juice as natural coagulant in control

4.3.2.3. pH

The pH of coconut based filled paneer and the milk paneer (control) is shown in Table17. In coconut based filled paneer initially, the pH varied from 5.90 to 6.20 in citric acid coagulated products and 5.87 to 6.10 in bilimbi juice coagulated products. The highest and lowest pH was noticed in T_1 (whole milk + coconut milk) and T_7 (skim milk + coconut milk) respectively.

Based on DMRT, initially, the pH of T_1 (whole milk + coconut milk) differed significantly only with T_7 (skim milk + coconut milk) and T_{10} (skim milk + coconut slurry), products prepared with citric acid and with T_7 (skim milk + coconut milk) alone in case of products prepared using bilimbi juice. The pH of all the products including control decreased during storage. About 1.82 to 6.86 percent reduction in pH was noticed in different products during ten days of storage. Statistically significant variation was not observed in pH of different products on tenth day of storage.

The action of two coagulants in decreasing the pH of filled paneer over periods of storage was found to be statistically significant. However, the percentage decrease in pH in different treatments during ten days of storage was found to be statistically insignificant.

4.3.2.4. Total solids

The total solids of coconut based filled paneer prepared using both coagulants increased gradually during storage. The observation on total solids of filled paneer is given in Table.18. Initially, and on tenth day of storage, the total solids in different filled paneer was higher than milk paneer (control). But on fifth day of storage, lower total solids than control was noticed in T_1 (whole milk +

Table 17. pH of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period						% variation			
							Phases of storage			
	Initial		5th Day		10th Day		0-5		5-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	6.00^{bcd}	6.10^{ab}	5.70^{a}	5.70^{a}	5.53^{a}	5.50^{a}	5.00	6.56	2.98	3.51
T_1– whole milk + coconut milk (80:20)	6.20^{ab}	6.10^{ab}	5.80^{a}	5.70^{a}	5.40^{a}	5.40^{a}	6.45	6.56	6.90	5.26
T_4 – whole milk + coconut slurry (80:20)	6.10^{ab}	6.07^{abc}	5.70^{a}	5.70^{a}	5.53^{a}	5.53^{a}	6.56	6.10	2.98	2.98
T_7 – skim milk + coconut milk (80:20)	5.90^{cd}	5.87^{d}	5.50^{b}	5.63^{ab}	5.40^{a}	5.40^{a}	6.78	4.09	1.82	4.09
T_{10}– skim milk + coconut slurry (80:20)	5.90^{cd}	5.93^{bcd}	5.70^{a}	5.67^{a}	5.53^{a}	5.53^{a}	3.39	4.38	2.98	2.47
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	6.00^{bcd}	6.00^{bcd}	5.73^{a}	5.67^{a}	5.40^{a}	5.40^{a}	4.50	5.50	5.76	4.76
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	6.10^{ab}	6.00^{bcd}	5.70^{a}	5.70^{a}	5.40^{a}	5.43^{a}	6.56	5.00	5.26	4.74

F value	
Coagulants	19.71**
Phases of storage	0.094^{NS}
Treatments	2.752**

** 1% significant level, NS – non significant

* Lemon juice as natural coagulant in control

Table 18. Total solid (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period						% variation			
							Phases of storage			
	Initial		5th Day		10th Day		0-5		5-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	41.53^{h}	41.53^{h}	44.90^{d}	44.90^{d}	47.13^{i}	47.26^{hi}	8.11	8.11	4.97	5.26
T_1– whole milk + coconut milk (80:20)	42.00^{f}	42.37^{e}	44.69^{ef}	45.67^{b}	47.77^{ef}	47.60^{fg}	6.40	7.79	6.89	4.23
T_4 – whole milk + coconut slurry (80:20)	44.83^{a}	44.70^{a}	46.23^{a}	46.30^{a}	48.00^{cde}	47.99^{cde}	3.12	3.58	3.83	3.65
T_7 – skim milk + coconut milk (80:20)	41.83^{g}	41.43^{h}	44.70^{e}	44.53^{f}	47.43^{gh}	47.73^{ef}	6.86	7.48	6.11	7.19
T_{10}– skim milk + coconut slurry (80:20)	44.41^{b}	44.40^{b}	46.30^{a}	46.30^{a}	48.89^{a}	47.85^{def}	4.26	4.28	5.59	3.35
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	42.97^{c}	42.53^{d}	45.81^{b}	45.77^{b}	48.15^{bc}	48.13^{bcd}	6.61	7.62	5.11	5.16
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	42.37^{e}	42.37^{e}	45.50^{c}	45.47^{c}	48.33^{b}	48.88^{a}	7.39	7.32	6.22	7.50

F value	
Coagulants	2.7212^{NS}
Phases of storage	129.48^{NS}
Treatments	142.17**

** 1% significant level, NS – non significant
* Lemon juice as natural coagulant in control

coconut milk) and T_7 (skim milk + coconut milk) in case if citric acid coagulated paneer and T_7 in case of paneer coagulated with bilimbi juice when compared to control paneer. On the basis of DMRT, initially, significant variation among different filled paneer under each coagulant was noticed with respect to total solids. When the products were compared based on coagulants, significant difference was noticed in T_1 (whole milk + coconut milk), T_7 (skim milk + coconut milk) and T_{13} (whole milk + coconut milk: soy milk).

Initially the highest total solid content of 44.83 per cent was noticed in T_4 – whole milk + coconut slurry based filled paneer coagulated by citric acid and the lowest content of 41.43 per cent inT_7 - skim milk + coconut milk based filled paneer coagulated by bilimbi juice. At the end of storage period the highest and lowest total solid contents were noticed in T_{10} (skim milk + coconut slurry-48.89%) and T_7 (skim milk + coconut milk -47.43%) respectively of citric acid coagulated filled paneer.

Statistically, coagulants had no influence on the percentage increase in total solids of filled paneer over periods of storage. The percentage increase in total solid content in different treatments during ten days of storage was also found to be statistically insignificant.

4.3.3. Nutritional qualities of coconut based filled paneer

Nutritional constituents of coconut based filled paneer and milk paneer (control) coagulated using citric acid and bilimbi juice were analysed for protein, fat, free fatty acids, ash, calcium, iron, phosphorus, sodium and potassium initially and on 10^{th} day of storage. The results are as follows.

4.3.3.1. Protien

The protein content in coconut based filled paneer in comparison with milk paneer during storage is furnished in Table 19. In coconut based filled paneer prepared using citric acid and bilimbi juice, the initial protein content varied from 18.51 to 24.62 per cent and 18.54 to 24.57 per cent respectively. Initially, the protein content was 18.53 and 18.27 per cent in milk paneer (control) coagulated with citric acid and lemon juice respectively.

Table 19. Protein (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10th Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	18.53^{f}	18.27^{h}	17.52^{g}	17.15^{k}	5.45	6.13
T_1– whole milk + coconut milk (80:20)	18.57^{e}	18.56^{e}	17.32^{j}	17.44^{h}	6.73	6.03
T_4 – whole milk + coconut slurry (80:20)	18.51^{g}	18.54^{ef}	17.45^{h}	17.38^{i}	5.73	6.26
T_7 – skim milk + coconut milk (80:20)	23.44^{c}	23.45^{c}	22.37^{c}	22.35^{cd}	4.56	4.69
T_{10}– skim milk + coconut slurry (80:20)	23.42^{c}	23.44^{c}	22.23^{d}	22.34^{cd}	5.08	4.69
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	19.60^{de}	19.64^{d}	18.49^{e}	18.35^{f}	5.66	6.57
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	24.62^{a}	24.57^{a}	23.59^{a}	23.36^{b}	4.18	4.92
					F value	
** 1% significant level					Coagulants	57.951**
					Treatments	14.913**

* Lemon juice as natural coagulant in control

In filled paneer coagulated with citric acid and bilimbi juice the highest protein content was noticed in T_{16} (skim milk + with coconut milk + soy milk) through out the storage period. Initially the lowest protein content was noticed in T_4 (whole milk + coconut slurry) and in T_1 (whole milk + coconut milk) prepared with citric acid and at the end of ten days of storage T_4 prepared out of bilimbi juice had the lowest protein content.

Based on DMRT, the protein content of filled paneer under each coagulant varied significantly except in T_7 and T_{10} initially. On tenth day of storage too significant variation was noticed between treatments except in T_7 and T_{10} coagulated using bilimbi juice. With respect to coagulants, the protein content of coconut based filled paneer prepared using citric acid and bilimbi juice differed significantly only in T_4 (whole milk + coconut slurry) and T_{16} (skim milk + with coconut milk + soy milk) initially. At the end of ten days of storage significant variation was noticed in T_1, T_4, T_{13} and T_{16}.

The protein content decreased in coconut based filled paneer during storage The percentage decrease in protein content varied from 3.1 to 8.1 per cent in different treatments. The influence of two coagulants on the percentage decrease in protein content of filled paneer over periods of storage was found to be statistically significant. The percentage decrease in protein content in different treatments during ten days of storage was also found to be statistically significant.

4.3.3.2. Fat

The observation regarding the fat content of coconut based filled paneer prepared out of two coagulants are given in Table 20.

Skim milk based filled paneer had lower fat content than whole milk based filled paneer and milk paneer (control). Whole milk based paneer had higher fat content than milk paneer in all periods under study. Initially the fat content in coconut based filled paneer prepared using citric acid and bilimbi juice varied from 7.07 to 25.68 per cent and 7.40 to 25.63 per cent respectively. On tenth day of storage, the fat content varied from 6.59 to 24.88 per cent and 6.55 to 24.87 per cent respectively.

Table 20. Fat (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10th Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	24.30^{e}	24.30^{e}	23.75^{b}	23.75^{b}	2.26	2.26
T_1– whole milk + coconut milk (80:20)	25.68^{a}	25.63^{ab}	24.88^{a}	24.79^{a}	3.12	3.28
T_4 – whole milk + coconut slurry (80:20)	25.37^{bc}	25.44^{ab}	24.65^{a}	24.87^{a}	2.84	2.24
T_7 – skim milk + coconut milk (80:20)	7.33^{f}	7.40^{f}	6.59^{c}	6.55^{c}	10.10	11.49
T_{10}– skim milk + coconut slurry (80:20)	7.60^{f}	7.47^{f}	6.82^{c}	6.60^{c}	10.26	11.65
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	25.07^{d}	25.12^{cd}	24.66^{a}	24.66^{a}	1.64	1.83
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	7.07^{g}	7.40^{f}	6.66^{c}	6.73^{c}	5.80	9.05
					F value	
					Coagulants	1.84^{NS}
** 1% significant level, NS – non significant					Treatments	14.28**

* Lemon juice as natural coagulant in control

Based on DMRT, significant variation was not observed in the fat content of filled paneer when they were compared based on coagulants throughout the storage period, except T_{16} (skim milk + coconut milk: soy milk) initially. Among different combinations of filled paneer coagulated with citric acid, T_7 (skim milk + coconut milk) and T_{10} (skim milk + coconut slurry) were on par initially and they differed significantly from other treatments. But on tenth day of storage significant variation was notcied between wholemilk and skim milk based filled paneer with respect to fat content. Similar trend was also noticed in filled paneer coagulated with bilimbi juice.

The fat content in all the products decreased during ten days of storage. The effect of two coagulants on the percentage decrease in fat content of filled paneer over periods of storage was found to be statistically insignificant. However, the percentage decrease in fat content in different treatments during ten days of storage was found to be statistically significant.

4.3.3.3. Free fatty acids

The effect of storage on free fatty acid content of coconut based filled paneer and control is furnished in Table 21. An increase in free fatty acid content was noticed in coconut based filled paneer prepared using both coagulants and in milk paneer during storage. Compared to control and whole milk based filled paneer, skim milk combinations had lower free fatty acid content.

In coconut based filled paneer prepared using citric acid as well as blimbi juice, initially the highest value for free fatty acid content was noticed in T_4 (whole milk + coconut slurry) and T_{13} – whole milk + coconut milk: soy milk (0.19 and 0.187 % respectively) and they differed significantly from all other filled paneer and control. Based on coagulants, significant variation in FFA content was noticed except in T_7 (skim milk + coconut milk) on tenth day of storage.

The free fatty acid content increased in all the products during ten days of storage upto 100 per cent. The influence of two coagulants on the percentage increase in free fatty acid content of filled paneer over periods of storage was found to be statistically insignificant. However the percentage increase in fat

Table 21. Free fatty acids (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10th Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	0.170^{e}	0.170^{e}	0.190^{g}	0.200^{f}	11.76	17.65
T_1– whole milk + coconut milk (80:20)	0.180^{c}	0.177^{d}	0.200^{f}	0.203^{e}	11.11	14.69
T_4 – whole milk + coconut slurry (80:20)	0.190^{a}	0.187^{b}	0.210^{d}	0.213^{c}	10.53	13.90
T_7 – skim milk + coconut milk (80:20)	0.020^{k}	0.023^{j}	0.040^{j}	0.040^{j}	100	73.91
T_{10}– skim milk + coconut slurry (80:20)	0.030^{h}	0.027^{i}	0.040^{j}	0.037^{k}	33.33	38.88
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	0.190^{a}	0.187^{b}	0.220^{b}	0.223^{a}	15.79	19.25
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	0.040^{f}	0.037^{g}	0.060^{h}	0.057^{i}	50.0	54.05
					F value	
** 1% significant level, NS – non significant					Coagulants	1.715^{NS}
					Treatments	19.924**

* Lemon juice as natural coagulant in control

Table 22. Ash (%) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10th Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	2.50^{b}	2.50^{b}	2.33^{b}	2.33^{b}	6.80	6.80
T_1– whole milk + coconut milk (80:20)	2.47^{bc}	2.40^{c}	2.25^{c}	2.20^{cd}	8.91	8.33
T_4 – whole milk + coconut slurry (80:20)	2.40^{c}	2.40^{c}	2.20^{cd}	2.20^{cd}	8.33	8.33
T_7 – skim milk + coconut milk (80:20)	2.57^{a}	2.57^{a}	2.55^{ab}	2.55^{ab}	0.78	0.78
T_{10}– skim milk + coconut slurry (80:20)	2.57^{a}	2.57^{a}	2.55^{ab}	2.56^{a}	0.78	0.39
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	2.49^{b}	2.30^{d}	2.33^{b}	2.13^{d}	6.43	7.39
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	2.58^{a}	2.57^{a}	2.57^{a}	2.56^{a}	0.39	0.39
					F value	
NS – non significant					Coagulants	0.0040^{NS}
					Treatments	2.9521^{NS}

* Lemon juice as natural coagulant in control

content in different treatments during 10 days of storage was found to be statistically significant.

4.3.3.4. Ash

The ash content in coconut based filled paneer is given in Table 22. Compared to control, lower ash content was noticed in whole milk based filled paneer. Initially the ash content in filled paneer coagulated with citric acid and bilimbi juice varied from 2.30 to 2.58 per cent which decreased during ten days of storage. On tenth day of storage the ash content varied from 2.13 to 2.57 per cent.

Based on DMRT, significant variation in ash content of whole milk and skim milk based paneer was noticed through out the period of storage. When the ash content of filled paneer were compared based on coagulants, significant variation was noticed only in T_{13} (whole milk + coconut milk: soy milk) through out the storage period.

The decrease in ash content in different types of filled paneer during ten days of storage was found to be statistically insignificant and the coagulants had no influence on decreasing the ash content of filled paneer during storage.

4.3.3.5. Calcium

The observations on calcium content of filled paneer are given in Table 23. The calcium content of milk paneer (control) prepared using citric acid and lemon juice was 198.33 mg $100g^{-1}$ initially. The calcium content in skim milk based filled paneer was higher than the whole milk based filled paneer. Significant variation in calcium content was not observed in filled paneer and in milk paneer with respect to coagulants throughout the study.

Based on DMRT, initially the calcium content of T_1 (whole milk + coconut milk) and T_4 (whole milk + coconut slurry), T_0 (control) and T_{16} (skim milk + coconut milk: soy milk) as well as T_7 (skim milk + coconut milk) and T_{10} were on par and differed significantly from T_{16} (skim milk + coconut milk: soy milk). On tenth day of storage significant variation was noticed in calcium between whole milk based, as well as skim milk based and control paneer. The calcium content in all the products decreased during storage.

Table 23. Calcium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10^{th} Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	198.33^b	198.33^b	191.05^b	191.72^b	3.67	3.33
T_1– whole milk + coconut milk (80:20)	184.72^c	184.57^c	177.13^c	177.15^c	4.11	4.02
T_4 – whole milk + coconut slurry (80:20)	184.93^c	185.49^c	176.39^c	176.20^c	4.62	5.01
T_7 – skim milk + coconut milk (80:20)	211.13^a	210.76^a	203.67^a	202.40^a	3.53	3.97
T_{10}– skim milk + coconut slurry (80:20)	212.14^a	211.69^a	203.35^a	203.64^a	4.14	3.80
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	182.12^d	181.76^d	175.72^c	176.35^c	3.51	2.98
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	197.99^b	198.21^b	190.91^b	190.74^b	3.58	3.77
					F value	
					Coagulants	0.0204^{NS}
NS – non significant					Treatments	2.3789^{NS}

* Lemon juice as natural coagulant in control

The decrease in calcium content of filled paneer during ten days of storage was found to be statistically insignificant among all the products expect T_{13}. The effect of two coagulants was statistically analyzed and decrease in calcium content of paneer over the storage period was uniform for both the coagulants as evident by the non significance of the F statistics.

4.3.3.6. Iron

In control paneer and coconut based filled paneer prepared using citric acid and bilimbi juice, iron content was not detected.

4.3.3.7. Phosphorous

The observations regarding the phosphorus content of coconut based filled paneer are given in Table 24. The phosphorous content in skim milk based filled paneer was lower when compared to whole milk paneer and control, initially and on tenth day of storage.

In milk paneer (control) the phosphorus content was 138.55 mg $100g^{-1}$ (citric acid) and 138.37 mg $100g^{-1}$ (lemon juice) initially. The highest phosphorus content was noticed in T_4 (whole milk + coconut slurry) throughout the study. On the basis of DMRT, variation in phosphorus content was not observed with respect to coagulants in any of the filled paneer and control throughout the storage period. But significant variation in phosphorus content was noticed between whole milk and skim milk based paneer through out the storage period.

The phosphorus content significantly decreased in all the treatments during ten days of storage. However, the effect of coagulants in lowering the phosphorus content during storage was insignificant.

4.3.3.8. Sodium

Sodium content in coconut based filled paneer prepared using both coagulants in comparison with control is given in Table 25. The sodium content in filled paneer was lower than the control through out the period under study.

Table 24. Phosphorus (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10^{th} Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	138.55^{b}	138.37^{b}	130.19^{b}	129.93^{b}	6.03	6.10
T_1– whole milk + coconut milk (80:20)	139.06^{b}	139.07^{b}	131.42^{ab}	131.42^{ab}	5.49	5.50
T_4 – whole milk + coconut slurry (80:20)	141.29^{a}	141.29^{a}	133.76^{a}	132.43^{ab}	5.33	6.27
T_7 – skim milk + coconut milk (80:20)	111.31^{e}	111.25^{e}	102.02^{e}	102.55^{e}	8.34	7.82
T_{10}– skim milk + coconut slurry (80:20)	111.31^{e}	111.38^{e}	102.48^{e}	102.40^{e}	7.93	8.06
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	134.08^{c}	134.09^{c}	126.49^{c}	126.27^{c}	5.66	5.83
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	114.78^{d}	114.48^{d}	108.45^{d}	108.99^{d}	5.51	4.80
					F value	
					Coagulants	0.0004^{NS}
NS – non significant, ** 1% level significant					Treatments	7.0193^{**}

* Lemon juice as natural coagulant in control

Among filled paneer coagulated with citric acid the highest sodium content was noticed in T_4 (whole milk + coconut slurry) in both periods and lowest in T_7 (skim milk + coconut milk) initially and in T_{10} (skim milk + coconut slurry) on tenth day of storage. In case of filled paneer coagulated with bilimbi juice, the highest content of sodium was noticed in T_1 (whole milk + coconut milk) and lowest in T_{16} (skim milk + coconut milk: soy milk) through out the storage period.

Based on DMRT initially, in filled paneer coagulated with citric acid T_1 (whole milk + coconut milk) and T_4 (whole milk + coconut slurry) as well as T_7 (skim milk + coconut milk) and T_{10} (skim milk + coconut slurry) were on par and they differed significantly from T_{13} (whole milk + coconut milk: soy milk) and T_{16} (skim milk + coconut milk: soy milk). But, on tenth day of storage significant difference was observed between the treatments. In products coagulated with bilimbi juice only T_7 (skim milk + coconut milk) and T_{10} (skim milk + coconut slurry) were on par initially and they day of storage and differed significantly from other treatments.

In all the products the sodium content decreased during ten days of storage and nearly 6.5 per cent reduction was noticed among different products. The effect of two coagulants was statistically analysed and decrease in sodium content of paneer over the storage period was uniform for both the coagulants as evident by the significance of the F statistics. The percentage variation in sodium content in different treatments during storage was found to be statistically significant

4.3.3.9. Potassium

The variation in potassium content of coconut based filled paneer prepared using two different coagulants during storage is furnished in Table 26. Compared to control, the potassium content in coconut based filled paneer was significantly higher in both periods under study. In control the potassium content was 133 mg $100g^{-1}$ under both coagulants initially which decreased to 129 mg $100g^{-1}$ in milk paneer prepared with citric acid and 129.67 mg $100g^{-1}$ in control coagulated with lime juice on tenth day of storage.

Table 25. Sodium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10^{th} Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	58.99^{a}	58.99^{a}	56.08^{a}	56.08^{a}	4.93	4.93
T_1– whole milk + coconut milk (80:20)	58.60^{bc}	58.50^{c}	55.40^{c}	55.40^{c}	5.46	5.30
T_4 – whole milk + coconut slurry (80:20)	58.68^{b}	58.14^{d}	55.66^{b}	55.17^{d}	5.15	5.11
T_7 – skim milk + coconut milk (80:20)	52.12^{fg}	52.12^{fg}	49.38^{g}	49.25^{gh}	5.26	5.51
T_{10}– skim milk + coconut slurry (80:20)	52.23^{f}	51.97^{g}	49.15^{h}	49.05^{h}	5.90	5.62
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	54.18^{e}	54.26^{e}	52.31^{e}	51.29^{f}	3.45	5.47
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	46.31^{h}	46.27^{h}	44.37^{i}	43.30^{j}	4.19	6.42
					F value	
					Coagulants	1.047^{NS}
NS – non significant					Treatments	15.205^{**}

*Lemon juice as natural coagulant in control

*

Table 26. Potassium (mg $100g^{-1}$) content of coconut based filled paneer in comparison with control during storage

Treatments / Coagulants	Storage period				% variation	
					Phase of storage	
	Initial		10th Day		0-10	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	133.00^{d}	133.00^{d}	129.00^{e}	129.67^{e}	3.01	2.50
T_1– whole milk + coconut milk (80:20)	145.00^{c}	145.33^{c}	142.00^{c}	140.67^{cd}	2.07	3.21
T_4 – whole milk + coconut slurry (80:20)	144.00^{c}	144.00^{c}	141.00^{cd}	141.00^{cd}	2.08	2.08
T_7 – skim milk + coconut milk (80:20)	160.00^{a}	160.00^{a}	156.00^{ab}	155.33^{ab}	2.50	2.92
T_{10}– skim milk + coconut slurry (80:20)	161.00^{a}	161.00^{a}	157.33^{a}	157.00^{a}	2.28	2.48
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	144.00^{c}	144.00^{c}	140.33^{cd}	139.33^{d}	2.55	3.24
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	158.00^{b}	158.00^{b}	154.33^{b}	154.00^{b}	2.32	2.53
					F value	
					Coagulants	8.957^{NS}
NS – non significant					Treatments	2.4031^{NS}

*Lemon juice as natural coagulant in control

In coconut based filled paneer prepared out of citric acid and bilimbi juice the highest potassium content was noticed in T_{10} (skim milk + coconut slurry) in throughout the storage period. The lowest was noticed in T_4 (whole milk + coconut slurry) and T_{13} (whole milk + coconut milk: soy milk) initially and in T_{13} (whole milk + coconut milk: soy milk) alone on tenth day of storage. Significant difference in potassium content of filled paneer was not noticed when they were compared based on coagulants in both periods under study. But significant variation in potassium content was noticed between whole and skim milk based paneer in both evaluations.

The potassium content in all the products decreased by ten days of storage upto 3.2 per cent. Based on F statistics the percentage decrease in the potassium content of filled paneer over ten days of storage with respect to coagulants was uniform. When the treatments were taken, the percentage decrease during ten days of storage was insignificant.

4.3.4. Organoleptic qualities of coconut based filled paneer

Organoleptic evaluation of selected coconut based filled paneer and control was carried out using score card based on a nine point hedonic scale by the panel of ten selected judges initially, on fifth day and tenth day of storage. The mean scores and rank scores obtained for various quality attributes like colour and appearance, flavour, body and texture and overall acceptability of filled paneer coagulated with citric acid and bilimbi juice are presented in Table 27 and 28.

4.3.4.1. Organoleptic qualities of filled paneer prepared using citric acid during storage

The mean score for different quality attributes of filled paneer was lower than control in all evaluations. The mean score for different quality attributes decreased gradually in all the products including milk paneer during ten days of storage.

The mean score for colour and appearance of milk paneer was 9.0 (6.65) initially which decreased to 8.6 (5.95) and 8.3 (6.65) on 5^{th} and 10^{th} days of storage respectively. Among filled paneer, initially the highest mean score for colour and

appearance was noticed in T_1- whole milk and coconut milk (8.8; 5.55) and the lowest in T_{10}- skim milk and coconut slurry (8.2; 1.85) which decreased to 8.2 (5.35) and 7.4 (1.50) respectively by ten days of storage.

The mean score for flavour of filled paneer varied from 7.0 (1.10) to 8.8 (6.05) initially. The highest and lowest mean score for flavour was noticed in T_1 (whole milk + coconut milk) and T_{16} (skim mik + coconut milk: soy milk) respectively, initially and on fifth day of Storage. On tenth day of storage the highest was noticed in T_7 (skim milk +coconut milk) and lowest in T_{16} (skim mik + coconut milk: soy milk) itself.

For body and texture the highest and lowest mean score was noticed in T_1 (whole milk + coconut milk) and T_4 (whole milk + coconut slurry) respectively during all the evaluations. The mean scores were 8.6 (5.00), 8.4 (5.95) and 8.2 (5.25) for T_1 (whole milk + coconut milk) and 7.8 (1.50), 7.6(1.95) and 7.4 (1.55) for T_4 (whole milk + coconut slurry), initially, on fifth day and tenth day of storage respectively.

For overall acceptability, the mean score for milk paneer was 9.0 (6.70) initially, which decreased to 8.8 (6.55) and 8.5 (6.85) on fifth and tenth days of storage respectively. In filled paneer the mean score for overall acceptability varied from 7.7 (1.75) to 8.7 (5.85) initially. By ten days of storage the mean score for overall acceptability decreased gradually and it varied from 7.1 (1.40) to 8.1 (5.50). The highest and lowest mean score for overall acceptability was noticed in T_1 and T_{10} respectively through out the storage period.

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer prepared out of citric acid during storage.

4.3.4.2. Organoleptic qualities of filled paneer prepared using bilimbi juice during storage

As revealed in Table 28, the mean score for different quality attributes of filled paneer prepared out of bilimbi juice was lower than control in all evaluations.

Table 27. Mean scores for organoleptic qualities of coconut based filled paneer prepared using citric acid during storage

Treatments	Colour and appearance			Flavour			Body and texture			Overall acceptability		
	Days of storage											
	1	5	10	1	5	10	1	5	10	1	5	10
T_0-Control	9 (6.65)	8.6 (5.95)	8.3 (6.65)	9 (6.75)	8.5 (6.35)	8 (5.05)	9 (7.00)	8.7 (6.85)	8.5 (6.85)	9 (6.70)	8.8 (6.55)	8.5 (6.85)
T_1– whole milk + coconut milk (80:20)	8.8 (5.55)	8.5 (5.65)	8.2 (5.35)	8.8 (6.05)	8.5 (6.35)	7.9 (5.60)	8.6 (5.00)	8.4 (5.95)	8.2 (5.25)	8.7 (5.85)	8.5 (5.70)	8.1 (5.50)
T_4 – whole milk + coconut slurry (80:20)	8.6 (4.55)	8.4 (4.95)	8 (5.15)	8 (3.10)	7.8 (3.20)	7.4 (3.15)	7.8 (1.50)	7.6 (1.95)	7.4 (1.55)	7.8 (1.85)	7.5 (1.60)	7.2 (1.60)
T_7 – skim milk + coconut milk (80:20)	8.4 (1.75)	8.1 (2.80)	7.7 (2.85)	8.4 (4.80)	8.2 (4.70)	8 (6.85)	8.3 (5.00)	8.1 (4.15)	7.9 (4.05)	8.6 (5.05)	8.4 (5.10)	8 (5.15)
T_{10}– skim milk + coconut slurry (80:20)	8.2 (1.85)	7.8 (1.60)	7.4 (1.50)	8.3 (4.25)	8 (4.20)	7.7 (4.25)	7.9 (1.50)	7.7 (1.05)	7.5 (1.80)	7.7 (1.75)	7.4 (1.40)	7.1 (1.40)
T_{13} – whole milk + coconut milk: soy milk(80:10:10)	8.5 (4.20)	8.3 (4.75)	7.9 (4.05)	7.7 (2.05)	7.4 (2.10)	7.1 (2.00)	8.4 (5.00)	8.2 (4.25)	8 (4.95)	8.4 (2.55)	8.3 (4.45)	7.9 (4.30)
T_{16}– skim milk + coconut milk: soy milk(80:10:10)	8.3 (3.45)	8 (2.30)	7.6 (2.45)	7 (1.10)	6.7 (1.10)	6.5 (1.10)	8.2 (3.00)	8 (3.80)	7.8 (3.55)	8.2 (4.35)	8 (3.20)	7.6 (3.20)
Kendall's W value	0.769 **	0.733 **	0.804**	0.968**	0.920**	0.943**	1.00**	0.947**	0.869**	0.940**	0.929**	0.952**

Figures parenthesis indicate mean rank scores. ** significant at 1% level

The mean score for different quality attributes decreased gradually in all the products including milk paneer during ten days of storage.

The mean score for colour and appearance of milk paneer was 9.0 (6.25) initially which decreased to 8.8 (6.60) and 8.6 (6.50) on 5^{th} and 10^{th} days of storage respectively. Among filled paneer, initially the highest mean score for colour and appearance was noticed in T_1- whole milk and coconut milk (8.8; 5.65) and the lowest in T_{10}- skim milk and coconut slurry (8.2; 1.70) which decreased to 8.4 (6.50) and 7.8 (1.10) respectively by ten days of storage.

The mean score for flavour of filled paneer varied from 7.8 (1.83) to 8.8 (6.17) initially. The highest and lowest mean score for flavour was noticed in T_1 (whole milk + cconut milk) and T_{13} (whole milk + coconut milk: soy milk) as well as T_{16} (skim ilk + coconut milk: soy milk) respectively, initially. On tenth day of storage the highest was noticed in T_4- whole milk and coconut slurry (8.2)and lowest in T_{16}- skim milk with coconut milk and soy milk (7.3).

For body and texture the highest and lowest mean scores was noticed in T_1 (whole milk + coconut milk) and T_{10} (skim milk + coconut slurry) respectively during all the evaluations. The mean scores were 8.8 (5.80), 8.6 (6.15) and 8.4 (6.25) for T_1 (whole milk + coconut milk) and 7.6 (1.00), 7.4 (140) and 7.2 (1.20) for T_{10} (skim milk + coconut slurry), initially, on fifth day and tenth day of storage respectively.

For overall acceptability, the mean score for milk paneer was 9.0 (6.50) initially, which decreased to 8.7 (6.40) and 8.5 (6.80) on fifth and tenth day of storage respectively. In filled paneer the mean score for overall acceptability varied from 7.6 (1.55) to 8.7 (5.85) initially. By ten days of storage the mean score for overall acceptability decreased gradually and it varied from 7.4 (1.15) to 8.4 (5.80). The highest mean score for overall acceptability was noticed in T_1 (whole milk + coconut milk) and T_7 (skim milk + coconut milk) initially and on fifth day of storage. On tenth day of storage the highest was for T_7 (skim milk + coconut milk). The lowest was noticed in T_{10} through out the storage period.

Table 28. Mean scores for organoleptic qualities of selected coconut based filled paneer prepared using bilimbi juice during storage

Treatment	Colour and appearance			Flavour			Body and texture			Overall acceptability		
	Days of storage											
	1	5	10	1	5	10	1	5	10	1	5	10
T_0-Control	9 (6.25)	8.8 (6.60)	8.6 (6.50)	9 (6.72)	8.6 (6.40)	8.3 (6.15)	9.0 (6.75)	8.8 (6.70)	8.5 (6.55)	9 (6.50)	8.7 (6.40)	8.5 (6.80)
T_1– whole milk + coconut milk (80:20)	8.8 (5.65)	8.6 (5.70)	8.4 (6.50)	8.8 (6.17)	8.3 (5.20)	8 (4.50)	8.8 (5.80)	8.6 (6.15)	8.4 (6.25)	8.7 (5.85)	8.5 (5.75)	8.3 (5.25)
T_4 – whole milk + coconut slurry (80:20)	8.4 (3.70)	8.2 (3.25)	8 (4.15)	8.6 (3.78)	8.4 (4.25)	8.2 (4.95)	7.9 (2.00)	7.5 (1.65)	7.3 (1.80)	7.7 (1.85)	7.5 (2.15)	7.3 (2.00)
T_7 – skim milk + coconut milk (80:20)	8.3 (2.55)	8.2 (3.25)	8 (4.15)	8.4 (3.83)	8.2 (6.15)	8 (4.50)	8.5 (4.10)	8.3 (3.40)	8.1 (4.55)	8.7 (5.25)	8.5 (5.75)	8.4 (5.80)
T_{10}– skim milk + coconut slurry (80:20)	8.2 (1.70)	8 (2.70)	7.8 (1.10)	8.4 (3.83)	8.3 (2.00)	8.1 (4.80)	7.6 (1.00)	7.4 (1.40)	7.2 (1.20)	7.6 (1.55)	7.5 (1.25)	7.4 (1.15)
T_{13} – whole milk + coconut milk: soy milk(80:10:10)	8.5 (4.45)	8.2 (3.25)	7.9 (2.90)	7.8 (1.83)	7.6 (2.00)	7.4 (1.55)	8.4 (4.25)	8.2 (4.35)	8 (4.15)	8.4 (2.65)	8.2 (2.60)	8 (4.15)
T_{16}– skim milk + coconut milk: soy milk(80:10:10)	8.4 (3.70)	8.2 (3.25)	7.9 (2.90)	7.8 (1.83)	7.6 (2.00)	7.3 (1.55)	8.3 (4.10)	8.1 (4.35)	7.9 (3.50)	8.2 (4.35)	8 (4.10)	7.6 (2.85)
Kendall's W value	0.682**	0.751**	0.952**	0.886**	0.946**	0.801**	0.955**	0.947**	0.947**	0.930**	0.948**	0.969**

Figures parenthesis indicate mean rank scores. ** significant at 1% level

Based on Kendall's (W) value, significant agreement among judges was noticed in the evaluation of different quality attributes of filled paneer prepared out of bilimbi juice during storage.

4.3.5. Microbial qualities of selected coconut based filled paneer during storage

Microbial enumeration of coconut based filled paneer and milk paneer (control) was carried out for contaminating bacteria, mold and yeast initially, on fifth day and tenth day of storage. The coliform count of the product was also enumerated.

4.3.5.1. Total count of contaminating bacteria in coconut based filled paneer

The total bacteria count in coconut based filled paneer prepared out of citric acid and bilimbi juice in comparison with control during storage is presented in Table 29. In all the products including control, bacterial count was noticed initially and the count increased in all the products during ten days of storage.

Initially, the bacterial count in filled paneer varied from 1.4 x 10^4 cfu/g (T_4- whole milk + coconut slurry, T_{13}- whole milk + coconut milk: soy milk, T_{16}- skim milk + coconut milk: soy milk) to 1.5 x 10^4 cfu/g (T_1- whole milk + coconut milk, T_7- skim milk +coconut milk, T_{10}- skim milk + coconut slurry) in citric acid coagulated ones and 1.5 x 10^4 cfu/g to 1.7 x 10^4 cfu/g in bilimbi juice coagulated paneer. On tenth day of storage the bacterial count increased to 2.0 x 10^4 cfu/g (T_7- skim milk +coconut milk , T_{16}- skim milk + coconut milk: soy milk) to 2.6 x 10^4 cfu/g (T_1- whole milk + coconut milk) in citric acid ones and 2.1 x 10^4 cfu/g (T_1- whole milk + coconut milk, T_{13}- whole milk + coconut milk: soy milk) to 2.4 x 10^4 cfu/g (T_7- skim milk +coconut milk, T_{16}- skim milk + coconut milk: soy milk) in bilimbi juice based paneer.

Table 29. Total bacterial count ($\times 10^4$ cfu g^{-1}) in coconut based filled paneer during storage

Treatments / Coagulants	Storage period					
	Initial		5th Day		10th Day	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	1.5	1.6	1.6	2.0	2.3	2.3
T_1– whole milk + coconut milk (80:20)	1.5	1.6	1.6	1.8	2.6	2.1
T_4 – whole milk + coconut slurry (80:20)	1.4	1.5	1.5	1.7	2.2	2.2
T_7 – skim milk + coconut milk (80:20)	1.5	1.7	1.6	2.1	2.0	2.4
T_{10}– skim milk + coconut slurry (80:20)	1.5	1.6	1.6	2.0	2.1	2.3
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	1.4	1.6	1.8	1.8	2.2	2.1
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	1.4	1.7	1.6	2.1	2.0	2.4

* Lemon juice as natural coagulant in control

Table 30. Total yeast count ($\times 10^2$ cfu g^{-1}) in coconut based filled paneer during storage

Treatments / Coagulants	Storage period					
	Initial		5th Day		10th Day	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	ND	ND	ND	ND	ND	ND
T_1– whole milk + coconut milk (80:20)	ND	ND	ND	ND	ND	ND
T_4 – whole milk + coconut slurry (80:20)	ND	ND	ND	ND	ND	1.3
T_7 – skim milk + coconut milk (80:20)	ND	ND	ND	ND	1.1	ND
T_{10}– skim milk + coconut slurry (80:20)	ND	ND	ND	ND	1.3	1.3
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	ND	ND	ND	ND	ND	1.1
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	ND	ND	ND	ND	ND	ND

* Lemon juice as natural coagulant in control

Table 31. Total mold count ($\times 10^2$ cfu g^{-1}) in coconut based filled paneer during storage

Treatments / Coagulants	Storage period					
	Initial		5th Day		10th Day	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	ND	ND	ND	ND	ND	ND
T_1– whole milk + coconut milk (80:20)	ND	ND	ND	ND	ND	1.2
T_4 – whole milk + coconut slurry (80:20)	ND	ND	ND	1.2	0.56	1.4
T_7 – skim milk + coconut milk (80:20)	ND	ND	1.4	ND	2.2	2.2
T_{10}– skim milk + coconut slurry (80:20)	ND	ND	ND	ND	ND	ND
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	ND	ND	ND	ND	1.4	ND
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	ND	ND	ND	1.4	ND	1.6

* Lemon juice as natural coagulant in control

Table 32. Total coliform count ($\times 10^2$ cfg^{-1}) in coconut based filled paneer during storage

Treatments / Coagulants	Storage period					
	Initial		5th Day		10th Day	
	Citric acid	Bilimbi* Juice	Citric acid	Bilimbi Juice	Citric acid	Bilimbi Juice
T_0- Milk paneer (Control)	ND	ND	0.4	0.6	0.56	0.89
T_1– whole milk + coconut milk (80:20)	ND	ND	0.56	ND	0.89	0.22
T_4 – whole milk + coconut slurry (80:20)	ND	ND	0.22	0.66	0.67	0.68
T_7 – skim milk + coconut milk (80:20)	ND	ND	0.56	0.56	0.89	0.74
T_{10}– skim milk + coconut slurry (80:20)	ND	ND	0.78	0.6	0.82	0.72
T_{13} – whole milk + coconut milk: soy milk (80:10:10)	ND	ND	0.67	0.69	0.72	0.84
T_{16}– skim milk + coconut milk: soy milk (80:10:10)	ND	ND	0.69	ND	0.89	0.56

* Lemon juice as natural coagulant in control

4.3.5.2. Total yeast count in coconut based filled paneer

The total yeast count of selected coconut based filled paneer and control is presented in Table 30. Initially and on fifth day of storage yeast growth was not detected in coconut based filled paneer prepared using both coagulants and in milk paneer (control). On tenth day of storage, presence of yeast was noticed in T_7- skim milk + coconut milk (1.1 x 10^2 cfu/g) and T_{10}- skim milk + coconut slurry (1.3 x 10^2 cfu/g) coagulated with citric acid and T_4-whole milk + coconut slurry, T_{10}- skim milk + coconut slurry (1.3 x 10^2 cfu/g) and T_{13}- whole milk + coconut milk: soy milk (1.1 x 10^2 cfu/g) coagulated with bilimbi juice.

4.3.5.3. Total mold count in coconut based filled paneer

Mold growth was not detected in coconut based filled paneer and in control initially. On fifth day of storage, Mold growth was detected in T_7- skim milk + coconut milk (1.4 x 10^2 cfu/g) prepared using citric acid and in T_4- whole milk + coconut slurry (1.2 x 10^2 cfu/g) coagulated using bilimbi juice. On tenth day of storage, mold growth increased and in citric acid based filled paneer it was noticed in treatments T_4- whole milk + coconut slurry (0.56 x 10^2 cfu/g) and T_7- skim milk + coconut milk (2.2 x 10^2 cfu/g) and T_{13}- whole milk with coconut milk and soy milk (1.4 x 10^2 cfu/g) in bilimbi juice based ones T_1- whole milk + coconut milk (1.2 x 10^2 cfu/g), T_4- whole milk + coconut slurry (1.4 x 10^2 cfu/g), T_7- skim milk + coconut milk (2.2 x 10^2 cfu/g) and T_{16}- skim milk + coconut milk: soy milk (1.6 x 10^2 cfu/g) had mold growth.

4.3.5.4. Coliform count in coconut based filled paneer

Coliform count was not detected in coconut based filled paneer and in control initially. On fifth day of storage, in all the products coagulated with citric acid coliform count was detected in all the products coagulated with citric acid and the count varied from 0.22 x 10^2 cfu/g (T_4- whole milk + coconut slurry) to 0.78 x 10^2 cfu/g (T_{10}- skim milk + coconut slurry). In case of filled paneer coagulated with bilimbi juice except in T_1 (whole milk + coconut milk) and T_{16} (skim milk + coconut

milk: soy milk), coliform count was detected and it varied from 0.56 x 10^2 cfu/g (T_7- skim milk + coconut milk) to 0.69 x 10^2 cfu/g (T_{13}- whole milk + coconut milk: soy milk). On tenth day of storage, coliform count was detected in all the products irrespective of coagulants.

4.4. Cost of production of coconut based filled paneer

The cost of production of milk paneer (control) and coconut based filled paneer was computed and the details are presented in Appendix II. The cost incurred for the production of control paneer was Rs. 24.39 for 100 g. Cost of production of coconut based filled paneer varied from Rs. 20.89 to Rs. 28.89. The minimum cost was for filled paneer prepared with whole milk and coconut slurry (T_4) and the maximum cost was noticed for the filled paneer prepared with skim milk and coconut milk + soy milk (T_{16}). The cost of production for all coconut based filled paneer was found to be lower than the price of milk paneer available in the market.

Discussion

5. DISCUSSION

Results of the study entitiled "Standardisation and quality evaluation of coconut based filled paneer" are discussed under the following headings.

5.1. Organoleptic qualities and yield of coconut based filled paneer

5.2. Organoleptic qualities and yield of milk paneer prepared using natural coagulants

5.3. Effect of storage on the quality parameters of coconut based filled paneer

5.4. Cost of production of coconut based filled paneer.

5.1. Organoleptic qualities and yield of coconut based filled paneer

Coconut based filled paneer was prepared by replacing whole milk and skim milk with coconut milk, coconut slurry and coconut milk + soy milk at different proportions. With a view to select most acceptable combinations for the preparation of filled paneer, 18 treatments were evaluated for various organoleptic qualities like colour and appearance, flavour, body and texture and overall acceptability and compared with the characteristics of paneer prepared with whole milk.. In different treatments tried for the preparation of coconut based filled paneer, the mean score for different quality attributes showed a decreasing trend with increase in the quantity of other ingredients like coconut milk, coconut slurry and coconut milk + soy milk combination.

The paneer prepared from 100 per cent whole milk was taken as the control. The control paneer was marble white in colour. Prince *et al.* (2007) has also reported that good quality milk paneer is marble white in appearance, having a slight spongy body, loose knit texture and possessing a sweetish acidic nutty flavour. In the case of coconut based filled paneer prepared in eighteen different combinations, the mean scores for organoleptic attributes were lower than the control. The coconut based filled paneer prepared with 80 per cent whole milk or skim milk with 20 percent coconut milk or coconut slurry or coconut milk + soy milk combination (T_1, T_4, T_7, T_{10}, T_{13}

and T_{16}) scored maximum for different organoleptic qualities. The filled paneer was also creamish white in colour

In the case of filled paneer prepared out of whole milk and coconut milk, a decreasing trend in mean score for different quality attributes was noticed with increase in the level of coconut milk. Coconut milk incorporation at a level of 20 per cent was found to be highly acceptable. The filled paneer had spongy body and loosely knit texture similar to milk paneer and had characteristic flavour of coconut. It was sliceable and retained the shape on frying. The same result was observed when the filled paneer were tried with skim milk and coconut milk as well as whole milk/ skim milk and coconut milk + soy milk combinations. Similar findings were also reported by Venkateswarlu *et al.* (2003) in coconut milk filled paneer and Bajwa *et al.* (2005) in vegetable impregnated paneer and Bhadekar *et al.* (2008) in sago powder incorporated filled paneer Venkateswarlu *et al.* (2003) observed addition of 10 per cent of coconut milk to skim milk as more ideal among different treatments tried to develop coconut based functional paneer.

The body and texture of filled paneer was found to be acceptable up to 30 per cent replacement with coconut milk. Further increase in coconut milk (upto 40 per cent) incorporation affected the texture of paneer. The moisture retention in filled paneer was high with increase in the level of coconut milk. The filled paneer was not sliceable in good shape and become mashed on frying, when the level of coconut milk was high.

Among the different combinations tried using whole milk and skim milk with coconut milk at 20 per cent level, maximum mean score for appearance and colour, flavour, body and texture and overall acceptability was noticed in whole milk and coconut milk based filled paneer (T_1). The lowest mean scores for different quality attributes in 20 per cent level replacement was noticed in skim milk (80%), coconut milk (10%) and soy milk (10%) combination (T_{16}).

In case of coconut slurry based filled paneer too, 20 per cent incorporation of coconut slurry was found to be acceptable based on organoleptic scores. The mouth

feel was good for 20 per cent coconut slurry incorporated filled paneer. Beyond 20 per cent the mouth feel was not much acceptable due to the higher level of coconut fibre. The moisture retention was not seen with increase in the level of coconut slurry as in the case of coconut milk based paneer. The filled paneer even at 40 per cent level of coconut slurry incorporation was porous and compact. Retention of shape on slicing was poor for coconut slurry based paneer. The texture is an important fundamental sensory property of all foods and it affects processing, handling and influences shelf life as well as consumer acceptance (Karadbhajne and Bhoyarkar, 2010). In coconut slurry incorporated paneer, the appearance and colour of all the treatments was not acceptable as in the case of coconut milk based paneer. Compared to coconut milk based paneer lower mean scores for different quality attributes was noticed for coconut slurry based paneer. When the coconut slurry based filled paneer prepared out of whole milk and skim milk was compared lower mean score for different quality attributes were noticed for skim milk based filled paneer.

The yield of filled paneer prepared by 18 different treatments was also evaluated. Compared to control (14.60%) better yield was noticed in filled paneer. Jadhavar *et al.* (2009) also reported a yield of 14.2 per cent for paneer from cow milk.

Composition of milk had profound effect on yield of paneer (Chawla *et al.*, 1987, Sachdeva and Singh, 1988 and Sharma *et al.*, 2002). The yield of filled paneer increased with increase in the level of incorporation of coconut milk and coconut slurry. Maximum yield was noticed in 60: 40 combinations. In coconut slurry based combinations better yield than coconut milk based filled paneer was observed. The higher fibrous matter in coconut slurry may have contributed to the better yield. Similar observation was also recorded by Kantha and Kanawjia (2007) who pointed out that incorporation of soy fibre had a significant effect on the yield of paneer. Whole milk based filled paneer had better yield than skim milk based paneer.

The yield of paneer was not taken into consideration for the selection of most acceptable treatments for further studies. With increasing yield the mean scores for organoleptic attributes showed a decreasing trend. Filled paneer tried with 80 per cent

whole/ skim milk and 20 per cent coconut milk/ coconut slurry/ coconut milk + soy milk combination were comparatively more acceptable organoleptically than 70:30 and 60: 40 proportions. So the treatments T_1 (whole milk+ coconut milk), T_4 (whole milk+ coconut slurry), T_7 (skim milk+ coconut milk), T_{10} (skim milk+ coconut slurry), T_{13} (whole milk+ coconut milk+ soy milk) and T_{16} (skim milk+ coconut milk+ soy milk) along with milk paneer (Control T_0) were selected for further studies.

5.2. Organoleptic qualities and yield of milk paneer prepared using natural coagulants

Extracts of fully ripened fruits like lemon (citric acid) as control, raw mango (malic acid), bilimbi (oxalic acid), garcinia (hydroxycitric acid), tamarind (tartaric acid) and carambola (oxalic acid) were used as natural coagulants in the preparation of milk paneer after standardising the acidity of juices to 1.5 per cent. The highest mean score for different quality attributes was obtained for milk paneer prepared with lemon juice. Among different types of natural coagulants tried other than lemon juice for preparation of milk paneer, the highest mean and rank scores for different quality attributes was noticed in milk paneer coagulated with bilimbi juice.

The yield of milk paneer prepared with lemon juice as natural coagulant (control) was 18.87 per cent. The yield of milk paneer prepared using other fruit juices varied from 16.47 to 18.76 per cent. Maximum yield was noticed for milk paneer coagulated with bilimbi juice and minimum yield was noticed for milk paneer prepared with juice of raw mango.

Citric acid and lemon juice are the most commonly used coagulants in the preparation of paneer (Vishweshwaraiah and Anantakrishnan, 1985). Usage of other acids like hydrochloric acid, phosphoric acid and tartaric acid (Sachdeva and Singh, 1987), acetic acid (Grover *et al.*, 1989) malic acid (Kumar *et al.*, 1998) and lactic acid (Kumar *et al.*, 2008) were also reported by various workers. Karadbhajne and Bhoyarkar (2010) tried different coagulants and reported that two per cent ascorbic acid solution as ideal for paneer preparation.

Mohanraj and Dhanalakshmi (2008) compared the suitability of lemon, tamarind and tomato juices for the preparation of paneer and observed maximum recovery of milk solids in paneer coagulated with tamarind juice. Khan and Pal (2011) observed a decrease in solid recovery, yield and sensory scores with an increase in the strength of the coagulant. In the present study, citric acid concentration of 1.0, 1.5 and 2.0 per cent solutions were tried. At 1.5 per cent concentration the paneer obtained had soft body and smooth texture and hence 1.5 per cent concentration was selected in the present study for coagulation. Natural coagulants were also used at 1.5 per cent concentration.

The paneer prepared out of natural coagulants had marked variation in their attributes especially in colour and flavour. This was more evident in paneer coagulated out of tamarind and garcinia juice. The colour of paneer was slightly brown and had characteristic fruit flavour of garcinia and tamarind and they scored minimum for appearance and color and flavour. Much variation for body and texture was not observed in paneer coagulated with different fruit juices. Lowest mean scores for overall acceptability was also noticed in milk paneer coagulated with tamarind followed by garcinia juice.

From the different fruit juices used as natural coagulants, the most ideal fruit juice for preparation of filled paneer was selected based on organoleptic scores and yield of milk paneer prepared with different natural coagulants. Lemon juice was also taken for further studies as control.

In case of milk paneer prepared with different natural coagulants, maximum yield and highest mean score for different quality attributes were noticed for paneer coagulated with lemon juice (control). Among other coagulants used, maximum yield of 18.76 per cent was noticed for milk paneer coagulated with bilimbi juice. The highest organoleptic scores for different quality attributes was also noticed for milk paneer coagulated using bilimbi juice. The quality of paneer coagulated with bilimbi juice was comparable to that of milk paneer coagulated with lemon juice (control).

Thus, bilimbi juice was selected as the most ideal natural coagulant for the preparation of filled paneer.

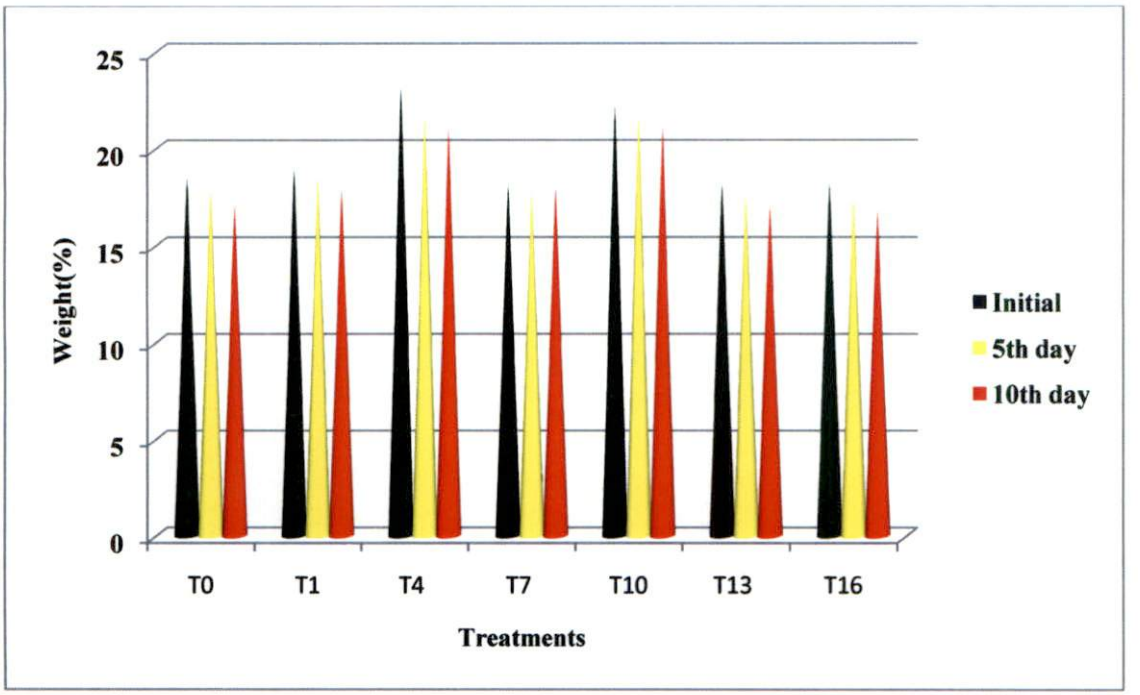
5.3. Effect of storage on the quality parameters of coconut based filled paneer

The selected six coconut based filled paneer from T_1 to T_{18} and the selected paneer prepared using bilimbi juice as natural coagulant along with controls (Cow milk paneer coagulated using citric acid and lemon juice) were packed in polythene covers and stored under refrigerated condition at 4 ± 1^{0}C for ten days. The products were evaluated for various physical, chemical, nutritional, organoleptic and microbiological qualities during storage. Physical, chemical, organoleptic and microbiological qualities of the product were assessed initially, on fifth day and tenth day of storage. Nutritional qualities of the product were evaluated initially and on tenth day of storage. The results are presented in this section.

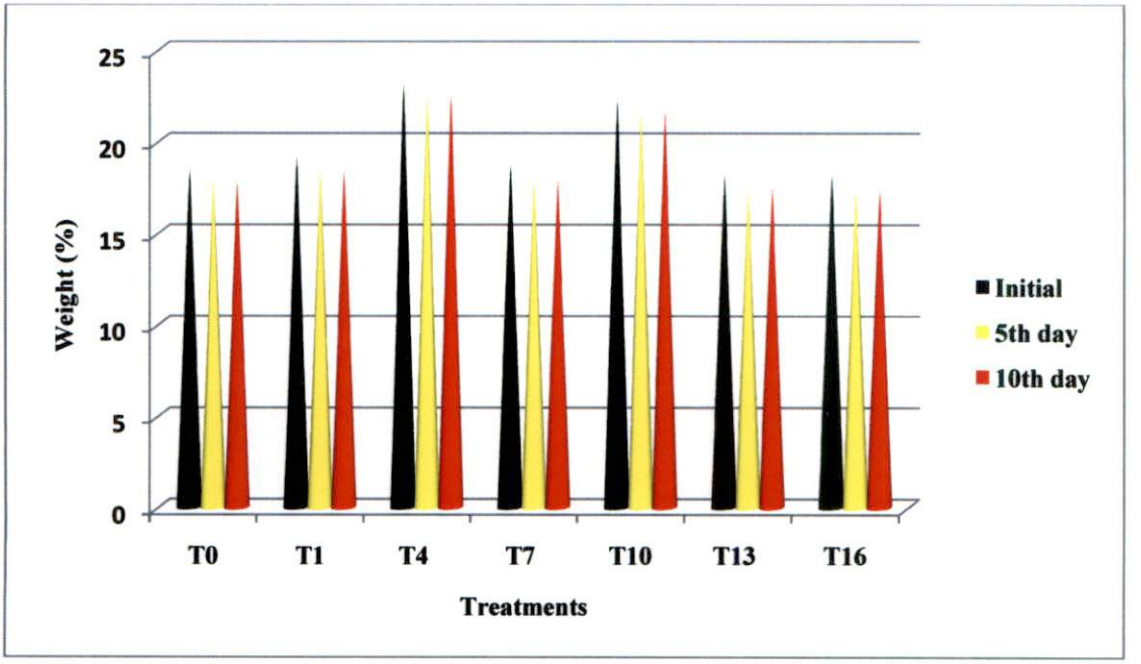
5.3.1. Physical qualities of coconut based filled paneer during storage.

Physical qualities like yield, weight loss and appearance and colour of selected coconut based filled paneer prepared using citric acid and bilimbi juice in comparison with control were evaluvated.

Compared to control, better yield was noticed for filled paneer coagulated using citric acid as well as bilimbi juice except in T_7 (skim milk + coconut milk and only in paneer coagulated with citric acid), T_{13} (whole milk + coconut milk: soy milk, 80:10:10) and T_{16} (skim milk + coconut milk: soy milk, 80:10:10) (Fig. 2). Various factors influence the yield of paneer. According to Chawla *et al.* (1987) and Sachdeva and Singh (1988) the yield of paneer is influenced by composition of milk used (type of milk, standardisation for fat and SNF), heat treatment given to milk, type and strength of coagulant, losses incurred after coagulation (based on pH and temperature of coagulation) and moisture content of resultant paneer after pressing. Sharma *et al.* (2002) reported that the composition of milk, which changes with the seasons of the year, also had a profound effect on the yield of paneer. Addition of calcium chloride as suggested by Singh and Kanawjia (1988) and Arya and Bhaik (1992) may have



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 2. Effect of storage on weight of coconut based filled paneer

improved the total solid recovery in filled paneer thereby increasing the yield. Wide variation in the yield of milk paneer as well as filled paneer was noticed through out the experiment. The change in composition of milk, coconut milk and coconut slurry may have contributed to this.

Coconut slurry incorporated filled paneer (22 to 23 per cent) had more yield than coconut milk incorporated (18 to19 per cent) ones. Among treatments, the highest yield was noticed for filled paneer prepared out of whole milk and coconut slurry (T_4). In coconut slurry, the bulk is more which may have contributed to the higher yield. Similarly Bajwa *et al.* (2005) and Kantha and Kanawjia (2007) observed increase in the yield of paneer with the incorporation of vegetables and soy fibre respectively.

The yield of filled paneer differed significantly with respect to coagulants only in T_1 (whole milk + coconut milk) and T_7 (skim milk + coconut milk). Several workers like Sachdeva and Singh (1987), Pal *et al.* (1999) and Kumar *et al.* (2007 & 2008) have reported about the profound effect of coagulants on the compositional, functional, physico-chemical and sensory characteristics of paneer mainly with respect to the strength of the coagulant. In the present study we used an acid strength of 1.5 per cent for the coagulation process was used and could not observe wide variation in same products coagulated out of citric acid and bilimbi juice with respect to yield. The weight of filled paneer decreased gradually with advancement in days of storage. The loss in moisture during storage may have contributed to the weight loss during storage. Bargale and Jha (1992) and Uprit and Mishra (2004) and Khodke *et al.* (2010) also observed similar findings and reported that weight loss of paneer is directly proportionate to moisture loss.

The coconut based filled paneer and the control paneer had a mean score above 8.0 for different quality attributes initially. A decrease in mean scores for appearance and colour of coconut based filled paneer was observed in all the products with advancement in days of storage. Development of slight creamish yellow colour was noticed in all the products towards the end of storage. Shrivastava *et al.* (2013) also observed changes in the colour of packaged and stored paneer at 3±1 ° C. Whole milk

and coconut milk based filled paneer coagulated with citric acid and bilimbi juice had maximum mean score for appearance and colour at the end of storage.

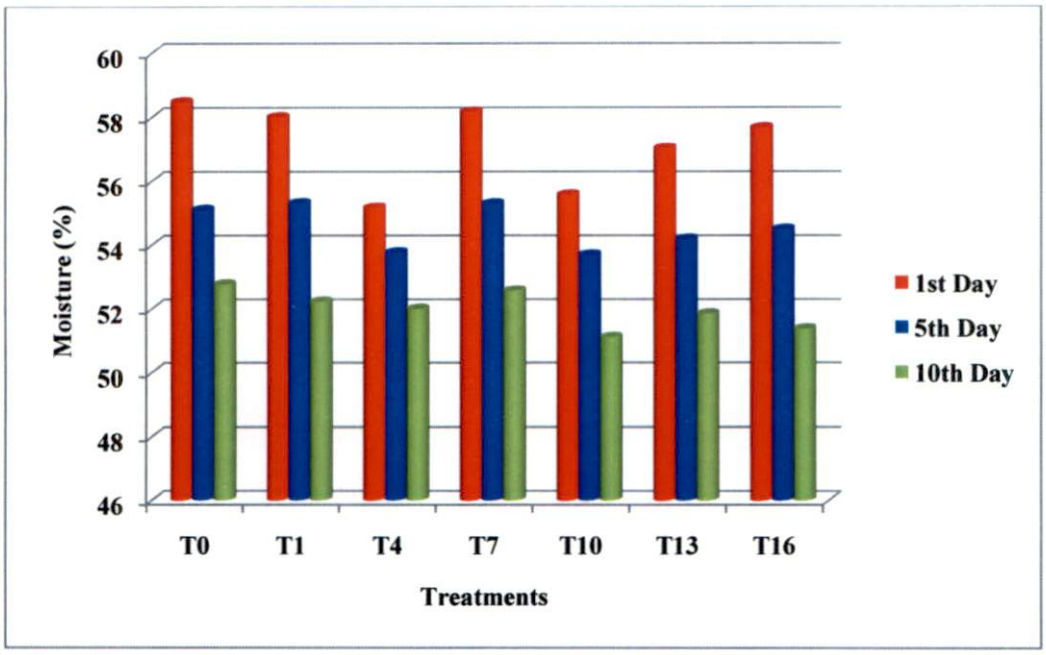
5.3.2. Chemical qualities of coconut based filled paneer during storage

Chemical constituents such as moisture, titrable acidity, pH and total solids of the selected coconut based filled paneer were evaluated initially, on fifth day and tenth day of storage and compared with milk paneer.

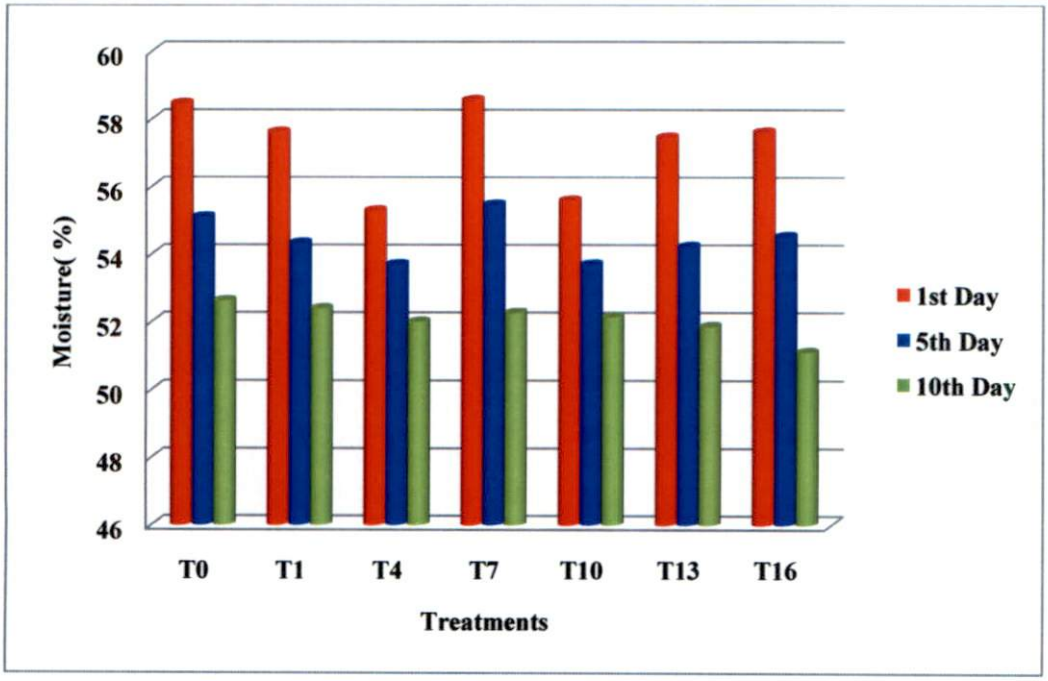
The moisture content in filled paneer prepared by coagulating with citric acid and bilimbi juice varied from 55.17 to 58.57 per cent initially (Fig. 3). According to FSSAI (2011) paneer should not contain more than 70.0 per cent moisture. In all the products the moisture was far below the specified level. David (2012) reported a moisture content of 52.92 per cent in paneer prepared by blending buffalo milk and coconut milk in 85:15 ratios. The moisture content of coconut slurry based filled paneer was lower than the coconut milk based ones. The porous nature of coconut slurry based filled paneer may have helped better removal of moisture. In soya milk incorporated filled paneer too the moisture content significantly differed from other filled products. The significant difference observed in the moisture content of filled products may be attributed to the structural matrix. The pressing of paneer after draining the coagulum may have also influenced the moisture level.

The moisture content in all the products decreased gradually with advancement in days of storage. According to Heldman and Hartel (1999) the loss in moisture content of refrigerated foods on storage is due to the moisture migration between structural elements which enhances the rate of evaporation of moisture from the food due to the lower vapour pressure of cool air. At the end of storage, the moisture content in filled paneer was significantly lower than the control. Shrivastava and Goyal (2009) also reported a reduction in moisture content of paneer during storage.

The titrable acidity and pH of the filled paneer prepared initially ranged from 0.220 to 0.230 per cent and 5.87 to 6.20 respectively (Fig. 4 and 5). Wide variation in titrable acidity and pH was not noticed with respect to coagulants. A lower acidity

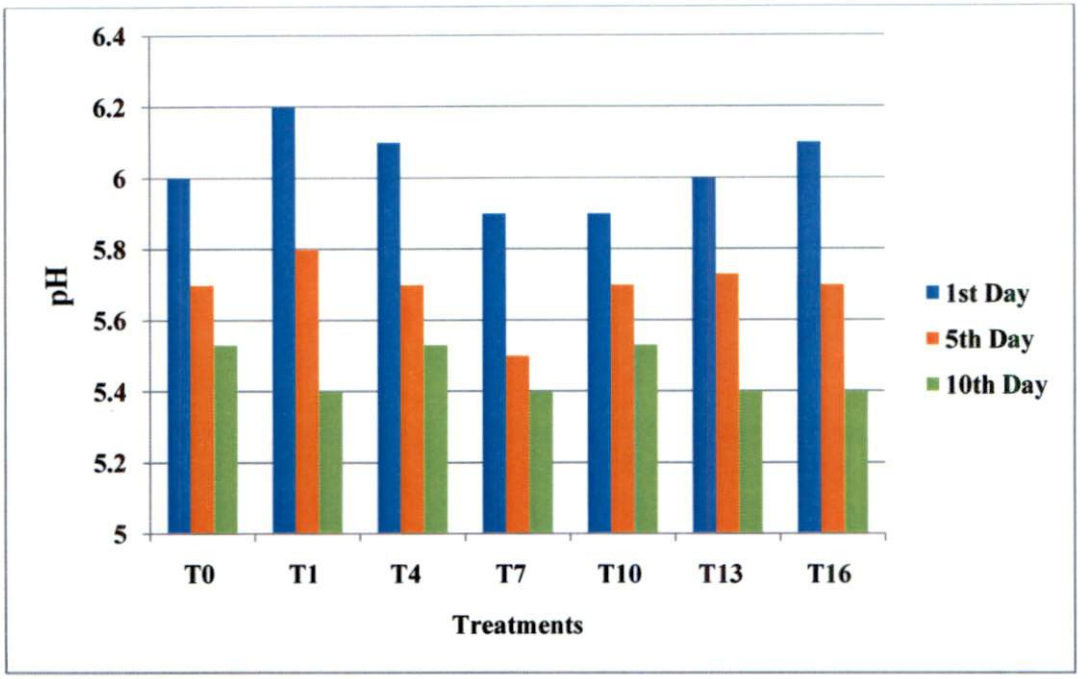


Coagulated with citric acid

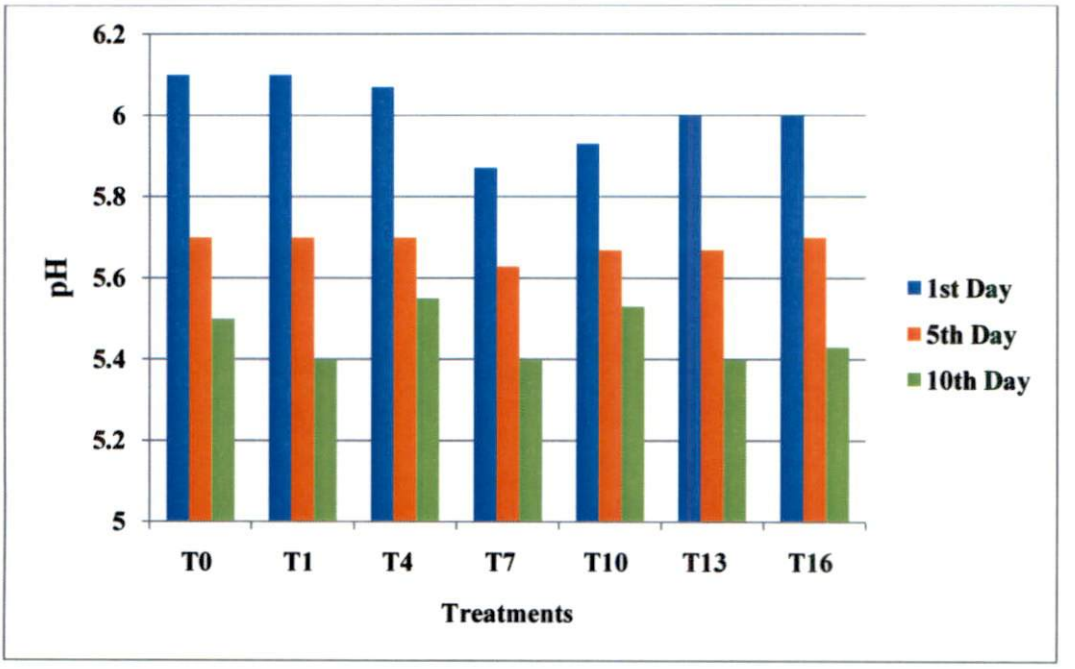


Coagulated with bilimbi juice

Fig. 3. Effect of storage on moisture content of coconut based filled paneer

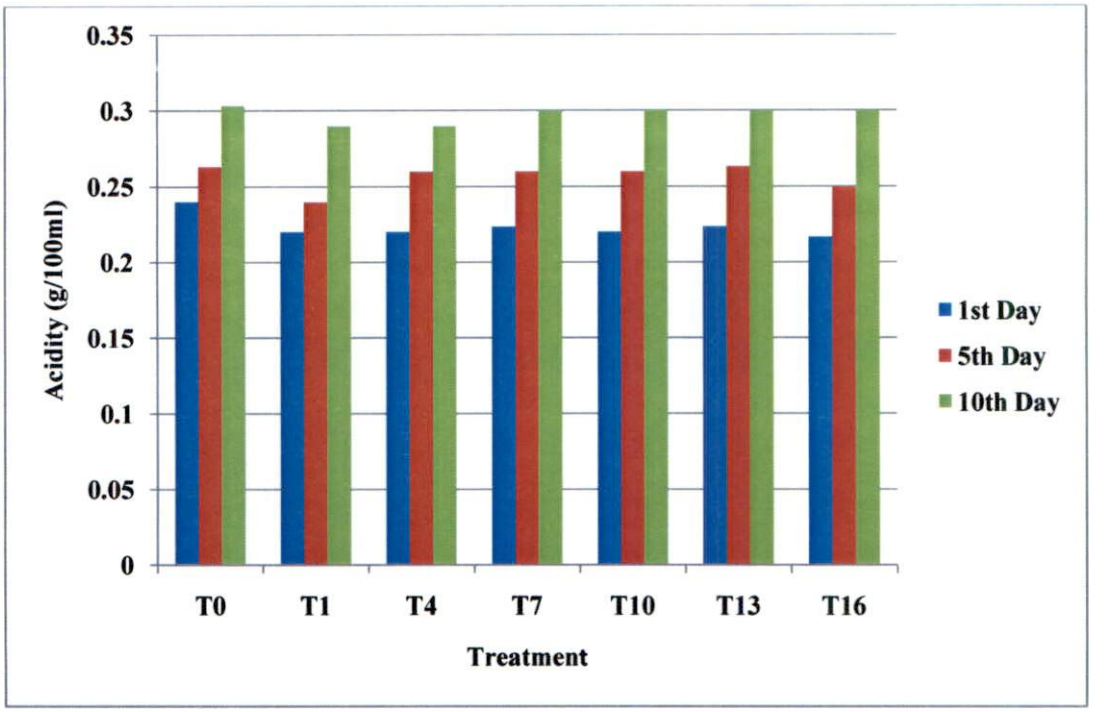


Coagulated with citric acid

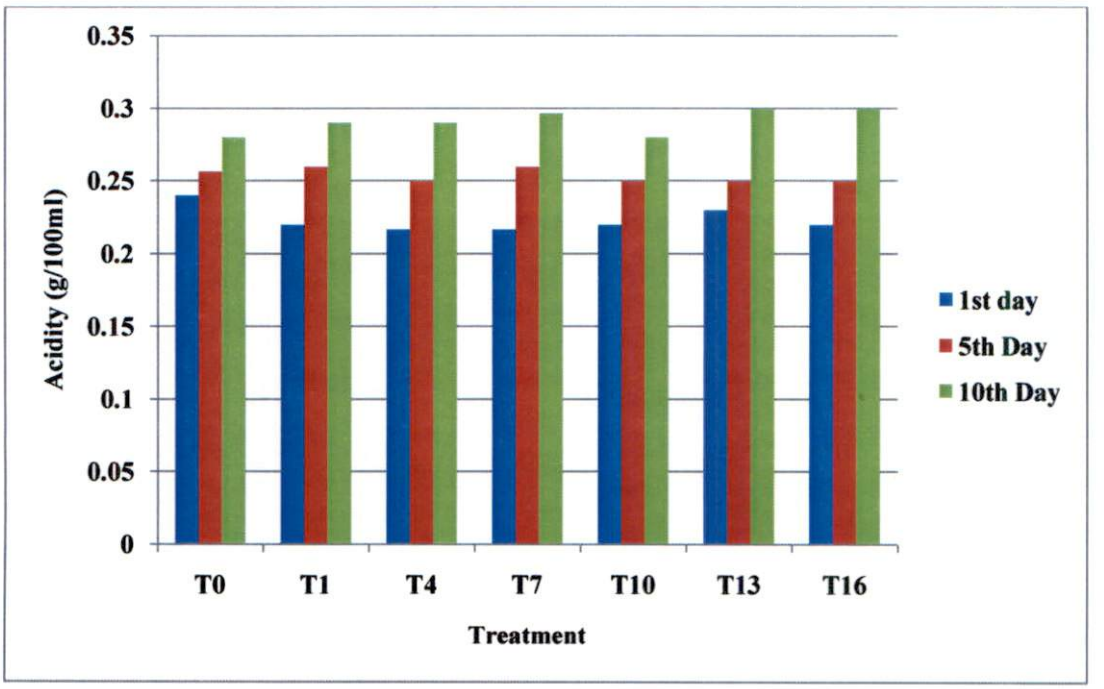


Coagulated with bilimbi juice

Fig. 5. Effect of storage on pH of coconut based filled paneer



Coagulated with citric acid



Coagulated with bilimbi juice

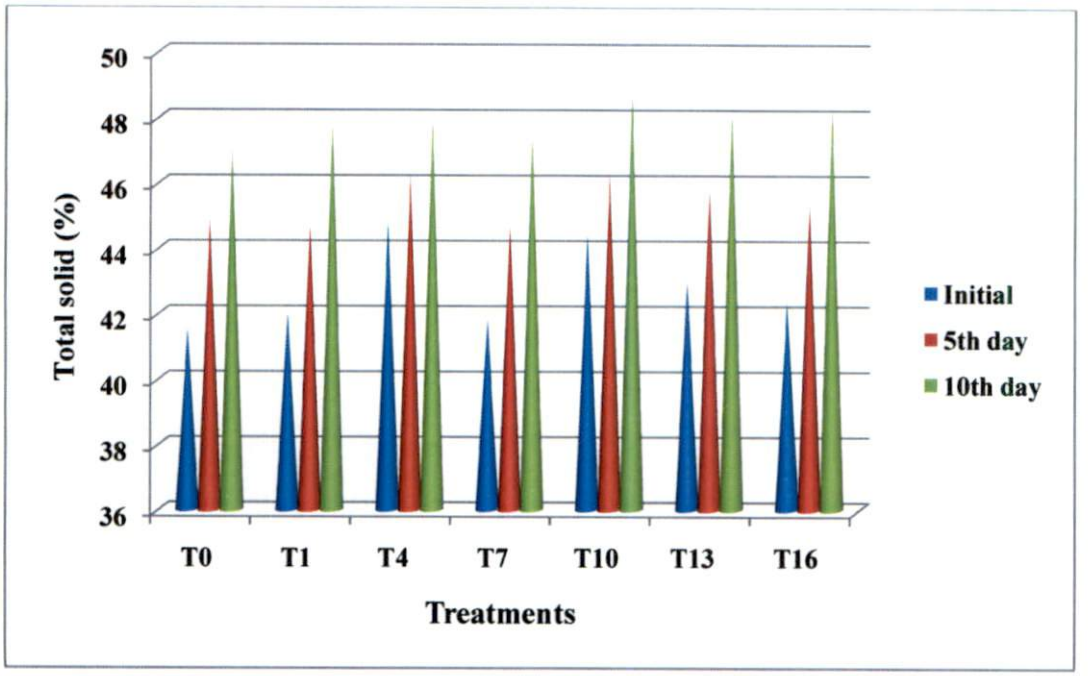
Fig. 4. Effect of storage on acidity content of coconut based filled paneer

than reported by Khodke *et al.* (2010) in soy paneer (0.43 per cent) and Goyal *et al.* (2007) in paneer available in the market (0.30 to 0.72 per cent) was noticed in the present study. Archana *et al.* (2012) reported a lower acidity of 0.185 per cent in freshly prepared milk paneer. According to Anon (2013) the maximum acidity in paneer should be 0.50 per cent. Dhankhar (2014) reported higher acidity of 0.63 to 1.70 per cent in paneer samples.

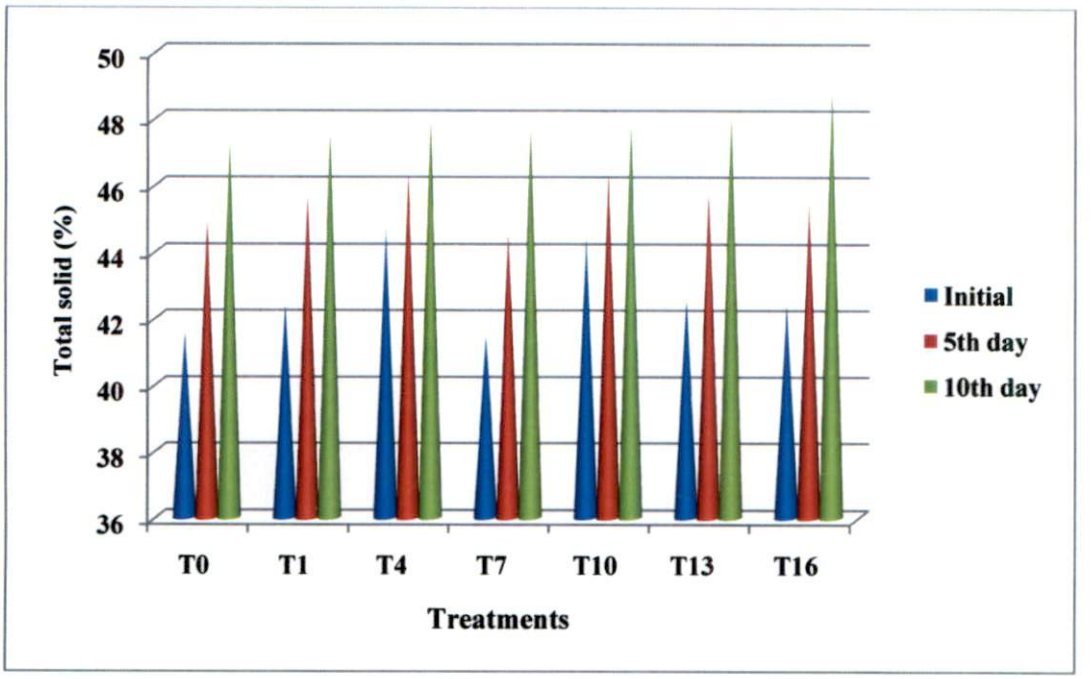
The pH of filled paneer noticed in the present study is almost similar to the pH reported by Agnihotri and Pal (1996) in freshly prepared goat milk paneer (5.69 to 6.13), Biradar *et al.* (2012) in paneer prepared by blending soy milk and bufallo milk at different levels (5.78 to 6.0). Archana *et al.* (2012) in freshly prepared milk paneer (5.78)

The pH of all the products decreased in accordance with increase in titrable acidity during storage. Kumar *et al.* (2008), Rai *et al.* (2008) and David (2012) also observed increase in titrable acidity of paneer samples during storage. They also reported a decrease in pH with increase in acidity. This change in pH value of filled paneer was within the safe limit and did not affect the shelf life of filled paneer.

Compared to control, the total solids was higher in coconut based filled paneer prepared using both coagulants in all periods under observation. Initially, the total solid in coconut based filled paneer prepared using citric acid, varied from 41.83 to 44.83 per cent. In filled paneer prepared using bilimbi juice, the total solids was 41.43 and 44.70 per cent (Fig. 6). According to Masud *et al.* (1992) the paneer prepared from buffalo milk had higher total solids as compared to paneer from cow milk. Agnihotri and Pal (1996) reported a total solid content of 48.20 to 57.78 per cent in goat milk paneer. Sharma *et al.* (2002) observed a lower total solid content of 13.31 per cent in cow milk paneer. Biradar *et al.* (2012) reported a total solid content of 45 to 50 per cent in paneer prepared by blending soy milk and bufallo milk at different levels. From these data it is clear that the total solid content in paneer may vary with respect to the raw ingredients used in its manufacture. In filled paneer comparatively better total solids were noticed than milk paneer. David (2012) also reported a total



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 6. Effect of storage on total solids content of coconut based filled paneer

solid recovery of 47.05 per cent in functional paneer prepared by blending buffalo milk and coconut milk in 85:15 ratio.

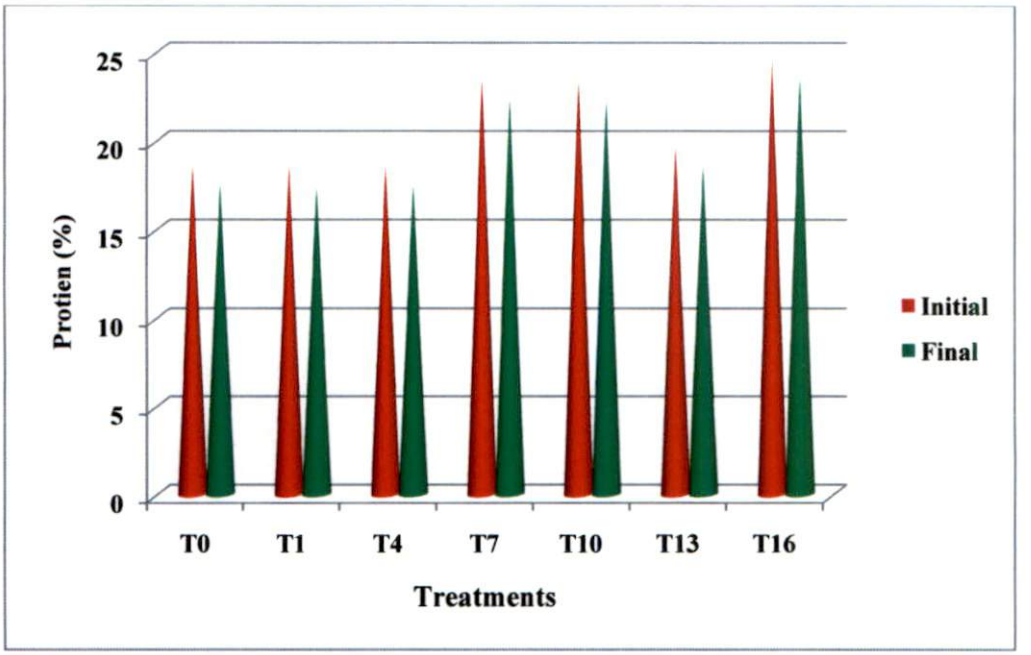
The addition of $CaCl_2$ may also have helped to improve the total solid recovery in all the products. Arora *et al.* (1996), Pombo (1997) observed comparatively higher transfer of milk solids into the curd by the addition of $CaCl_2$. This is probably because calcium ions helps in binding various component fractions of casein micelles to form a compact network, thus reducing the loss of total solids of paneer in the form of fines into the whey.

Maximum total solid recovery was noticed in filled paneer prepared out of coconut slurry. The higher solid matter in coconut slurry may have contributed to the better solid recovery in coconut slurry based filled paneer. An increase in the total solid content was noticed during storage of filled paneer. The increase may be due to moisture loss in paneer during storage. Kumar *et al.* (2008) pointed out the inverse relationship between total solids and moisture content of paneer

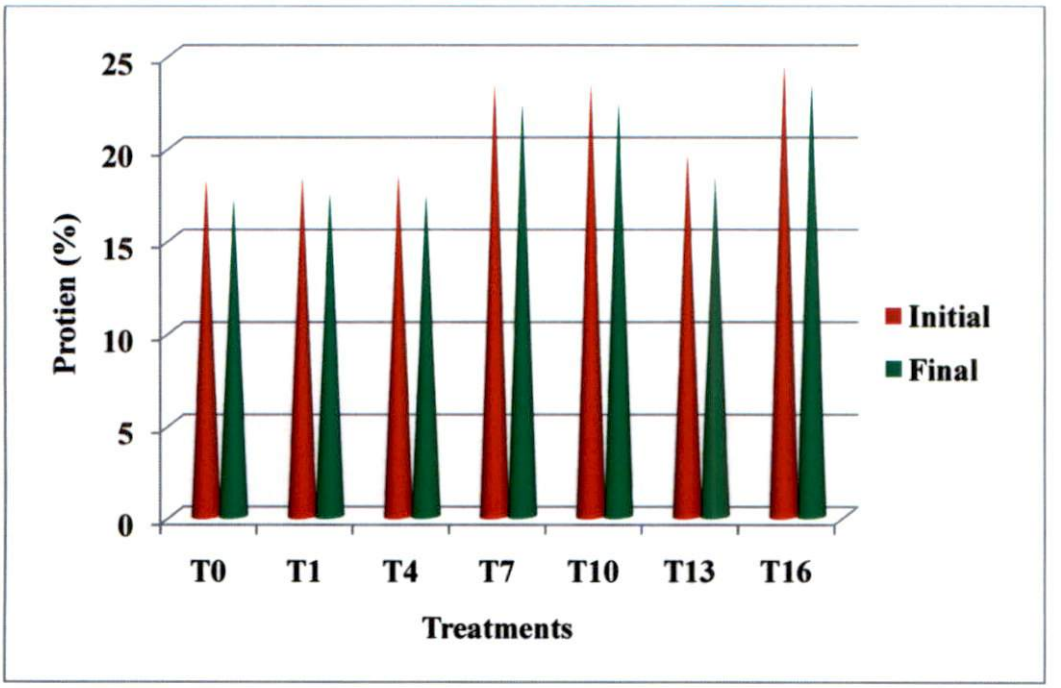
5.3.3. Nutritional qualities of coconut based filled paneer

The coconut based filled paneer and milk paneer (control) coagulated using citric acid and bilimbi juice were analysed for protein, fat, free fatty acids, ash, calcium, iron, phosphorus, sodium and potassium initially and on tenth day of storage.

The protein content of coconut based filled paneer prepared using citric acid initially varied from 18.51 to 24.62 per cent and in paneer prepared using bilimbi juice the content was between 18.54 to 24.57 per cent (Fig.7). The protein content of all the filled products significantly differed from milk paneer. The protein content observed in the present study in milk paneer (18.53 %) is found to be in line with the protein content reported by Chawla *et al.* (1987) in buffalo milk paneer 18.43 per cent, Syed *et al.* (1992) in cow milk paneer and Agnihotri and Pal (1996) in goat milk paneer 19.99 per cent. The protein content of 18.06 per cent reported by David (2012) in coconut milk based functional paneer prepared out of buffalo milk and coconut milk was found to be similar to the protein content noticed in whloe milk and coconut milk/



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 7. Effect of storage on protein content of coconut based filled paneer

slurry based filled paneer. Slight variation in protein content of filled paneer was observed with respect to coagulants which might be due to the variation in the protein content of raw ingredients used.

Skim milk based paneer had comparatively higher protein content than other treatments. The protein content in skim milk based filled paneer observed in the study was found to be lower than the protein content of 28.64 per cent reported by Sivakumar *et al.* (2005) in skim milk paneer. Twenty per cent replacement of milk with substitutes like coconut milk and coconut slurry and soy milk may have influenced the protein content.

The filled paneer prepared by incorporating soy milk (T_{16}) with skim milk and coconut milk had the highest protein content than other products. Soy milk is a good source of protein and contains about 3.6 per cent protein (Kartar and Bhargava, 1992 and Liu, 1997).

The protein content decreased in all the products during storage. The decrease in the protein content during storage can be attributed to the microbial load in the product which might have caused proteolysis to a greater extent. Similar findings were also reported by Arora and Gupta (1980), Rao *et al.* (1984), Kilic *et al.* (2004) and Sanyal *et al.* (2006) in paneer.

Skim milk based filled paneer had lower fat content than whole milk based filled paneer and milk paneer (control). The availability of fat in the low fat paneer was about four times lower than the level present in the full fat paneer (Kandeepan and Sangma, 2011). Kandeepan and Sangma (2011) also reported significantly lower fat content in low fat paneer than full fat paneer. Whole milk based filled paneer had higher fat content (24 to 25 per cent) than milk paneer in all periods under study. David (2012) also reported higher fat content of 26.32 per cent in coconut milk incorporated paneer (85:15).

According to FSSAI (2011) the fat content should not be less than 50.0 per cent of the dry matter in paneer. The fat content is expressed in terms of fresh weight

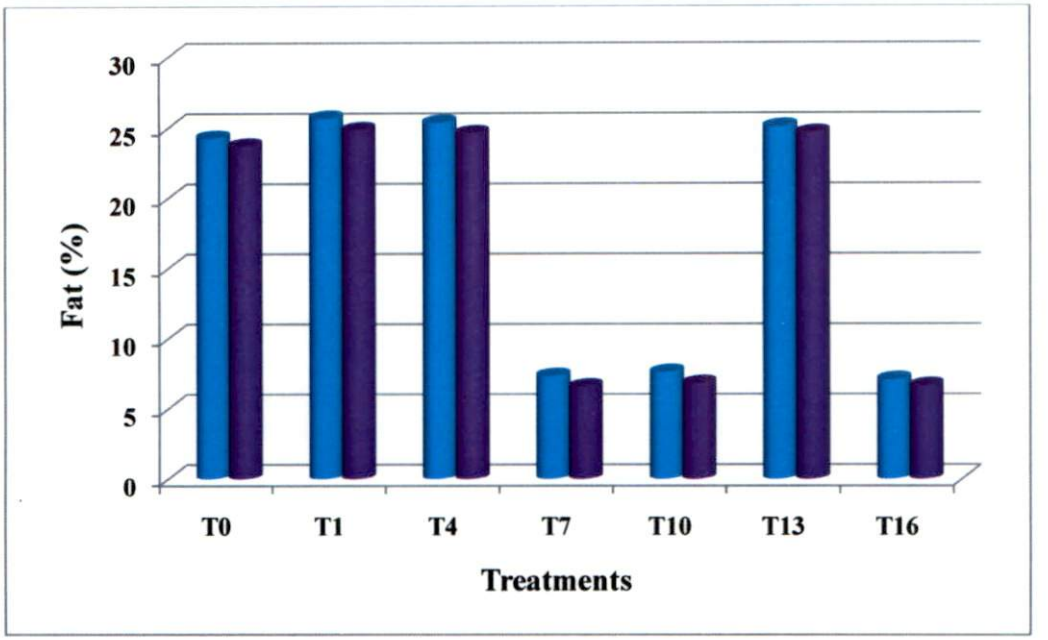
basis in the present study. The average moisture in filled paneer noticed in this study was above 50 per cent. So on dry matter basis the fat content in filled paneer was above 70 per cent except in skim milk based filled paneer. Variation in fat content of filled paneer was not noticed with respect to coagulants in all periods under study.

The fat content in milk paneer (control) was 24.30 per cent initially which decreased to 23.75 per cent on ten days of storage (Fig. 8). Pal and Kapoor (2000) reported a fat content of 24.12 per cent and Masud *et al.* (2007) indicated 23.0 per cent fat in paneer prepared from buffalo milk. Shashikumar and Puranik (2011) reported a fat content of 24.85 per cent in paneer prepared from cow milk. The fat content noticed in the present study was found to be in line with the above mentioned observations.

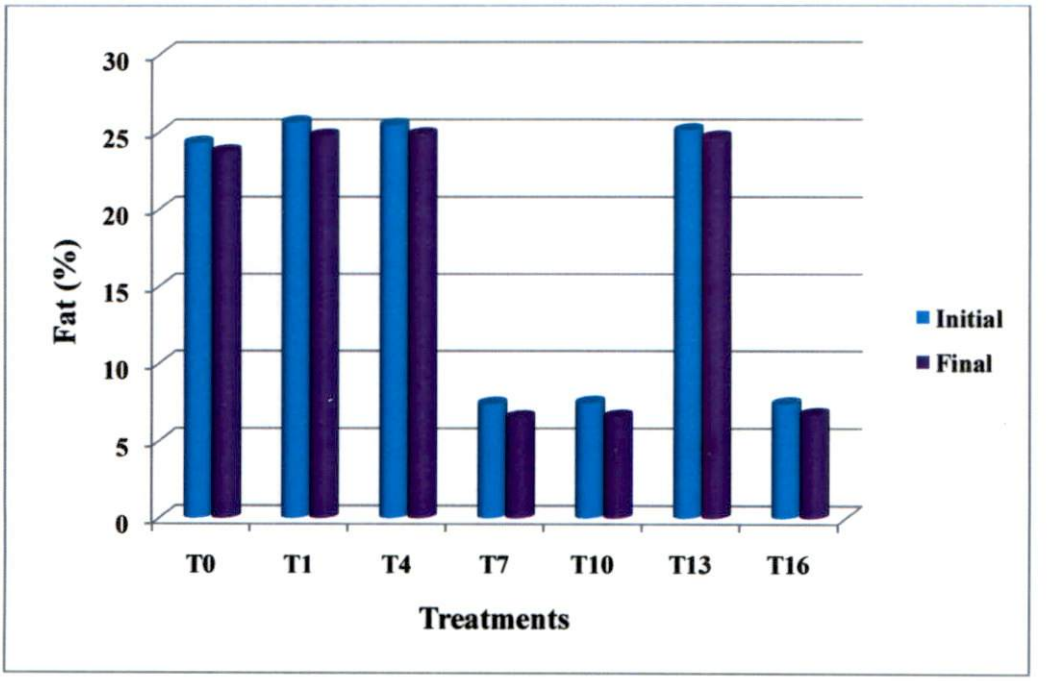
Syed *et al.* (1992) and Sivakumar *et al.* (2005) reported a fat content of 4.0 and 1.96 per cent respectively in skim milk paneer. In this study, the fat content in skim milk paneer is higher than the reported values. The fat content of skim milk used for the preparation of paneer has significant influence on the fat level of the finished product. The fat content of skim milk used in the present study was only 0.5 per cent and the fat content in skim milk based filled paneer can be attributed to the coconut fat.

The fat content in all the products decreased significantly during ten days of storage. The decrease might be a result of depletion of fat globules during storage. Similar findings were also reported by Arora and Gupta (1980), Rao *et al.* (1984), Sanyal *et al.* (2006) and Bukhari *et al.* (2012). According to Rao *et al.* (1984) decrease in fat content during storage may be due to the lipolytic activity of enzymes like lipase and lipoxidase produced by microorganisms if microbial load is high.

In coconut based filled paneer prepared using citric acid as well as bilimbi juice, initially the highest value for free fatty acid content was noticed in T_4 (whole milk + coconut slurry) and T_{13} – whole milk + coconut milk: soy milk (0.19 and 0.187 per cent respectively). The free fatty acid content of whole milk and coconut milk influences the FFA content of finished product.

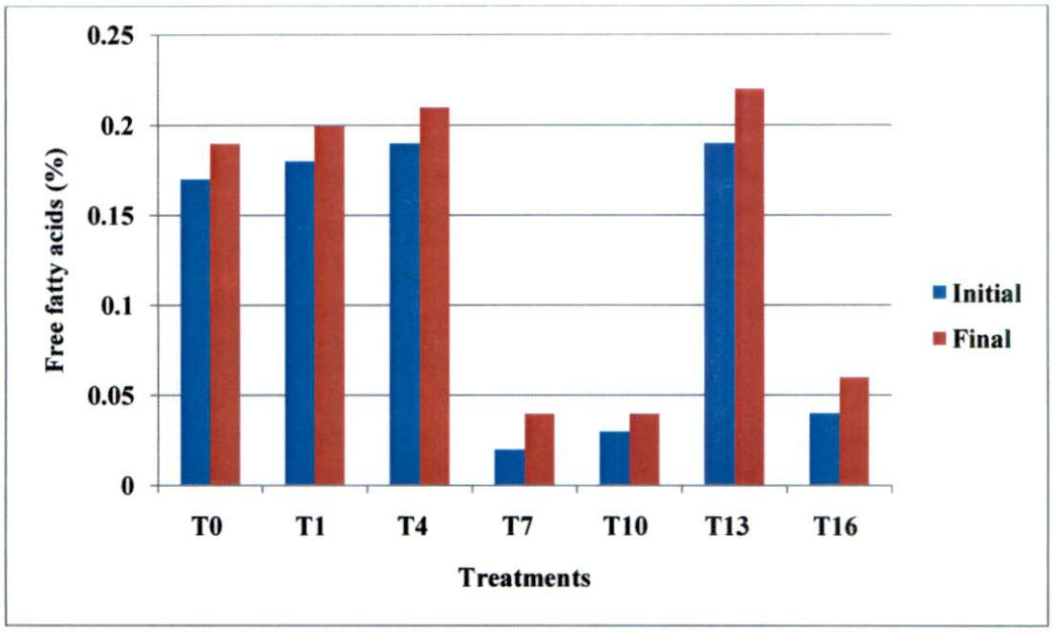


Coagulated with citric acid

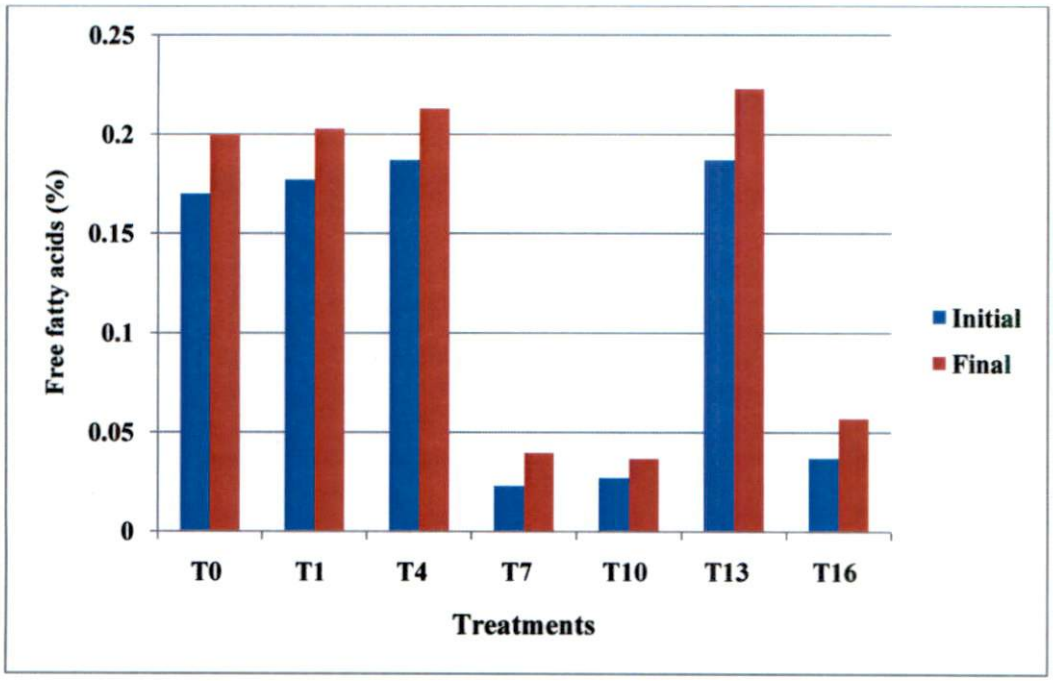


Coagulated with bilimbi juice

Fig. 8. Effect of storage on fat content of coconut based filled paneer



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 9. Effect of storage on Free fatty acids content of coconut based filled paneer

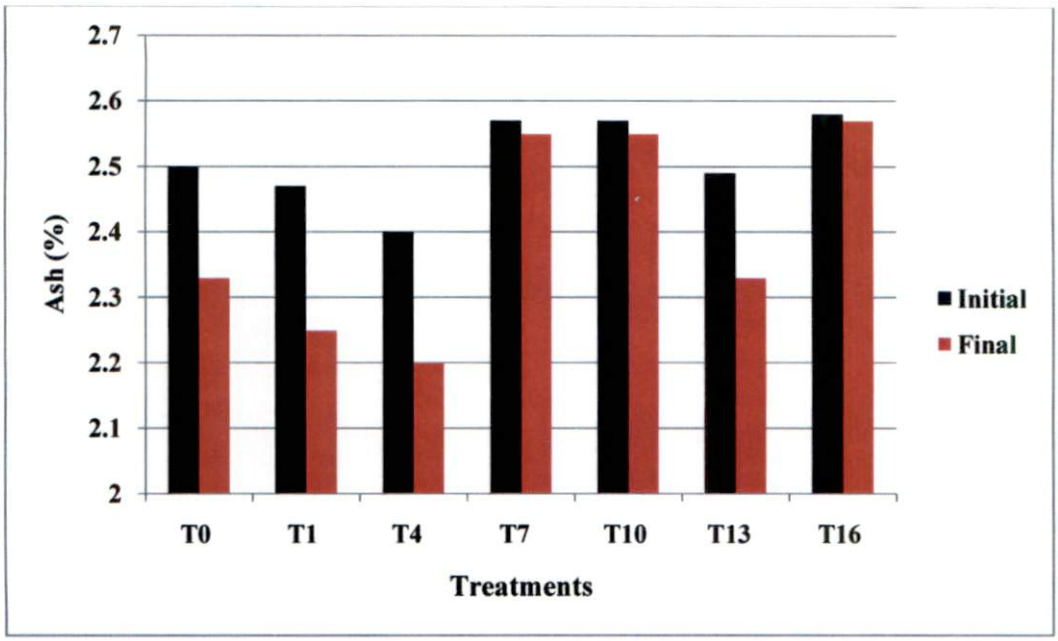
An increase in free fatty acid content was noticed in coconut based filled paneer prepared using both coagulants and in milk paneer during storage. According to Deepti *et al.* (2011) the increase in free fatty acid values in food products during storage is mainly because of lipase activity.

Kumar and Sinha (1989), Pal and Garg (1989), Pal *et al.* (1993), Rai *et al.* (2008) and Bukhari *et al.* (2012) also reported consistent increase in free fatty acids level of skim milk paneer samples during refrigerated storage (Fig. 9). In the present study, comparatively lower free fatty acid content was observed in skim milk. With respect to coagulants no variation was noticed in the free fatty acid content of filled paneer.

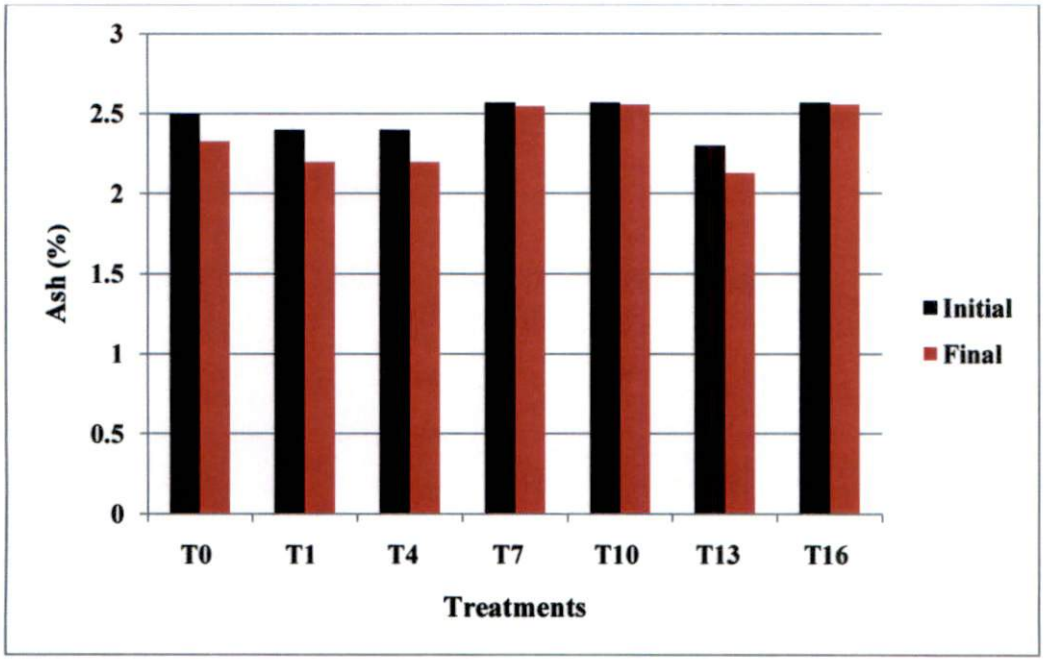
Ash content gives a direct measure of mineral content of a product. In this study maximum ash content was observed in skim milk based filled paneer (2.58 per cent). In milk paneer the ash content was 2.50 per cent (Fig. 10). The ash content revealed in the present study was higher than the reported value of 2.00 per cent by Pal and Garg (1989), and 1.45 to 2.00 per cent by Shashikumar and Puranik (2011): However, Masud *et al.* (2007) indicated 2.75 per cent ash in paneer. The composition of raw ingredients greatly influences the ash of paneer. The ash content of 2.43 per cent reported by Pal *et al.* (1999) in milk paneer is in line with the present observation.

In whole milk and skim milk, the ash content is about 0.8 and 0.7 per cent respectively. The ash content of coconut milk is about 0.9 per cent (Gopalan *et al.* (2012). The addition of coconut milk and soy milk improved the ash content of the products. The highest ash content was noticed in filled paneer prepared out of skim milk + coconut milk + soy milk combination through out the period under study. Kartar and Bhargava (1992), Biradar *et al.* (2012) reported an increase in the ash content of paneer samples with addition of soy milk.

Significant variation in ash content of whole milk and skim milk based filled paneer was noticed through out the period of storage. There was no significant difference in ash content of paneer prepared using citric acid and bilimbi juice. Khan and Pal (2011) reported that ash content of paneer did not show any variation when



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 10. Effect of storage on ash content of coconut based filled paneer

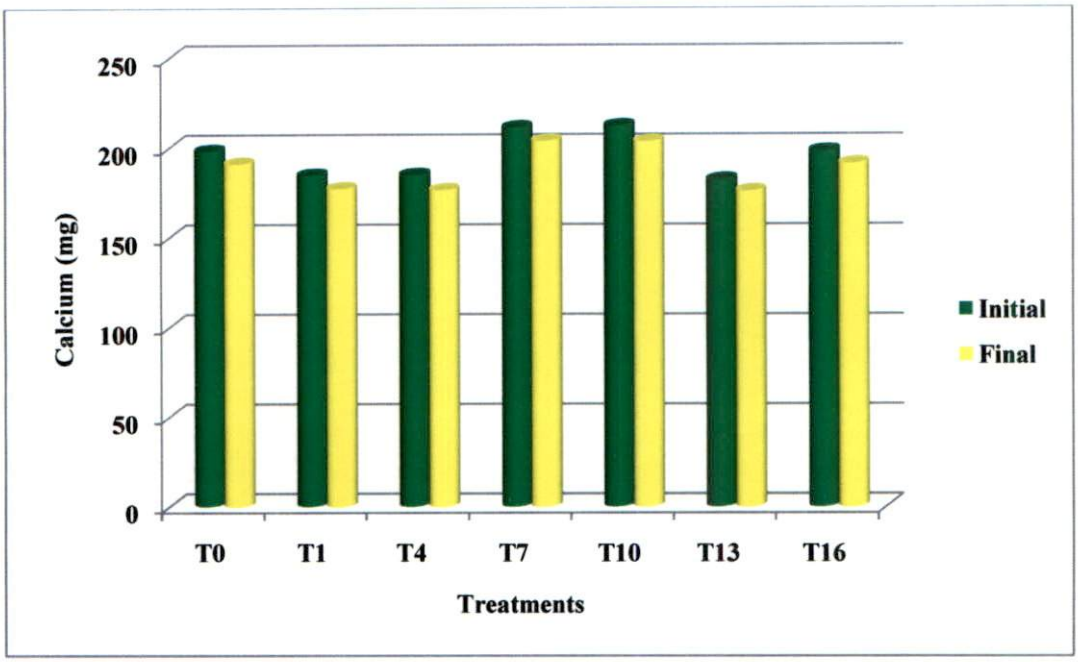
three coagulants namely citric acid, tartaric acid, malic acid were used in the preparation of paneer. The decrease in ash content during storage was statistically insignificant.

The minerals like calcium, phosphorus, iron, sodium and potassium content of coconut based filled paneer were evaluated (Fig. 11 to 14). Paneer is a valuable source of minerals like calcium and phosphorous. (Kumar *et al.*, 2011). Iron was not present in detectable level in the products.

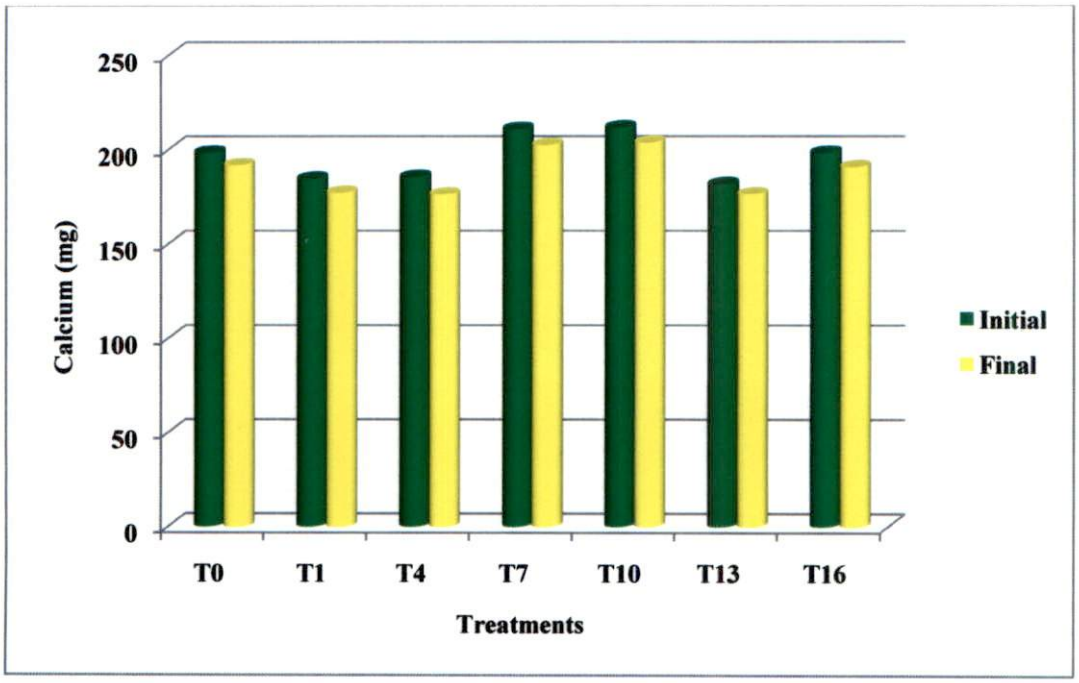
The calcium content of milk paneer was 198.33 mg 100^{-1} which decreased slightly during storage. The calcium content noticed in milk paneer was lower than the value of 208 mg 100^{-1} reported by Gopalan *et al.* (2012) in cow milk paneer. The variation in the composition of milk used may have given lower values in the present study. The calcium content of whole milk based filled paneer was significantly lower than the control. The highest calcium content was seen in skim milk based filled paneer. The higher levels of calcium in skim milk as well as the coconut milk and soy milk may have also contributed calcium to the final product. The calcium content of coconut milk as given by Ishiaq and Odeyemi (2012) was 213 mg $100g^{-1}$. More over the usage of $CaCl_2$ @ 0.15 per cent may have also contributed calcium to the products.

The phosphorous content in skim milk based filled paneer was lower when compared to whole milk paneer and control, initially and on tenth day of storage. In milk paneer the phosphorus content was 138.55 mg $100g^{-1}$ (citric acid) and 138.37 mg $100g^{-1}$ (lemon juice) initially. This was in line with the phosphorus content of 138 mg $100g^{-1}$ reported by Gopalan *et al.* (2012). The highest phosphorus content was noticed in T_4 (whole milk + coconut slurry) throughout the study. Coconut is a good source of phosphorus and may have contributed considerable amount of phosphorus to the finished products.

The sodium content in filled paneer was lower than the control through out the period under study where as the potassium content was higher. In 100 ml of cow milk the sodium and potassium content is about 73 and 140 mg $100g^{-1}$ respectively (Gopalan *et al.*, 2012). Based on the sodium and potassium content of milk, the filled

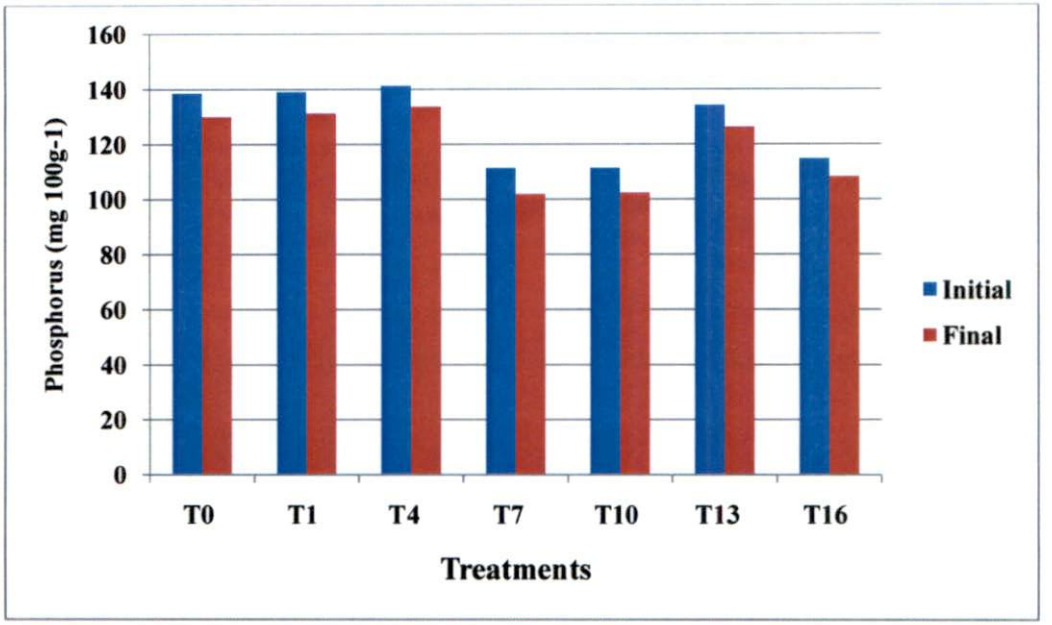


Coagulated with citric acid

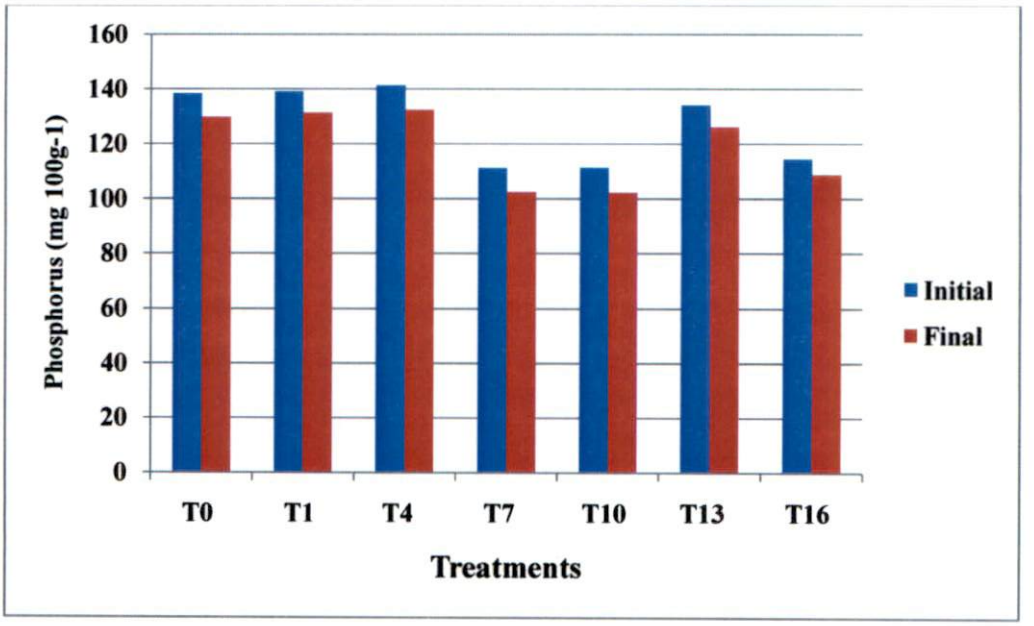


Coagulated with bilimbi juice

Fig. 11. Effect of storage on calcium content of coconut based filled paneer

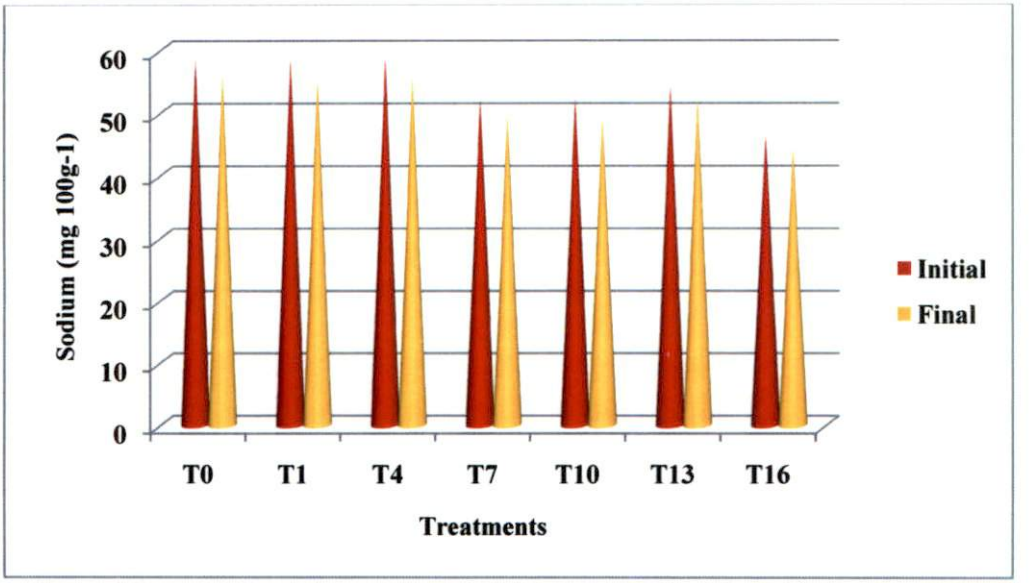


Coagulated with citric acid

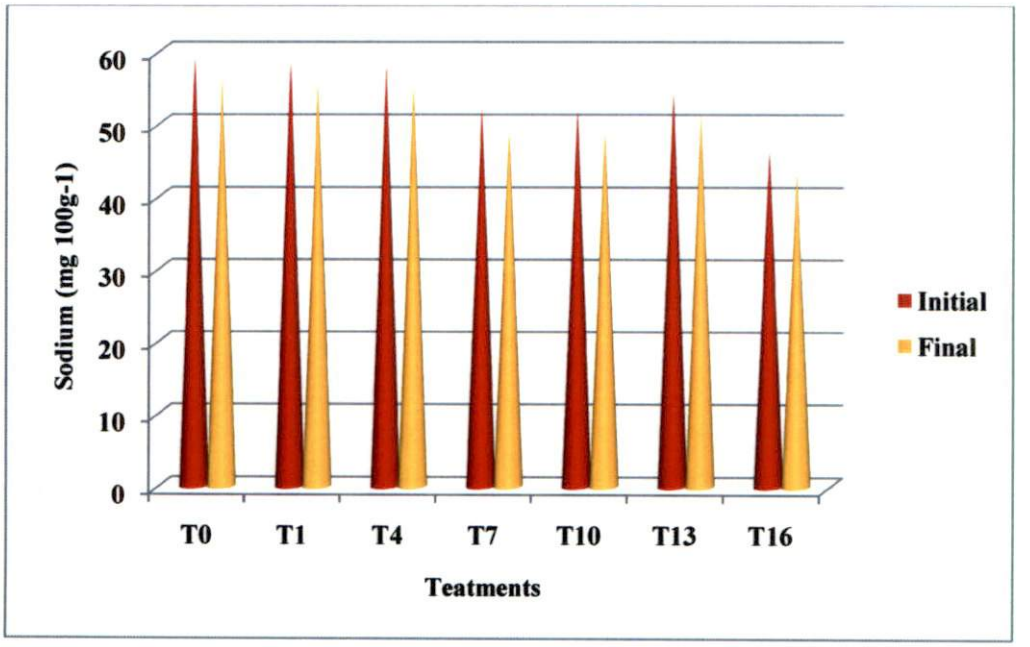


Coagulated with bilimbi juice

Fig. 12. Effect of storage on phosphorous content of coconut based filled paneer

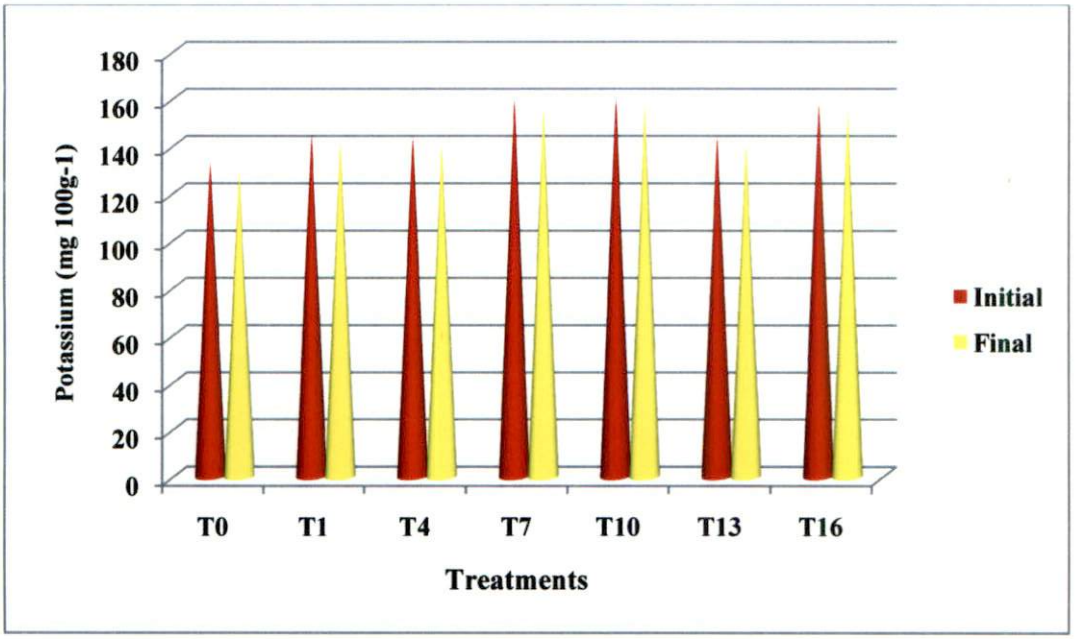


Coagulated with citric acid

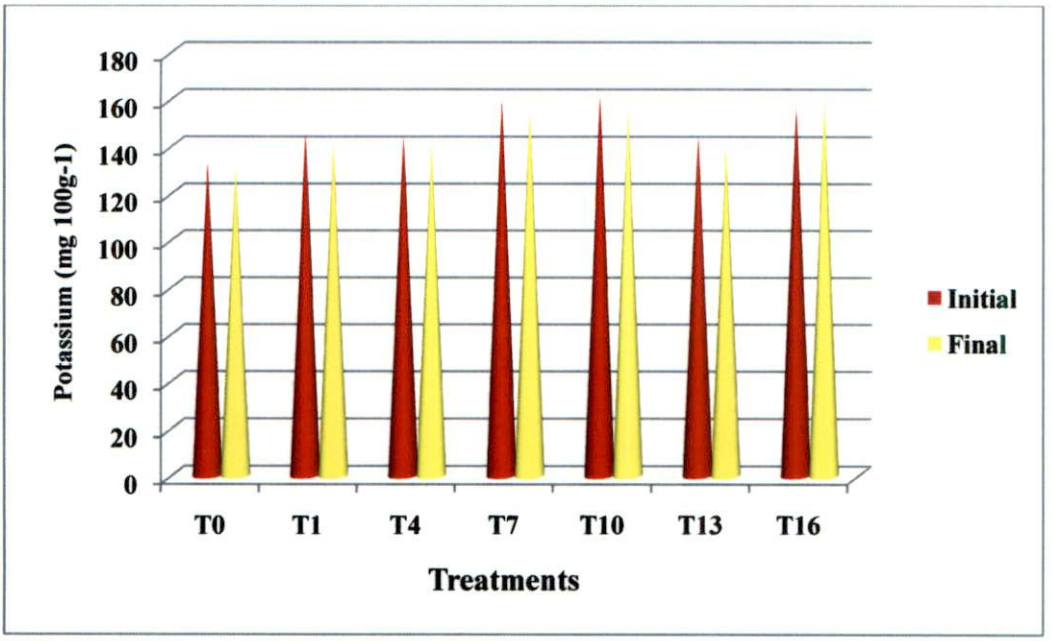


Coagulated with bilimbi juice

Fig. 13. Effect of storage on sodium content of coconut based filled paneer



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 14. Effect of storage on potassium content of coconut based filled paneer

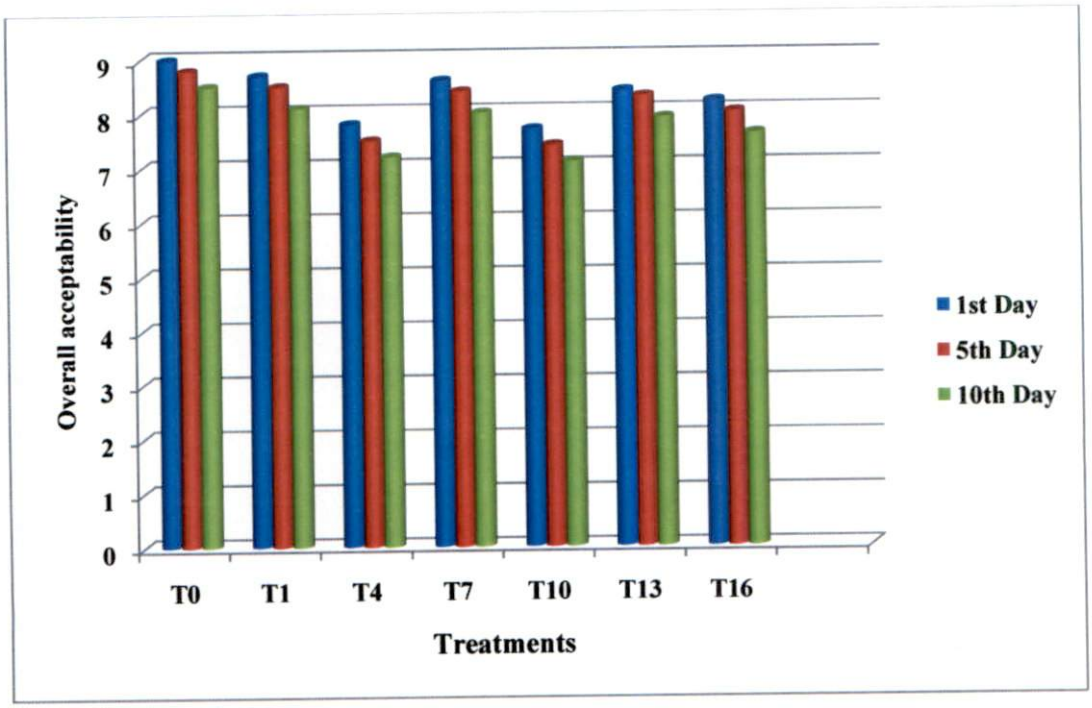
paneer should contain more amounts of sodium and potassium. The leaching of sodium and potassium during whey drainage may have resulted in lowers levels of these minerals in the final product. Goyal and Gandhi (2009) reported the sodium and potassium content in paneer whey as 350 mg/l and 1300 mg/ l respectively. Skim milk based filled paneer had lower sodium and higher potassium contents than whole milk paneer.

The calcium, phosphorus, sodium and potassium content of coconut based filled paneer decreased during ten days of storage. Sharon (2010) and Sarabhai (2012) also reported reduction in mineral content of products during storage. Significant difference was not noticed in mineral content of filled paneer with respect to coagulants.

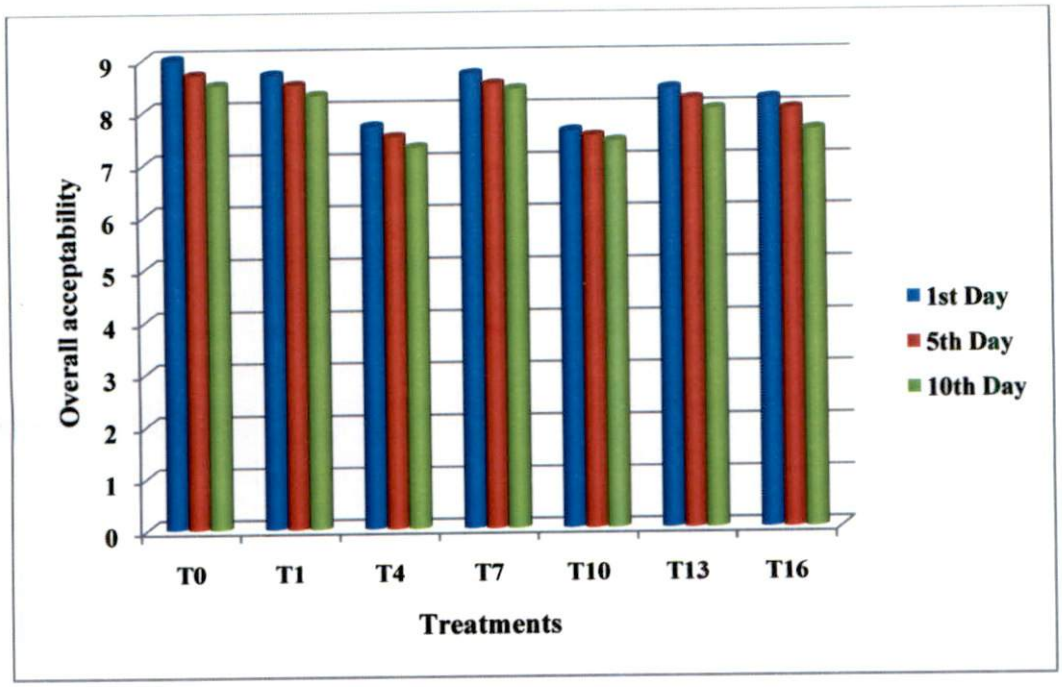
5.3.3. Organoleptic qualities of coconut based filled paneer during storage

The mean score for different organoleptic qualities of coconut based filled paneer prepared using citric acid and bilimbi juice was lower than the milk paneer in all periods under study. All the sensory parameters namely appearance and colour, flavour, body and texture and overall acceptability of filled paneer showed a decline during storage. The mean score for the overall acceptability of coconut based filled paneer preparedout of citric acid and bilimbi juice during storage is depicted in Fig. 15. Considerable reduction in moisture and increase in acidity of the product during storage might have negatively influenced the organoleptic qualities. Change in colour from creamish white to yellowish white and poor outer surface due to moisture loss also influenced the mean scores.

Agnihotri and Pal (1996) conducted a study to determine the quality and shelf life of goat milk paneer in refrigerated storage and reported change in colour from white to yellowish white especially on the outer surface. Sreeja and Jaya (2007) observed that the paneer stored under refrigeration temperature remained acceptable up to 15 days with negligible change in sensory evaluation score. Bhargave *et al.* (2007) revealed that the fat content plays an important role in determining the hardness and softness of the outer surface of paneer. There was reduction in fat



Coagulated with citric acid



Coagulated with bilimbi juice

Fig. 15. Mean scores for overall acceptability of coconut based filled paneer during storage

content of paneer during storage which may have also influenced the body and texture of paneer.

The mean score for overall acceptability of filled paneer also decreased during storage. Coconut milk incorporated filled paneer had mean score above 8.0 for overall acceptability even at the end of ten days of storage. Based on mean scores of organoleptic qualities, whole milk and coconut milk (T_1) combination was the most acceptable followed by skim milk + coconut milk (T_7) and whole milk + coconut milk +soy milk (T_{13}). David (2012) also reported that coconut milk incorporated functional paneer as an acceptable product based on sensory attributes.

5.3.4. Microbial qualities of coconut based filled paneer during storage

Microbial enumeration of coconut based filled paneer and milk paneer was carried out for contaminating bacteria, mold and yeast initially, on 5th day and 10th day of storage. The coliform count of the product was also enumerated.

The microbiological quality of paneer depends on the microbiological quality of milk, and the hygiene exercised during manufacture of paneer and its subsequent handling, packaging and storage. Microorganisms such as coliform, yeast and mold that might be present in raw milk get destroyed almost completely, when milk is heated at 90°C for 15 min. But these microbes may contaminate the product through a number of sources like air, water, equipment, knife, muslin cloth and persons handling the products (Aggarwal and Shrinivasan, 1980). These microbes can cause proteolytic and lipolytic changes, discoloration and other defects in the product (Thakral *et al.*, 1986). Paneer is highly susceptible to spoilage and does not keep good for more than a day at room temperature, the growth of bacteria yeast and molds are the major causes of spoilage (Nath *et al.*, 2007).

Bacterial count was noticed in all the products (1.4 to 1.7×10^4 cfu/g) initially itself where as the mold, yeast and coliform counts were not detected initially. FSSAI (2011) had given maximum permissible limits in paneer as not more than 50,000/g, total plate count (TPC), coliform not more than 90/g, yeast and mold not more than

250/g. The maximum total plate count noticed in the present study was $1.7x10^4$cfu/g initially in T_7 and T_{13} and it was found to be lower than the specified limits of $5x10^4$cfu/g suggested by FSSAI (2011).

Total bacterial count increased in all the products during storage. Much variation was not noticed in microbial count of filled paneer with respect to coagulants. Sachdeva *et al.* (1985), Pal *et al.* (1993) Sanyal *et al.* (2006) and Bukhari *et al.* (2012) also reported increase in microbial load during refrigerated storage of paneer and paneer like products. They have pointed out that the initial microbial load determines the shelf life of paneer in refrigerated storage. In the present study the initial microbial load was comparatively low and the increase in microbial population was not at a faster rate. The maximum TPC observed in different products at the end of storage was $2.6x10^4$cfu/g and it was found to be within the specified level by FSSAI (2011). The mold, yeast and coliform counts on 10^{th} day of storage was also found to be within the limits of $2.5x10^2$/g, and 90/g respectively specified by FSSAI (2011). Microbiologically, the product was safe even after 10 days of storage.

5.4. Cost of production of coconut based filled paneer

The cost incurred for the production of control paneer was Rs. 24.39 for 100 g. The cost of milk paneer available through the sales outlet of KVASU Dairy Plant is Rs.40/ 100g. Cost of production of coconut based filled paneer varied from Rs. 20.89 to Rs. 28.89. The computed cost was minimum for filled paneer prepared with whole milk and coconut slurry (T_4) and the maximum cost was noticed for the filled paneer prepared with skim milk and coconut milk + soy milk (T_{16}).The usage of tetra packs for skim milk and soy milk enhanced its cost of production. The cost of production for all coconut based filled paneer was found to be lower than the price of milk paneer available in the market. Replacing of milk fat with vegetable fat and usage of other filling agents are helpful in reducing the production cost of paneer.

Summary

5. SUMMARY

The study entitled "Standardisation and quality evaluation of coconut based filled paneer" was aimed to standardise the preparation of paneer incorporating coconut milk, coconut slurry and soymilk in different proportions and to evaluate the physical, chemical, nutritional, organoleptic and keeping qualities of the developed paneer. The feasibility of using natural coagulants in the preparation of paneer was also evaluated.

Coconut based filled paneer was standardised by replacing whole milk and skim milk with coconut milk, coconut slurry and coconut milk + soy milk at 80:20, 70:30 and 60:40 proportions. Eighteen different treatments were tried. Citric acid at a concentration of 1.5 per cent was used for coagulation of milk. Calcium chloride at 0.15 percent level was also used in all the treatments to improve the solid recovery.

With a view to find out the most appropriate combination for the preparation of coconut based filled paneer, the 18 treatments were evaluated for various organoleptic qualities like appearance and colour, flavour, body and texture and overall acceptability and compared with the characteristics of milk paneer. The mean score for different quality attributes showed a decreasing trend with increase in the proportion of coconut milk and coconut slurry.

The mean score for different quality attributes of filled paneer prepared out of coconut milk, coconut slurry and coconut milk and soymilk combination was comparatively lower than the control. Among the 18 different combinations tried for the standardisation of filled paneer, maximum mean score for different quality attributes was noticed in combinations of whole milk and skim milk with coconut milk, coconut slurry, coconut milk + soy milk in 80:20 proportions.

Compared to control, the filled paneer had better yield. The yield of paneer prepared with 100 percent cow milk was 14.60 percent. The yield of filled paneer varied from 15.15 (T_7) to 23.80 (T_6) per cent. The yield of filled paneer increased with

increase in the proportion of coconut milk and coconut slurry and maximum yield was noticed in filled paneer prepared out of coconut slurry.

From the eighteen treatments (T_1 to T_{18}), highly acceptable filled paneer one each from whole milk and skim milk with coconut milk, coconut slurry and coconut milk+ soymilk, totaling six treatments were selected for further studies based on their mean scores for different quality attributes. The selected treatments were T_1 (whole milk: coconut milk), T_4 (whole milk: coconut slurry), T_7 (skim milk: coconut milk), T_{10} (skim milk: coconut slurry), T_{13} (whole milk: coconut milk+ soy milk) and T_{16} (skim milk: coconut milk+ soy milk). Paneer prepared using whole milk was also selected for further studies as control.

For evaluating the feasibility of using natural coagulants in the preparation of paneer, extracts of fully ripened fruits like lemon (control), raw mango, bilimbi, garcinia, tamarind and carambola were used after standardising the acidity of juices to 1.5 per cent. Maximum mean score for different attributes was noticed in milk paneer coagulated with lemon juice followed by bilimbi juice.

The yield of milk paneer prepared with lemon juice as natural coagulant (control) was 18.87 per cent. The yield of milk paneer coagulated using other fruit juices varied from 16.47 to 18.76 per cent. Maximum yield was noticed for milk paneer coagulated with bilimbi juice and minimum was noticed for milk paneer prepared with juice of raw mango.

From the different fruit juices used as natural coagulants, the most ideal fruit juice for the preparation of filled paneer was selected based on organoleptic scores and yield of milk paneer. Lemon juice was selected for further studies as control. Among other coagulants used, maximum yield and highest organoleptic scores for different quality attributes was noticed for milk paneer coagulated using bilimbi juice. Thus, bilimbi juice was selected as the most ideal natural coagulant for the preparation of filled paneer.

The selected six coconut based filled paneer from T_1 to T_{18} and the selected paneer prepared using bilimbi juice as natural coagulant along with controls (Cow milk paneer coagulated using citric acid and lemon juice) were packed in polythene covers and stored under refrigerated condition at 4 ± 1^0C for ten days. The products were evaluated for various physical, chemical, organoleptic and microbiological qualities initially, on 5th day and 10th day of storage. Nutritional qualities of the product were evaluated initially and on 10th day of storage.

Wide variation in the yield of milk paneer as well as filled paneer was noticed when it was determined through out the experiment. Compared to control, better yield was noticed for filled paneer coagulated using citric acid as well as bilimbi juice and the highest yield was noticed for filled paneer prepared out of whole milk and coconut slurry (T_4). The weight of filled paneer decreased gradually with advancement in days of storage. Compared to milk paneer, the percentage loss in weight was lower in filled paneer coagulated with citric acid in both periods under study.

A decrease in mean scores for appearance and colour of coconut based filled paneer was observed in all the products with advancement in days of storage. The highest and the lowest mean score for appearance and colour was noticed in filled paneer prepared using whole milk and coconut milk T_1 (80:20) and skim milk and coconut slurry T_{10} (80:20) coagulated with citric acid and bilimbi juice respectively in all periods under study.

The moisture content in filled paneer prepared by coagulating with citric acid and bilimbi juice varied from 55.17 to 58.57 per cent initially. The moisture content of coconut slurry based filled paneer was lower than the coconut milk based ones. In soya milk incorporated filled paneer too the moisture content significantly differed from other filled products. The moisture content in all the products decreased gradually with advancement in days of storage. At the end of storage, the moisture content in filled paneer was significantly lower than the control.

The titrable acidity and pH of filled paneer prepared initially ranged from 0.220 to 0.230 per cent and 5.60 to 6.20 respectively. Wide variation in titrable acidity

and pH was not noticed with respect to coagulants. The pH of all the products decreased in accordance with increase in titrable acidity during storage.

Compared to control, the total solids was higher in coconut based filled paneer prepared using both coagulants in all periods under observation. Initially, the total solid in coconut based filled paneer prepared using citric acid, varied from 41.83 to 44.83 per cent. In filled paneer prepared using bilimbi juice, the total solid was 41.43 and 44.70 per cent. Maximum total solid recovery was noticed in filled paneer prepared out of coconut slurry. An increase in the total solid content was noticed during storage of filled paneer.

The protein content of coconut based filled paneer prepared using citric acid, initially varied from 18.51 to 24.62 per cent and in paneer prepared using bilimbi juice the content was between 18.54 to 24.57 per cent. The protein content of all the filled products significantly differed from milk paneer (18.53 and 18.27 per cent) in all evaluations. Slight variation in protein content of filled paneer was observed with respect to coagulants. Skim milk based paneer had comparatively higher protein content than other treatments. The protein content decreased in all the products during storage.

Skim milk based filled paneer had lower fat content than whole milk based filled paneer and milk paneer (control). Whole milk based filled paneer had higher fat content (24 to 25 per cent) than milk paneer in all periods under study. Variation in fat content of filled paneer was not noticed with respect to coagulants in all periods under study. The fat content in all the products decreased significantly during ten days of storage.

An increase in free fatty acid content was noticed in coconut based filled paneer prepared using both coagulants and in milk paneer during storage. With respect to coagulants no variation was noticed in the free fatty acid content of filled paneer.

Compared to control, lower ash content was noticed in whole milk based filled paneer. Initially, the ash content in filled paneer coagulated with citric acid and bilimbi

juice varied from 2.30 to 2.57 per cent which decreased during ten days of storage. Significant variation in ash content of whole milk and skim milk based filled paneer was noticed through out the period of storage. The decrease in ash content during storage was statistically insignificant.

The calcium content of milk paneer was 198.33 mg $100g^{-1}$ which decreased slightly during storage. The calcium content of whole milk based filled paneer was significantly lower than the control. The highest calcium content was seen in skim milk based filled paneer. The phosphorous content in skim milk based filled paneer was lower when compared to whole milk paneer and control, initially and on tenth day of storage. The sodium content in filled paneer was lower than the control throughout the period under study where as the potassium content was higher. The calcium, phosphorus, sodium and potassium content of coconut based filled paneer decreased during ten days of storage.

The mean score for different organoleptic qualities of coconut based filled paneer prepared using citric acid and bilimbi juice was lower than the milk paneer (control) through out the storage period. All the sensory parameters namely, appearance and colour, flavour, body and texture and overall acceptability of filled paneer showed a decline during storage. Coconut milk incorporated filled paneer had mean score above 8.0 for overall acceptability even at the end of ten days of storage. Based on mean scores of organoleptic qualities whole milk and coconut milk combination was the most acceptable followed by skim milk + coconut milk and whole milk + coconut milk +soy milk.

Bacterial count was noticed in all the products initially itself where as the mold, yeast and coliform counts were not detected initially. Much variation was not noticed in microbial count of filled paneer with respect to coagulants. Total bacterial count increased in all the products during ten days of storage. Presence of yeast was noticed on tenth day of storage. The presence of mold and coliform was detected in filled paneer on fifth day of storage which gradually increased by ten days of storage.

The cost incurred for the production of control paneer was Rs. 24.39 for 100 g. Cost of production of coconut based filled paneer varied from Rs. 20.89 to Rs. 28.89. The computed cost was minimum for filled paneer prepared with whole milk and coconut slurry (T_4) and the maximum cost was noticed for the filled paneer prepared with skim milk and coconut milk + soy milk (T_{16}).

From this study, it is clear that fillers can be successfully used in the manufacture of paneer. The major concern with milk paneer is its high fat content especially saturated fat. Reducing the fat content of paneer to a greater extent will affect the product quality. So, replacing milk fat with healthy vegetable fat in paneer production is ideal and economical. Skim milk based filled paneer, although not in compliance with FSSAI product specifications for paneer, is a healthy product, since it is very low in fat. Coconut is now considered as a functional food. Although saturated, the lauric acid component of coconut is considered as an ideal dietary fat. It does not contain cholesterol and is easily metabolized in the body for energy purposes and helps to reduce fat accumulation in the body. In the rapidly changing socio-economic scenario, novel ways of value addition are essential to meet consumer needs for health foods.

Future line of the study

- Evaluation of cooking qualities of coconut based filled paneer
- Usage of other filling agents like starch powder for improving the textural properties of filled paneer

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Appendix

APPENDIX –I

Score card for organoleptic evaluation of Coconut based filled paneer

Name of the judge:
Date:

Sl.No.	Characteristics	1	2	3	4	5	6	7
1.	Colour and appearance							
2.	Body and texture							
3.	Flavour							
4.	Overall acceptability							

Evaluate the product on the basis of the scores given below

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

Signature

APPENDIX-II

1. **Cost of production for100 g of whole milk and coconut milk based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Whole milk	420	14.00
	Coconut milk	105	6.00
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15 minutes	2.50
Total			**26.39**

2. **Cost of production for 100 g of whole milk and coconut slurry based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Whole milk	360	12.00
	Coconut slurry	90	2.50
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15 minutes	2.50
Total			**20.89**

3. **Cost of production for 100 g of skim milk and coconut milk based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Skim milk	440	15.00
	Coconut milk	105	6.00
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15minutes	2.50
Total			**27.39**

4. **Cost of production for 100 g of skim milk and coconut slurry based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Skim milk	390	13.00
	Coconut slurry	95	2.50
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15minutes	2.50
Total			**21.89**

5. **Cost of production for 100 g of whole milk and coconut milk + soy milk based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Whole milk	440	15.00
	Coconut milk	55	3.00
	Soy milk	55	4.00
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15 minutes	2.50
Total			**28.39**

6. **Cost of production for 100 g of skim milk and coconut milk + soy milk based filled paneer**

Sl. No	Items	Quantity	Cost (Rupees)
1.	**Raw materials**		
	Skim milk	445	15.50
	Coconut milk	55	3.00
	Soy milk	55	4.00
	Citric acid	0.75	0.36
	Calcium chloride	0.75	1.00
	Polythene cover	1Nos	1.00
2.	**Other**		
	Electricity charge		0.03
	LPG	15 minutes	1.50
	Labour cost	15 minutes	2.50
Total			**28.89**

STANDARDISATION AND QUALITY EVALUATION OF COCONUT BASED FILLED PANEER

By

SUVARNA MOHAN
(2011-16-104)

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

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(FOOD SCIENCE AND NUTRITION)

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Kerala Agricultural University

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ABSTRACT

The present study entitled "Standardisation and quality evaluation of coconut based filled paneer" was undertaken to standardise the preparation of paneer incorporating coconut milk, coconut slurry and soy milk in different proportions and to evaluate the physical, chemical, nutritional, organoleptic and keeping qualities of the developed paneer. The study was also aimed to assess the practical feasibility of using natural coagulants in the preparation of paneer.

The standardisation of coconut based filled paneer was carried out in 18 different treatments by replacing whole milk and skim milk with coconut milk, coconut slurry and coconut milk and soy milk in combination at 20, 30 and 40 per cent levels. To find out the most appropriate combination for the preparation of coconut based filled paneer, the treatments were evaluated for various organoleptic qualities in comparison with milk paneer (control). The yield of filled paneer was also recorded.

The mean score for different quality attributes of filled paneer was comparatively lower than the milk paneer. Maximum mean score for different quality attributes was noticed in combinations of whole milk and skim milk with coconut milk, coconut slurry and coconut milk + soy milk in 80: 20 proportions and selected (6 treatments) for further studies. The yield of filled paneer increased with increase in the proportion of coconut milk and coconut slurry and maximum yield was noticed in filled paneer prepared out of coconut slurry.

For evaluating the feasibility of using natural coagulants in the preparation of paneer, extracts of fully ripened fruits were used after standardising the acidity of juices to 1.5 per cent. Maximum mean score for organoleptic qualities and maximum yield was noticed for milk paneer coagulated with bilimbi juice and it was selected as the most ideal natural coagulant for the preparation of filled paneer.

The selected six coconut based filled paneer were prepared using citric acid and bilimbi juice, packed in polythene covers and stored under refrigerated condition at 4 ± 1^0C for ten days. The products were evaluated for various physical, chemical, nutritional, organoleptic and microbiological qualities.

Wide variation in the yield of milk paneer as well as filled paneer was noticed when it was determined through out the experiment. Compared to control, better yield was noticed for coconut slurry based filled paneer. The moisture content in coconut slurry based filled paneer was lower than the coconut milk based ones and it decreased gradually with advancement in days of storage resulting in weight loss of filled paneer.

The pH of all the products decreased in accordance with increase in titrable acidity during storage. Maximum total solid recovery was noticed in filled paneer prepared out of coconut slurry. An increase in the total solid content was noticed during storage of filled paneer.

Slight variation in protein content of filled paneer was observed with respect to coagulants. Skim milk based paneer had comparatively higher protein content and lower fat content than whole milk based filled paneer. An increase in free fatty acid content was noticed in coconut based filled paneer prepared using both coagulants during storage.

Significant variation in ash content of whole milk and skim milk based filled paneer was noticed through out the period of storage. The ash, calcium, phosphorus, sodium and potassium content of coconut based filled paneer decreased during ten days of storage.

The mean score for different organoleptic qualities of coconut based filled paneer was lower than the milk paneer throughout the storage period. Based on mean scores of organoleptic qualities whole milk and coconut milk combination was the most acceptable followed by skim milk + coconut milk and whole milk + coconut milk +soy milk.

The initial microbial load was comparatively low in all the products and the increase in microbial population was not at a faster rate. The microbial load on tenth day of storage was found to be with in the range of FSSAI standards specified for paneer.

Cost of production of coconut based filled paneer varied from Rs.20.89 to Rs. 28.89 per 100g. The cost of production for all coconut based filled paneer was found to be lower than the price of milk paneer available in the market. Replacing of milk fat with vegetable fat and usage of other filling agents are helpful in reducing the production cost of paneer.