TECHNOLOGICAL ASPECTS ON RASMALAI AN INDIGENOUS CHHANA BASED SWEET

BY

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92AS91D

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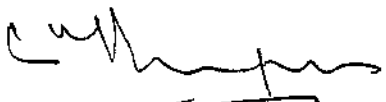
Grand Mother

CERTIFICATE-I

This is to certify that the thesis entitled **"Technological aspects on Rasmalai an Indigenous Chhana based Sweet"**, submitted for the degree of **Doctor of Philosophy** in the subject of **Animal Products Technology**, of the CCS Haryana Agricultural University, is a bonafide research work carried out by **Mr. Suraj Pal Sharma** under my supervision and that no part of this thesis has been submitted for any other degree.

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

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CERTIFICATE-II

This is to certify that the thesis entitled "**Technological aspects on Rasmalai an Indigenous Chhana based Sweet**", submitted by **Mr. Suraj Pal Sharma** to the CCS Haryana Agricultural University, in partial fulfillment of the requirements for the Degree of **Doctor of Philosophy**, in the subject of **Animal Products Technology**, has been approved by the Student's Advisory committee after an oral examination on the same, in collaboration with an External Examiner.

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Hisar

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CONTENTS

CHAPTER NO.	DESCRIPTION	PAGES
I	INTRODUCTION	1-4
II	REVIEW OF LITERATURE	5-35
III	MATERIAL AND METHODS	36-47
IV	RESULTS AND DISCUSSION	48-96
V	SUMMARY AND CONCLUSION	97-111
	LITERATURE CITED	i-x
	APPENDIX	i-iv

LIST OF TABLES

Table No.	Description	Page(s)
1.	Survey of Existing Technology of Rasmalai	52-54
2 (a).	Composition of rasmalai (market samples)	60
2 (b).	Composition of rasmalai (market samples)	61
3.	Sensory scores of Rasmalai for market samples	68
4.	Standardization of semolina level in Rasmalai	76
5.	Standardization of sugar level in Rasmalai	76
6.	Changes in mean values of moisture content of the Rasgulla in the product during storage	84
7.	Changes in mean values of moisture content of the concentrated milk during storage	84
8.	Changes in mean values of acidity (% lactic acid) of the Rasgulla in the product during storage	86
9.	Changes in mean values of acidity (% lactic acid) of the concentrated milk during storage	86
10.	Changes in mean values of pH of the Rasogolla in the product during storage	87
11.	Changes in mean values of pH of concentrated milk during storage	87
12.	Changes in mean values of TBA of the Rasgulla in the product during storage	89
13.	Changes in mean values of TBA of the concentrated milk during storage	89

14.	Changes in mean values of free fatty acid (% Oleic acid) content of the Rasogolla in the product during storage	91
15.	Changes in mean values of free fatty acid (% Oleic acid) content of the concentrated milk during storage	91
16.	Changes in mean values of colour and appearance of sensory evaluation scores during storage	93
17.	Changes in mean values of body and texture of sensory evaluation scores during storage	93
18.	Changes in mean values of flavour of sensory evaluation scores during storage	95
19.	Changes in mean values of overall acceptability of sensory evaluation scores during storage	95

LIST OF FIGURES

Figure No.	Description	After Page(s)
1.	Receiving of milk for Rasogolla making	70
2.	Heating of Milk	70
3.	Cooling of the milk	70
4.	Temperature checking	70
5.	Addition of whey as coagulant	71
6.	Coagulated milk holding	71
7.	Transfer of coagulated milk for filtration	71
8.	Filtered coagulum mass	71
9.	Hanging of chhana for whey removal	71
10.	Cooling of chhana	71
11.	Pressing of chhana	71
12.	Manual rolling of chhana	71
13.	Testing of chhana	72
14.	Transferring of chhana on wooden planks	72
15.	Rolling of chhana for ball making	72
16.	Making of chhana balls	72
17.	Heating of sugar syrup	73
18.	Transfer of chhana balls to boiling sugar syrup	73

19.	Cooking of Rasogolla	73
20.	Checking of cooked balls	73
21.	Completion of Rasogolla cooking	74
22.	Transfer of Rasogolla from boiling sugar syrup	74
23.	Sugar Syrup for dipping of Rasogolla	74
24.	Dipping and cooling of Rasogolla	74
25.	Receiving of Buffalo milk	74
26.	Transfer of milk for heating	74
27.	Transfer of milk for heating	74
28.	Boiling of milk to desired concentration	74

CHAPTER-I

Introduction

India has emerged as the world's largest milk producing country. India's milk production during 2002 is estimated to be 81 million tonnes per annum. It is projected that during 2009-2010 the milk production in our country would reach 115 million tonnes at an expected growth rate of 4 per cent in milk production (Chennegowda, 2002 and Vaswani, 2002).

Traditional dairy products have played a significant role in the economic, social, religious and nutritional well being of our people since time immemorial. It is estimated that about 50-55 per cent of milk (approx. 42 million tons) produced is converted by the traditional sector (halwais) into variety of Indian milk products, (Banerjee, 1997). The market for Indian milk products, is estimated to be of the order of Rs. 250 billion. This fact underlines the

significance of traditional dairy products in the national economy. In spite of such a great importance of traditional dairy products in our country these products are still produced manually in the small sector with variable quality depending upon the skill of the halwais. There is hardly any quality control and shelf life is poor. The current methods for manufacture of these products are primitive and based on techniques that essentially remained uncharged over ages.

Traditional dairy products of India can be classified into the following broad categories.

1. Fat rich products (*Ghee*, makhan and Malai)
2. Concentrated products (Khoa, Khoa based sweets, basundi and *rabri*)
3. Coagulated products (*Chhana*, channa based sweets and paneer)
4. Fermented products (*Dahi*, misti - doi, chakka, *Srikhand* and lassi)
5. Frozen products (*kulfi* and kulfa)

Indigenous dairy products of India is a novelty segment for international dairy market, which can give India entrepreneurs an edge over their competitors. But producing these products hygienically and imparting them long shelf

life calls for thorough knowledge of their physico-chemical attributes.

The increased demand of milk sweets influenced by the nutritional and social values attached to each of them, led to produce them under the traditional sector by small scale traders and halwais using primitive techniques. These products of masses are very much region specific and have large variations, in physical, chemical, sensory, textural and microbiological quality. Industrial method on a factory scale production have been developed during last 10 years for mechanized production, packaging and storage of khoa, *chhana, paneer, ghee, dahi, gulabjamun, kulfi, peda, resogolla, kalakand* and *Srikhand* (Parsad and Katre, 2002).

Chhana is obtained from milk by heating and acidifying it by the use of a suitable coagulant. Sour whey, citric acid, lactic acid and calcium lactate are generally used as the coagulants. Whey is predominantly used for coagulating the milk. *Chhana* is base material used for preparation of Rasogolla *Sandesh, Rasmalai* (Jonkman and Das, 1993; Singh 1994; Chaudhary *et al*; 1998)

Rasmalai is a milk product containing about 60% total solids including sugar as the sweetening agent. This sweet has extremely delicate texture and taste. *Chhana* and

rabri are used as base materials for preparation of *rasmalai*, *chhana* is required for Rasogolla preparation and *rabri* is required for dipping these *rasogollas* before serving. It is popular in eastern northern part of India. Very scanty literature is available on this product. Thus it was felt desirable to standardize the technology of *rasmalai* preparation so that the possibilities for its large scale commercial manufacture may be explored. Hence this study was proposed with the following objectives:

1. To conduct survey of existing technology of *rasmalai* preparation.
2. To determine physico-chemical, bacteriological and sensory attributes of the product.
3. To standardize technology of the product.
4. To enhance shelf life of the product by using suitable preservative and microwave heat treatment.

CHAPTER-II

Review of Literature

The relevant literature on "*Rasmalai*" on its technology, composition , microbiological quality and nutritional aspects is very scanty. However, the relevant available literature on its base product *chhana*, rasogolla and *rabri* have been reviewed in this chapter under the following heads.

2.1 Technology of *Chhana* preparation

2.2 Composition and yield of *chhana*

2.3 Technology of Rasogolla preparation

2.4 Composition and yield of Rasogolla

2.5 Factors controlling physico-chemical characteristics of Rasogolla

2.5.1 Effect of composition of milk and *chhana* on Rasogolla.

2.5.2. Effect of body and texture of *chhana* on Rasogolla.

2.5.3. Effect of concentration of cooking sugar syrup in Rasogolla.

2.5.4. Effect of time and temperature of cooking on Rasogolla.

2.5.5. Effect of repeatedly use of cooking syrup and evaporation of water on Rasogolla.

2.5.6. Effect of acidity of sugar syrup on Rasogolla.

2.6 Physical deterioration of Rasogolla during processing and storage

2.6.1. Browning/discoloration

2.6.2. Loss of crispness

2.7 Technology of *Rabri* Preparation

2.8 Composition of *Rabri*

2.9 Bacteriological quality of *RABRI*

2.10 Preservation of ingredients used in *Rasmalai*

2.10.1. *Chhana*

2.10.2. Rasogolla

2.11 *Rasmalai* Technology

2.12 Microbiological quality

2.13 Preservation

2.1 Technology of *Chhana* preparation

According to the PFA Rules (1976) *chhana* or *paneer* is the product obtained from 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 per cent moisture and the milk fat content should not be less than 50 percent of the dry matter.

De and Ray (1954) reported the *chhana* preparation from cow milk standardized to 4.0 to 4.5 per cent fat, SNF/fat ratio of about 2.0, heated to boiling point for few seconds, cooled to 82°C, then coagulated by adding 1.0 to 2.0 per cent citric or lactic acid solution (pH of whey 5.4 per cent) cool down to room temperature, then after straining the coagulum (*chhana*) ceased to drip.

Chander shekh ra *et al.* (1957) treated buffalo milk with a mixture of sodium dihydrogen phosphate (9 g) and disodium monohydrogen phosphate (7 g) or 0.1 to 0.2 per cent Sodium Citrate for every 12 ltrs of milk. Treatment of milk with these chemicals resulted in the production of *chhana* which was quite soft. The rasogolla prepared from it was also found to be quite satisfactory.

Davis (1958), Srinavasan and Anantkrishanan (1964) reported two methods i.e. small scale and commercial

method of *chhana* making. In small scale, juice of ripen citrus lime was used as a coagulant whereas acid whey (0.8 to 0.9% acidity) in commercial method of *chhana* making.

Jagtiani *et al.* (1960) demonstrated that more the amount of calcium added to the milk, the harder was the *chhana.* Addition of 0.2 to 0.3 per cent sodium citrate as softening agent and storing the hot milk for sometime before precipitation helped in production of a very soft *chhana.*

Srinivasan and Anantkrishnan (1964) suggested sour whey as coagulant. They also suggested citric acid or lactic acid (2 per cent solution) as coagulant in another approach. Whereas, Bhattacharya *et al* (1971) suggested one per cent citric acid solution as coagulant.

Kundu and De (1972) outlined method of producing *chhana* from buffalo milks standardized to 5.0 per cent fat and homogenized at 176 kg/cm (after preheating to 60°C), brought it to boil and promptly cooled to 70°C and then rapidly coagulated by addition of 1 per cent citric acid to pH 5.7.

Singh and Ray (1977) used citric acid, lactic acid and sour *chhana* whey as coagulants in the preparation of *chhana.* According to them *chhana* obtained with citric acid was soft and smooth, without sour taste where those of lactic

acid and sour whey resulted in hard and granular product with slight sour taste. The yield of *chhana* was 20 percent with sour whey and 18 per cent with citric and lactic acids.

Gera (1978) and Aneja *et al.* (1982) had also suggested the use of sour whey for producing soft quality *chhana* suitable for rasogolla making. The use of calcium lactate as a coagulant for *chhana* making is very common in West Bengal (Chakravarti, 1982). Calcium lactate produced *chhana* is with bright white colour, soft body, smooth texture and pleasant flavour. This *chhana* could be used for *Sandesh* prepration (Sen and De, 1984).

Soni *et al.* (1979) studied the use of buffalo milk for rasogolla manufacture. Buffalo's milk, boiled then left to cool to 70°C was coagulated with 0.5 per cent lactic acid to whey pH of 5.7. After separation of the coagulum (*chhana*) using a muslin cloth, it was kneaded with suji, maida and sammunder jhag and roll into balls. After cooking the *chhana* balls in 80 per cent sugar solution, the resulting *rasogollas* were preserved in 40 per cent sugar solution at 10°C. Composition of rasogolla was 37 per cent moisture, 51.9 per cent sucrose, 6.8 per cent protein and 4.2 per cent fat. The product was acceptable in appearance, colour, taste and texture.

Bhattacharya and Desh Raj (1980a,b) standardized milk 3.0 to 4.0 per cent fat, boiled for few seconds and cooled to 80-90°C. Milk was precipitated using 0.8 per cent citric acid solution. Coagulated mass was held for 5-10 minutes before the whey drained out. Product was cooled for 20-30 minutes in running tap water.

De (1980) recommended that a minimum fat content of 4·0per cent in cow milk and 5·0per cent in buffalo milk was essential to obtain *chhana* with satisfactory body and texture.

Soni *et al.* (1980) prepared *chhana* by the method described by De and Ray (1954), using buffalo milk, with certain modifications. One kg of buffalo or cow milk or a combinations was made to boil and allowed to cool to 70°C, then coagulated with 0.5 per cent lactic acid solution (pH of whey 5.7) and was allowed to cool down to about 25°C. After straining, the coagulam (*chhana*) was dipped in tap water (15 to 20 minutes) and hung till *chhana* ceased to drip.

Murthy and Rao (1982) studied production and quality of *chhana* from goat milk. *Chhana* prepared from goat milk of 3, 4 or 5 per cent fat using lactic acid, sour whey or citric acid as coagulant was compared with *chhana* made from cow milk of 4·0per cent fat. The *chhana* was tested for

moisture content, fat losses in whey, organoleptic quality and yield. Rasogolla made from *chhana* was also tested for its quality. Goat milk of 5.0 per cent fat with citric acid as coagulant resulted in higher yields.

Sen and De (1984) studied the use of calcium lactate as a coagulant for *chhana* (milk coagulate) indicated that yield is higher (23.6 and 24.8%) when compared to citric acid (16.8 and 18.%) at coagulation temperatures of 85 and 80°C, respectively. Higher yield is attributed to better retention of moisture and higher recovery of milk solids. Sensory evaluation revealed that colour, body and texture and flavour (taste) of calcium lactate *chhana* were significantly different from that of citric acid channa, taste of whey also was different.

Chaudhary *et al* (1998) studied the effect of heat treatment during heating and cooling of cow and buffalo milk for preparation of *chhana* and recovery of solids in *chhana* were studied. Whey protein denaturation used as the parameter, describing the heat treatment of milk. When the whey protein denaturation was varied from 0.485 to 6.642, the recovery of milk solids ranged from 0.512 to 0.649 kg/kg milk solids for cow milk and 0.535 to 0.649 kg/kg milk solids for buffalo milk. The recovery of milk solids increased, when

the milk attained lower whey protein denaturation during its heating and cooling prior to acidification. For low whey protein denaturation, it was necessary that milk should be subjected to a temperature over 75°C for a possible short duration. A fast cooling rate was found to be more desirable than fast heating rate.

Puranik and Nawalkar (1999) reported the feasibility of using recombined milk (RCM) in the manufacture of *chhana*. RCM was prepared by mixing dried skim milk, butter oil and H_2O in a blender, followed by heating and homogenization. RCM and whole milk blends were also prepared. The moisture content in *chhana* decreased with increase in the level of RCM in the blend. The decrease in moisture content was directly proportional to the yield of these products. Sensory evaluation indicated that *chhana* of acceptable quality could be obtained from blended RCM. Texture profile analysis for RCM milk products showed that hardness increased with increase in the RCM level. Springness, gumminess and chewiness also increased as the RCM level increased.

A process has been developed for the manufacture of good quality *chhana* using skim milk ultra-filtered/di-filtered retentate and plastic cream (Sharma and Reuter,1991). Heat treated (92°C for 5 min) skim milk is

subjected to ultra-filtration followed by di-filtration (23% TS) and the resultant retentate is mixed with plastic cream and mixture is heated to 90°C for 5 min and coagulated with lactic acid to develop soft coagulum. The granular mass is pressed to remove free moisture, yielding *chhana.* The yield of the process is 18-19 per cent extra due to recovery of whey protein.

For the preparation of rasogolla, *chhana* is kneaded to a homogenous and smooth dough, which is then made into balls and cooked in boiling sugar syrup. Cow milk is preferred, which yields soft, smooth and spongy rasogolla. The important factors which influence the textural properties of rasogolla are the moisture content and acidity of *chhana*, the fat and solid-not-fat content of milk from which *chhana* has been produced, the time and temperature of cooking the *chhana* balls in sugar syrup and the degree of kneading of *chhana* (Ten Hove and Das, 1995; Tarafdar *et al.*, 1998).

The proteins in buffalo milk were modified by partial hydrolysis using trypsin immobilized on CM sephadex. Hydrolysed milk was then used to produce *chhana.* The overall textural quality of *chhana* prepared from protein modified buffalo milk differed significantly compared to the control. Firmness and chewiness attributes were improved

and the *chhana* possessed soft body and smooth texture. Rasogolla prepared from modified milk *chhana* was also judged to have better firmness, chewiness and sponginess. (Pushpa and Bhat, 1997)

Aneja *et al* (1982) developed a prototype continuous *chhana* making machine involving tubular heat exchanger, acid injection chamber, holding coil and strainer. A process has been developed on similar principle for the mechanized production of *chhana* at IIT, Kharagpur, which involves indirect heating of milk in a tubular heat exchanger to 95°C, cooling to 70°C, continuous coagulation with hot citric acid (70°C) in a vertical tube, holding milk-acid mixture to permit complete coagulation, separation of whey in a continuous flow employing double wall basket cabinets and chilling to 4°C by directly spraying chilled water on the layer of *chhana* (Singh, 1994).

Developments have also been made in mechanization of *chhana*-based sweets. Kumar *et al.* (1997) designed a screw conveyor for kneading of *chhana* and a cutter provided at the exit spit the *chhana* into lumps and 10 g each. The lumps are made to fall on a spinning disc and stationary disc above, which converts lumps of *chhana* into round balls. Another machine has recently been developed at NDRI, Karnal which

involves kneading of *chhana* using screw conveyor, portioning *chhana* into lump of 10 g each with a cutting device and ball formation in a revolving cylinder (Chaudhary *et al*, 2001).

2.2 Composition and yield of *chhana*

An average composition of cow and buffalo milk *chhana* studied by the different workers is presented in the form of table

Type of milk	Moisture	Fat	Protein	Lactose	Ash	References
Cow milk	53.4	24.7	17.6	2.2	2.1	Srivnivasan and Anantkrishnan (1964)
Cow milk	-	26.35	21.36	-	–	Jagtap and Shukla (1973)
Cow milk	51.62	24.20	-	-	–	Bhattacharya and Desh Raj (1980)
Buffalo milk	61.99	38.01	29.18	-	–	Soni *et al* (1980)
Cow milk	43.43	22.37	16.48	3.06	1.50	Bogra (1988)
Buffalo milk	46.21	24.50	17.10	2.57	2.03	Bogra (1988)

Table revealed that moisture content of cow milk *chhana* varied between 43.43 to 53.4, whereas in buffalo milk it varied between 46.21 to 61.99. The fat content in cow

milk *chhana* varied between 22.37 to 26.35 while in buffalo milk *chhana* it varied between 24.50 to 38.01 percent, Protein percent in cow milk *chhana* varied between 16.48 to 21.36 whereas in buffalo milk it varied between 17.10 to 29.78. Lactose percent varied between 2.2 to 3.06 in cow milk *chhana* and in buffalo milk it was 2.57. The ash content in cow milk *chhana* varied between 1.50 to 2.1 and in buffalo milk it is 2.03.

2.3 Technology of Rasogolla preparation

Srinivasan and Anantkrishanan (1964) used the following ingredients for the preparation of rasogolla : *chhana* (of cow milk) 400 g. cane sugar : 1.5 kg, corn flour : 50-100 g, barned (edible camphor): 50 mg powdered cardamom: 1 g and baking soda : 50 g.

Singh and Ray (1977) successfully manufactured rasogolla from cow milk *chhana*, with components : *chhana* : 50 g, white wheat flour : 10 g, sugar 16.5 gm, baking powder : 5 g.

Soni *et al.* (1980) reported the method of preparation of rasogolla following the method described by Jagtiani *et al.* (1960) with some modifications. *Chhana* from buffalo milk was kneeded with suji, maida and samunder jhag in order to obtain the desired body and texture. The

final mixture had the composition : *chhana*, 290 g, suji, 2.125 g, maida 8.50 g, smunder jhag, 150 g. After cooking rasogolla was dipped in 40 per cent sugar syrup and kept at 10±2°C for 12-16 hours prior to analysis.

Bhattacharaya and Desh Raj (1980a) reported the traditional method of manufacturing rasogolla from cow milk without addition of any additive. In this method about 10 to 15 litres of freshly clarified 50-60 per cent sugar syrup was brought to boil by heat. *Chhana* balls were cooked in boiling syrup. After 20 minutes of heating steam was discontinued for a few seconds to determine whether the rasogolla balls would sink into the sugar syrup, this being a sign of complete cooking. After 20-30 minutes of cooking, heating was stopped, rasogolla were transferred to clarified hot (50-60°C), 40 per cent sugar syrup. After cooling to room temperature the entire product was stored in a refrigerator at 4 to 6°C for 3-4 hours. Bhattacharaya and Desh Raj (1980b) also reported pressure cooker method. Similar to above except time of cooking, with pressure 1 kg/cm^2 for 2-3 minutes was employed whereas traditional method no pressure was employed and time of cooking was 20-30 minutes.

Bandyopadhyay *et al.* (1980) reviewed the steps in the manufacture of rasogolla such as milk, boiling of milk, cooling to 70°C, coagulation with 0.5 per cent lactic acid, draining of whey, coagulum (*chhana*), kneading of *chhana* with suji, maida and other ingredients and subsequent preparation into balls, cooking of the balls in sugar syrup, dipping the rasogolla in hot sugar syrup, storing the canned rasogolla in cold.

2.4 Composition and yield of rasogolla

As per ISI (1967) specification canned rasogolla should contain minimum 45 per cent total solids, 5 per cent fat, 5 per cent protein and maximum of 45 per cent sucrose.

Mitra *et al.* (1967) analysed different types of rasogolla procured from Calcutta market on the basis of body and texture. The products were categorized, namely 'ordinary' and sponge. Starch was absent in ordinary category. Chemical analysis revealed 38.36 per cent moisture, 7.3 per cent fat, 43.3 per cent sucrose and 6.4 per cent protein in the ordinary rasogolla. The sponge rasogolla had 50 per cent moisture, 5.3 per cent fat, 37.0 per cent sucrose and 5.5 per cent total proteins.

Singh and Ray (1977) reported higher total solids (54.43), fat (7.15) and protein (6.24) using citric acid as coagulant in laboratory prepared rasogolla.

Bhattacharya and Desh Raj (1980a) observed that rasogolla by traditional method contained 7.5 per cent fat by using cow milk of 4.0 per cent fat level. They further reported that rasogolla with 50.5 per cent moisture was very much acceptable when *chhana* was prepared by coagulating milk at pH 5.4. They obtained on an average yield i.e. 34.10 per cent. They further observed that the rasogolla prepared by pressure cooker method by using milk 4.0 per cent fat, coagulated at pH 5.4, contained fat 8.42 per cent and moisture 50.61 per cent. The yield of rasogolla on an average was 33.50 per cent.

Soni *et al.* (1980) reported the average composition of rasogolla prepared from buffalo milk had moisture, sucrose, protein and fat as 37.0, 51.9, 6.8 and 4.2 per cent, respectively.

Sur *et al.* (2000) Standardized method for the manufacture of rasogolla from buffalo milk. Compositional analysis revealed that total solids, fat, protein, sucrose and ash were 44.83, 5.39, 6.32, 32.12 and 0.33 per cent, respectively. A gradual increase in syrup acidity, volatile,

fatty acids and peroxide value and decrease in sodium chloride soluble protein and sensory attributes were noticed with the increase in temperature and period of storage.

The shelf-life of buffalo milk rasogolla in metallized polyester packaging was observed to be 14 days when stored at 30°C±1 and up to 28 days when stored at 7±1°C.

2.5 Factors controlling physico-chemical characteristics of rasogolla

The factors affecting the characteristics of rasogolla are reviewed as follows:

2.5.1. Effect of composition of milk and *chhana* on rasogolla

De and Ray (1954) reported that excessive greasyness of buffalo milk *chhana* due to high content of milk fat makes it unsuitable for rasogolla. Date *et al.* (1958) reported that standardization of buffalo milk 4 to 5 per cent fat and subsequent treatment with sodium citrate or phosphate was essential to produce good quality *chhana*.

Cross-bred cow's milk having 4 percent fat resulted in best quality *chhana* for rasogolla making (Rao 1971). Lower than 4 per cent fat lead to hard body and coarse texture in *chhana* while higher fat level results in the greasy surface. Homogenisation of cow milk could bring

about minor improvement in the recovery of milk solids without affecting the quality of *chhana* (Jagtap and Shukla, 1973).

Bhattacharaya and Desh Raj (1980a) reported that better quality rasogolla was obtained when moisure of *chhana* was between 50 to 60 per cent range. They also reported that about 55-58 per cent moisture in *chhana* was found to be optimum for good quality and acceptability of rasogolla. Rasogolla made with less than 50 per cent moisture was less acceptable due to hard body and grainy sensation during chewing though it had spongy texture. Above 60 per cent moisture in *chhana* gave rasogolla as soft, broken texture with irregular sized bigger cavities.

Bhattacharaya and Desh Raj (1980a) reported that higher fat in *chhana* improved the body and texture of rasogolla, but led to greater loss of fat in the cooking syrup. Overall, by increasing the fat level in milk, a base ingredient, the body and texture of rasogolla are improved but the fat recovery is decreased. They further observed that a pH of 5.4 was found to be optimum for good yields of *chhana* as well as rasogolla and a highly acceptable product of white colour round shape soft body and maximum sponginess. At lower pH (5.2), the rasogolla was not acceptable due to its brown

colour and slimy surface hard body and irregular texture with a rubbery rind on the outer side and uncooked material in the central portion of the rasogolla balls. De and Ray (1954) stated that a good quality of rasogolla from *chhana* desired by coagulation of cow milk at pH 5.4 and 5.5 can be obtained.

2.5.2. Effect of body and texture of *chhana* on rasogolla

It is well established that soft and smooth *chhana* is essential for obtaining soft spongy rasogolla. De and Ray (1954) observed that *chhana* prepared from cow milk using lactic acid as the coagulant was more suitable for rasogolla. They further reported that cow milk with 4 to 4.5 per cent fat and SNF/fat ratio 2.0 gave *chhana* of most desirable quality. Addition of 0.2 to 0.3 per cent sodium citrate as softening agent to buffalo milk before coagulation helped in producing a very soft *chhana* suitable for rasogolla (Srinivasan and Ananantkrishanan, 1964; Singh and Ray, 1977) On the other hand, Kundu and De (1972) observed that the *chhana* produced by coagulating standardized buffalo milk (5% fat) at 70°C with 1 per cent citric acid solution to a pH of 5.7, was highly suitable for its use in the preparation of rasogolla.

Chakrabarti *et al.* (2001) revealed the rheological properties of rasogolla and to obtain a standard value for rasogolla (sponge and ordinary). 15 mm cubes were used to test the texture profiles using texture analyzer and chemical composition of rasogolla. Results of the chemical composition revealed that sponge rasogolla had higher moisture content and protein and lower fat, sugar, ash and additive when compared to ordinary rasogolla. Textural properties of whole sponge rasogolla was observed to have significantly lower ($P<0.05$) hardness, fructureability, springiness and adhesiveness but have higher cohesiveness, gumminess, chewiness and resilience when compared to whole ordinary rasogolla.

2.5.3. Effect of concentration of cooking sugar syrup on Rasogolla

Date *et al.* (1958) reported 60 per cent sugar solution for cooking and 50 to 55 per cent sugar solution for preserving the product in cans. Srinivasan and Ananatkrishanan (1964) reported that the syrup concentration is likely to affect physico-chemical quality of rasogolla. The desired form of product is largely dependent on the syrup concentration in which it is cooked and stored. They also advocated approximately 60 per cent sugar syrup

for cooking and preservation. Singh and Ray (1977) used 55 per cent sugar solution for cooking. Soni (1978) used 80 per cent sugar syrup for cooking and 40 per cent sugar solution for preservations. Bhattacharya and Desh Raj (1980a,b) reported that 50 to 60 per cent sugar concentration, with an optimum at 55 per cent, the quality of rasogolla was most acceptable.

2.5.4. Effect of time and temperature of cooking on rasogolla

Cooking of *chhana* balls in boiling sugar syrup for 20 to 30 mintues was observed to be optimum for proper swelling of the balls (De, 1976; Date *et al.*, 1958; Singh and Ray, 1977; Soni, 1978). Patton (1955) reported that cooking in concentrated sugar syrup for longer period caused caramelization imparting undesirable colour to the product. Bhattacharya and Desh Raj (1980a,b) reported that cooking of balls for 25 to 30 minutes in traditional method and 2 to 3 minutes in pressure cooker method were optimum for good quality and acceptability of rasogolla. Excessive cooking i.e. above 30 minutes resulted rasogolla of brown colour, excessive loss of moisture and fat, hard body, undesirable texture and poor taste less than 25 minutes cooking leads rawness inside the rasogolla balls

2.5.5 Effect of repeatedly use of cooking syrup and evaporation of water on rasogolla.

Srinivasan and Anantkrishanan (1964) reported that boiling syrup should not be allowed to concentrate in order to maintain proper body and texture of rasogolla. De (1976) and Soni (1978) reported that frequent sprinkling of hot water during the process of cooking has been suggested to maintain sugar concentration.

Bhattacharaya and Desh Raj (1980a) revealed that use of sugar syrup upto the second time gave rasogolla of acceptability quality. After use in the second preparation, the brown colour of sugar syrup intensified and led to rasogolla of inferior colour. Moreover, the fat lost from the *chhana* during cooking accumulated in the sugar syrup, resulting in a greasy surface in rasogolla. Thereafter, it can be used with the addition of an equal amount of fresh clarified sugar syrup, though not more than once.

2.5.6. Effect of acidity of sugar syrup on rasogolla

Sugar syrup acidity is directly related to the concentration of sugar syrup. The maximum permitted acidity of the syrup is 5 ml 0.1 N NaOH/100 ml of syrup (ISI, 1967). Singh and Ray (1977) reported that the acidity of market rasogolla syrup is usually more than that of

laboratory made rasogolla syrup. However, amongst the coagulants used in the laboratory, lactic acid produced comparatively higher acidity in the rasogolla syrup.

2.6. Physical deterioration of rasogolla during processing and storage

2.6.1 Browning/discolouration

The browning and discolouration during processing and storage is due to denaturation of protein and cooked flavour developed due to release of sulphydral compounds lead to the physical deterioration of the product. There appears to be three types of browning (a) caramelization or non-amine browning of sugar, (b) amine sugar or maillard type of browning and (c) oxidative browning.

Patton (1955) reported that type of browning which prevails in milk and milk products is maillard type of browning, resulting from the interaction of amine compounds with sugars. Ellias (1959) suggested that there is no relation of browning and disappearance of amine groups as free aldehydic group of lactose interact with amino group of lysine. They have shown that rasogolla turned brown after three weeks of storage at 55°C.

2.6.2. Loss of crispness

Date *et al.* (1958) observed that during storage of rasogolla in can there was loss in crisp texture of the product. A good correlation existed between the crispness and the per cent sodium chloride soluble protein (which was taken as a measure of extent of denaturation of protein).

2.7 Technology of *Rabri* Preparation

The second part of *rasmalai* (concentrated milk) making is the product in which this sweet is served i.e. *rabri.* After Rasogolla making, Rasogolla is squeezed/pressed and dipped into *rabri. RABRI* is the product, which resembled with concentrated milk of this product to a great extent. In this product, evaporation of milk was done to one-third of its original volume by continuous stirring. Sugar is added in the final product in which squeezed/pressed balls are dipped for soaking, storage and serving.

Different workers have defined *rabri* is a specially prepared product of milk when successive layers of clotted cream are skimmed off while the milk is being slowly evaporated (Davis, 1940). Whereas, Chapman (1953) stated that clotted cream (*Malaisar*) is moderately thick with soft granular texture and attractive characteristic nutty flavour. Fat content is more than 55 per cent and it is also rich in

solid-not-fat and vitamins. Srinivasan and Anantkrishanan (1964) stated that *rabri* is an essentially clotted cream skimmed off from slowly evaporating milk and lastly sweetened. Mahanta (1968) defined *rabri* as a milk product prepared by the formation of successive layers of clotted cream, which are skimmed off while the milk is being slowly evaporated. *Rabri* is a synonym of sweetened clotted cream (De, 1980), on the basis of colour and consistency Bandhopadhyaya and Mathur (1987) reported that *rabri* is a heat desiccated, thickened milk sweet, pale yellow to light caramel in colour/flavour. *Rabri* is generally prepared by using simple equipment like karahi, bamboo sticks, palta (iron) and bhathi (coal/gas/diesel, etc). Successive layers of clotted cream are skimmed off while the milk is being slowly evaporated. Sugar is dissolved in it when volume of milk is reduced to one-eighth and the clotted cream is then scrapped off the sides of the pan where it has been collected and it is immersed in the thick sweetened milk (Davis, 1940; Rangappa and Achaya, 1948; Srinivasan and Anantakrishanan, 1964).

Mahanta (1968) mentioned almost a similar technique for *rabri* preparation and suggested that cream can also be added to soak the evaporated milk and final product

will be a homogenous mass of honey texture. Whereas, Bandhopadhyaya and Mathur (1987) observed that buffalo milk is simmered in a shallow vessel with frequent scrapping of bottom and sugar is added when some clots begin to appear and continuously stirred till desirable plastic consistency is achieved.

Srinivasan and Anantkrishanan (1964), Bandhopadhyaya and Mathur (1987) reported that shelf-life of *rabri* is of 5-7 days at refrigeration temperature.

Gayen and Pal (1991) described a small scale process developed for manufacture of *rabri* involved holding about 5 litres buffalo milk (6% fat) at 90-95°C in a steam jacketed stainless steel kettle, removing clotted cream (malai) every 10 min until about 500 g had been removed, then concentrating the remaining portion 3-fold by boiling with scrapping and stirring, 6 per cent sugar and the malai were then added and the product cooled to about 10°C.

Jain and Gupta (1992) reported the 6 years programme of the Indian Council of Agricultural Research to upgrade the processes for manufacture of traditional milk products (Khurchan, *rabri*, etc.) to large-scale industrial application.

2.8 Composition of *Rabri*

Different workers have reported the composition of *rabri* as given below in the farm of table:

Total solids	Moisture	Fat	Protein	Lactose	Sucrose	Sugar	Ash	References
-	30	20	10	17	-	20	3.0	Srivason and Anaktkrishnan (1964)
								Singh (1968) & Mahanta (1968)
-	30	20	13	16	-	15	3.5	Bandhopadhya ya and Mathur (1980)
55.29	-	16.64	-	12.24	11.82	-	-	Gayan (1989) Gayan and Pal (1991)
								Delhi market samples
49.84	-	12.90	-	11.48	12.29	-	-	Karnal market samples
50.8	-	16.1	10.01	11.8	11.9	-	1.99	Laboratory Samples

Table revealed that total solid and moisture content in *rabri* varied between 49.84 to 55.29 and 30.00 to 50.16 per cent. The fat protein, lactose and sucrose percent in *rabri* ranged between 12.9 to 20.0; 10.0 to 13.00; 11.48 to 17.00 and 11.82 to 12.92 respectively. Sugar level in *rabri* 25-30 percent also studied (Srinivasan and Aanatkrishanan,

1964). Ash content in *rabri* ranged between 1.99 to 3.5 per cent.

2.9 Bacteriological quality of *RABRI*

Gayen (1989) reported standard plate count, coliforms count, yeast and mould count of 2.4×10^4, 2.02×10^2 and 7.2×10^1 respectively in the samples of *rabri* collected from the Karnal, 10.01×10^4, 2.5×10^2 and 4.1×10^2, respectively in the samples collected from Delhi. In the *rabri* prepared while attempting to standardize its technique, he observed standard plate count of 3.4×10^4, coliform count of 60, yeast and moulds count of 75.

Gayen and Pal (1991) described microbial count of *rabri* reached 67400 and 38600 total viable organisms, 150 and 100 coliforms and 320 and 280 yeasts and moulds, respectively after 18 hrs storage at 30°C and 20 days at 5°C respectively.

Coliform was reported to be low when total solids percentage was high and increased sugar content also showed a decreasing trend in the coliform count.

2.10 Preservation of ingredients used in *Rasmalai*

The short life of the traditional dairy product is the major limitation in organized marketing of these products. Another emerging technology for preservation of perishable foods is "bio-preservation". It refers to extend shelf life and enhanced safety of foods using their natural or

controlled microflora and/.or their anti microbial products. The lactic acid bacteria synthesize variety of inhibitory substances including bacteriocins or bactericidal proteins. Currently large amount of research on application of natural antimicrobials for food preservation is being carried out. Nisin was the first recognized antimicrobial substance produced by lactic Streptococci that has realized commercial application in food preservation.

2.10.1 *Chhana*

Mahanta (1955) reported that *chhana* could be kept well only for two days at room temperature. He also studied the preservation of *chhana* by using sodium benzoate, sodium propionate and sugar. Kulkarni *et al.* (1984) found that ordinary steaming of *chhana* had no beneficial effect on the shelf-life while intermittent heating improved the keeping quality up to 3 days. This might be due to destruction of germinated spores. They also found that the steaming of *chhana* for 10 min in the presence of one to two per cent lactic acid concentration increased the shelf-life up to 6 days. They further reported that sterilization of *chhana* in the presence of one per cent lactic acid improved the shelf-life of *chhana* up to 8 days. But steaming resulted in the

hardening of texture. Besides, sterilization resulted in browning of the product.

2.10.2. Rasogolla

Jagtiani *et al.* (1962) found that there was no browning in rasogolla when the sulphur dioxide content in final syrup was 8 ppm or more.

Ghosh and Chakravorty (1979) reported prevention of browning in canned rasogolla by added sulphur dioxide. The role of SO_2 in the prevention of browning in the canned rasogolla was studied. Of the 4 concentration of SO_2 used (25, 50, 100 and 200 ppm), 100 ppm gave the most satisfactory results in terms of prevention of browning without sacrificing flavour and texture. It was possible to extend the shelf life of the product with added SO_2 (100 ppm) upto 6 months as against 9 week without SO_2. Under PFA Act 1954 and PFA rules, 1955 of India amended upto 1976 100 ppm SO_2 (max.) is permitted to be used as preservative in canned *rasogollas* provided the cans are lacquered with sulphur resistant lacquer.

Ghosh and Chakraborthy (1979) observed that prevention of browning in canned *rasogollas* by added sulphur dioxide. *Rasogollas* were placed in sterile sulphur-resistant cans and filled with sugar syrup (52° Brix) at

180-185 °F, 25-200 ppm SO_2 (as potassium metabisulphite) and canned were double seamed, inverted and water cooled. Use of 100 ppm SO_2 extended the storage from 6 week to 6 months at ambient temperature and from 4 week to 9 week at 110°F.

2.11 *Rasmalai* Technology

Rasmalai making can be divided into two parts. First part is making *chhana* from cow milk for its ball making, cooking in the sugar syrup and the second part is making of *rabri* from buffalo milk for dipping, pressed /squeezed balls made from *chhana* in sugar syrup.

Aneja (1997) described the method of *Rasmalai* preparation. *CHHANA* along with 1 to 4 per cent wheat flour in kneaded into smooth dough, portioned and rolled into balls having a smooth texture without cracks. The balls are processed like rasogolla and subsequently stored in thickened milk (to one fourth of its volume by heating) with added sugar (5-6%) of its original volume of milk).

2.12 Microbiological quality

Grewal and Tiwari (1990) reported microbiological quality of rasmali. Twenty-five market samples of *rasmalai* showed aerobic plate counts from 10^2-10^6 CFU/g. Staphylococcus aureus was the most common isolate (76%)

followed by *Escherichia coli* (72%) and Klebsiella (68%). The other organisms isolated were species of *Pseudomonas* (52%), Enterobactor (44%), Bacillus (32%) and Citrobactor (8%). However, no correlation could be established between the type of isolate with the total aerobic count. Samples having an aerobic count of 10^3-10^4 CFU/g yielded majority of the entric organisms. Only one isolate of *S. aureus* could be typed with the usual set of phases routinely used for typing clinical isolates.

2.13 Preservation

Tiwari and Grewal (1999) reported the effect of preservatives on the keeping qualityi of *rasmalai.* The post-processing development of contaminating microorganisms present in *rasmalai* were controlled effectively with the addition of low concentrations (100-200 ppm) of selected preservatives like butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and lauricidin (LC). *Rasmalai* samples containing these preservatives showed significant decrease in viable count as compared to control. Slight variation in pH was seen on storage at 4°C, room temperature (22-25°C) or at 37°C) for 1-10 days.

CHAPTER-III

Material and Methods

Materials and methods are discussed under following heads:

3.1 Survey of existing technology

3.2 Collection of samples

3.3 Analytical procedure

3.3.1 Composition of Rasogolla

3.3.1.1 Fat

3.3.1.2 Protein

3.3.1.3 Total Carbohydrates

3.3.1.4 Total solids

3.3.1.5 Ash

3.3.1.6 Acidity

3.3.1.7 pH

3.3.1.8 TBA value

3.3.2 Bacteriological analysis of *Rasmalai*

3.3.2.1 Osmophilic count

3.3.2.2 Coliform count

3.4 Sensory evaluation

3.5 Laboratory Scale Product development

3.5.1. Semolina level in *chhana*

3.5.2. Sugar level in concentration milk

3.6 Storage study

3.7 Analytical procedure

3.7.1 Physico-chemical parameter

3.7.1.1. Moisture

3.7.1.2. Acidity

3.7.1.3. pH

3.7.1.4. TBA value

3.7.1.5. Free Fatty acids

3.7.2 Bacteriological analysis of stored samples of *Rasmalai*

3.7.2.1. Osmophilic count

3.7.2.2. Coliform count

3.8 Sensory evaluation

3.9 Statistical analysis

3.1 Survey of existing technology

Ten Sweetmeat shops of Hisar city were randomly selected to have the information on the existing technology of preparation of *Rasmalai*. These ten shops were also selected

for the purpose of collecting samples of the *Rasmalai* for analysis. A questionnaire was prepared to elicit information on the prevalent practices related to the common equipment used, methods of preparation, raw material used (type and amount). The cost of production, shelf-life and packaging etc. (Annexure 1).

3.2 Collection of samples

About 30 sweetmeat shops of Hisar city were initially surveyed out of which 10 shops were randomly selected for the collection of market samples of *Rasmalai.* All 10 shops had refrigeration units.

Rasmalai sampling was done at the retail counters of these shops. Samples in triplicate were collected from these shops. Thus a total of 30 samples were taken for analysis. Samples were collected under conditions in which these were sold to consumers. Since the samples were to be examined for chemical as well as bacterial examination, all precautions were taken to prevent contamination. The equipment used was properly sterilized and samples were aseptically taken and transferred to the icebox. These were brought to the laboratory and were kept in a refrigerator at 5±2°C for further analysis, which was carried out with the minimum possible delay.

3.3 Analytical procedure

Market sample of *Rasmalai* were analyzed for their composition, concentrated milk/evaporated milk in which product (Rasogolla) is served and Rasogolla (in the product) were analyzed separately.

3.3.1. Composition of Rasogolla

Samples were analyzed for fat, protein total carbohydrates, total solids, ash, acidity, pH and TBA value.

3.3.1.1. Fat

The fat contents of *Rasmalai* samples (3-4g) Rasogolla (R) and concentrated/evaporated milk (C)) were determined by gravimetric method using mojonnier's fat extraction method (BIS 1989).

3.3.1.2. Protein

The total protein contents of Rasmali samples (3.4g) from each part were determined by Micro-kjeldhal method (A.O.A.C. 1995). Approximately 3-3.5g of sample was weighed accurately and digested. After digestion the samples was diluted to volume of 100 ml in volumetric flask. Five ml of this dilution was used for distillation in 4 per cent Boric acid. It was titrated with 0.01 N H_2SO_4. A Blank determination was also carried out simultaneously. A

conversion factor of 6.38 was used to determine the total protein contents in the samples.

3.3.1.3 Total carbohydrates

It was calculated by difference i.e. Carbohydrates per cent = 100 – (moisture + fat + protein + ash)

3.3.1.4. Total solids

The total solids contents in *Rasmalai* samples were estimated by Gravimetric method B.I.S (1989).Approximately (3-4g) of *Rasmalai* sample was taken for total solids determination.

3.3.1.5. Ash

For estimation of ash 3g of sample was taken in a previously dried and weighted silica crucible. It was heated over the hot plate till black ash resulted and then transferred to muffle furnace at 550°C ± 20°C for about 5 hrs. till gray ash formed. The crucibles were then cooled in desiccators and weighted (A.O.A.C., 1995).

3.3.1.6. Acidity

The number of milliliters of O.I N NaoH required to neutralized acidity in specific weight of product was determined and percent acidity (as lactic acid) was calculated B.I.S. (1989).

$$\text{Acidity percent (as lactic acid)} = \frac{0.009 \times \text{ml. O.I N. NaoH used}}{\text{Wt. of sample}} \times 100$$

3.3.1.7. pH

Systronic pH meter was used to determine the pH of samples. pH meter was standardized with standard buffer solution. To measure the pH of Rasogolla 10 g sample was taken, grounded in to a paste by using pestle mortar and diluted with 25-30ml distilled water, while for concentrated/evaporated milk it was taken as such. pH indicated by the pH meter was recorded.

3.3.1.8 TBA value

The TBA value was determined by Whitte *et al.* (1970) method. Weighed 2 gm samples from each part of *Rasmalai* accurately and blending with 10 ml of 20 per cent TCA. Filter through filter paper Whatman No. 42. Keep on boiling in water bath for 35 minutes. OD (Optical density) was recorded at 532 nm. Standard curve was drawn by taking O.D. of different known concentrations. The samples values were determined by comparison O.D. reading with standard curve.

3.3.2 Bacteriological analysis of *Rasmalai*

Rasmalai samples were separated in to Rasogolla and concentrated milk. Osmophilic and coliform count were

determined separately for sampling (R) Rasogolla in the product) and (C) concentrated/evaporated milk.

For analysis 1g sample from each part was taken aseptically. Rasogolla part was ground into a paste with the help of presterilized pestle mortar under aseptic condition. It was transferred to dilution tube for further dilutions.

3.3.2.1 Osmophilic count

For the osmophilic count, the medium was prepared by dissolving readymade medium Wort Agar in a 45°Brix syrup containing 35g of sucrose and 10g of glucose in 100ml of solution. Sterilized the medium by autoclaving for 20 min, cooled to 45-50°C before pouring into plates. (Harrigan and Margaret, 1976). Dilutions up to 10^{-2} were prepared in dilution blanks. One ml from each dilution was poured into sterilized plates aseptically and spread evenly by rotating it gently. About 25-30 ml of media was poured into plates and incubated at 30±0.5°C for 72 hrs. Colonies appeared on the plates were counted.

3.3.2.2 Coliform count

Coliform bacterial count was studied by using Hi-media of Violet Red Bile Agar (41.5g) with following composition (gm) IS: 1479 (Part III) 1962.

Yeast extract	3.00g
Peptone	7.00g
Bile salt	1.5g
Lactose	10.00g
Sodium chloride	5.00g
Agar Agar	15.00g
Neutral Red	0.30g
Crystal violet	0.02g
Distilled water	1000.0ml.
pH	7.4

pH was adjusted to 7.4. The media was sterilized by autoclaving at 121°C for 15 minutes. Cooled it to 42°-44°C before pouring plates. 25-30ml media was poured in the dishes.

3.4 Sensory evaluation

The sensory evaluation of product (*Rasmalai*) was carried out by a panel of six semi trained Judges A nine points Hedonic scale was used for this purpose. Samples were examined in the sensory evaluation laboratory of Department of Animal Product Technology, CCS HAU, Hisar. Precautions were taken to avoid the biasness in judging by giving codes to the samples when offered for judging.

3.5 Laboratory Scale Product development

Fresh cow and Buffalo milk was collected from the Department of Animal Products Technology, College of Animal Sciences, CCS HAU, Hisar.

Based on the market survey, laboratory scale product was developed on the basis of the indigenous technology being followed by respondent D with some modifications. The following variables were studied.

3.5.1 Semolina level in *Chhana*

2%, 5% and 7% semolina level was incorporated in *chhana* for preparation of Rasogolla to be use in *Rasmalai*. *Chhana* without semolina was taken as control.

3.5.2 Sugar level in concentrated milk

1%, 2% and 3% sugar was added in concentrated/ evaporated milk. *Rasmalai* samples prepared by using above variables were offered for judging on the basis of sensory attributes best levels were selected for further study.

3.6 Storage study

To enhance the shelf-life of *Rasmalai* two preservatives were added viz nisin and potassium meta-bi-sulphite @ 100 ppm to concentrated/ evaporated milk required for dipping the rasogolla.

Microwave heat treatment (800 wt for 2.5 minutes) was also employed to the poly packed samples of *Rasmalai* as another treatment.

Samples were stored at 5±2°C in the refrigerator and analyzed on 0, 5th, 10th and 15th day of the storage.

The following abbreviations were used in this study.

R Rasogolla (in the product)

C Concentrated/evaporated milk.

3.7 Analytical procedure

3.7.1 Physico-chemical parameters

Stored samples of *Rasmalai* were analyzed for moisture, acidity, pH, TBA value and Free fatty acids..

3.7.1.1 Moisture

The moisture in *rasmalai* sample was determined as described in AOAC (1995) about (3-4g) sample was weighed accurately into a dish previously dried and weighed. The dish containing the material was heated in the electric oven maintained at 102±1° C for about 2 hrs. cooled in the desiccators and weighed. The process of drying, cooling and weighing was repeated at 30 minutes interval for three times till constant weight was attained. The moisture percentage was calculated as follows:

$$\text{Moisture per cent} = \frac{(W_1 - W_2)\ 100}{W_3}$$

Where

W_1 = Weight in g of the dish with the sample before drying.

W_2 = Weight in g of the dish with the sample after drying

W_3 = Weight in g of the empty dish. Weight of Sample

3.7.1.2 Acidity

The acidity in stored samples of *Rasmalai* determined by (B.I.S. 1989) method as decribed in 3.3.1.6.

3.7.1.3 pH

The pH of stored samples of *Rasmalai* was determined as described in 3.3.1.7.

3.7.1.4 TBA value

TBA value of *Rasmalai* samples were calculated as described in 3.3.1.8.

3.7.1.5 Free Fatty Acids

The method of Koniecko (1979) was followed for the determination of FFA. Five g of sample was blended for 2 minutes with 30 ml of Chloroform in presence of about 5 g anhydrous sodium sulphate. The contents were filtered into a 250ml conical flask by using Whatman 42 Titration of the filtrate was carried out against 0.1 N alcholic KOH using phenolpthalein as an indicator. The quantity of KOH

consumed during titration was recorded and FFA content, expressed as percent oleic acid, was calculated as under:

$$\text{FFA per cent} = \frac{2.82 \times V}{W}$$

Where

V = Volume of 0.1 N KOH required for titration in

W = Weight of the samples (g)

3.7.2 Bacteriological analysis of stored samples of *Rasmalai*

3.7.2.1 Osmophilic count

Osmophilic count of stored *Rasmalai* samples was determined by Harrigan and Margaret, (1976) method and procedure was followed as describe in 3.3.2.1.

3.7.2.2 Coliform count

Coliform count of stored *Rasmalai* samples was determined by IS : 1479 (Part III) 1962. Method and procedure was followed as described in 3.3.2.2.

3.8 Sensory evaluation

The sensory evaluation of stored *Rasmalai* samples were carried out by a panel of six semi trained judges using a nine point Hedonic scale.

3.9 Statistical analysis

The data generated was analysed by using simple Complete Randomized Block Design CRD and two factor factorial CRD. (Sheoran and Pannu, 1999).

CHAPTER-IV

Results and Discussion

In this chapter the data obtained on the existing technology, gross composition of the samples collected from various sources and technology development has been presented and discussed under following head and sub heads

4.1 Survey of existing technology

4.1.1. Education

4.1.2. Source of milk procurement

4.1.3. Type of milk

4.1.4. Test conducted

4.1.5. Quantity of milk per batch/ per day

4.1.6. Type of container used for preparation

4.1.7. Type of heating device

4.1.8. Quantity of fuel/batch

4.1.9. Additives used per batch

4.1.10. Time consumption of labour per batch

4.1.11. Yield per batch

4.1.12. Shelf-life of the product

4.1.13. Sale rate

4.1.14. Profit

4.1.15. Method of service

4.2 Collection and analysis of market *Rasmalai* samples

4.2.1. Physico-chemical analysis

4.2.2. Bacteriological quality

4.2.3. Sensory evaluation

4.3 Technology standardization

4.3.1. Standardization of semolina level to be added in *chhana* for Rasogolla preparation for *Rasmalai*

4.3.2. Standardization of sugar level to be used in concentrated milk/*Rabri*

4.4 *Rasmalai*

4.4.1. Preparation of Rasogolla

4.4.1.1. Receiving of milk

4.4.1.2. Filtration

4.4.1.3. Standardization

4.4.1.4. Heating

4.4.1.5. Coagulation

4.4.1.6. Whey separation

4.4.1.7. *Chhana*

4.4.1.8. Washing

4.4.1.9. Pressing

4.4.1.10. Ball making

4.4.1.11. Cooking (50 per cent sugar syrup)

4.4.1.12. Dipping

4.4.1.13. Pressing

4.4.2 Preparation of concentrated milk

4.4.2.1. Receiving of milk

4.4.2.2. Filtration

4.4.2.3. Standardization

4.4.2.4. Evaporation/Concentration

4.4.2.5. Adding sugar

4.4.2.6. Cooling

4.4.3 Product (*Rasmalai*)

4.4.4 Packing

4.4.5 Storage

4.5 Storage study

4.5.1. Physico-chemical parameter

4.5.1.1. Moisture

4.5.1.2. Acidity

4.5.1.3. pH

4.5.1.4. TBA value

4.5.1.5. Free Fatty acids

4.5.2. Microbiology

4.5.3. Sensory Evaluation

4.5.3.1. Colour and appearance

4.5.3.2. Body and texture

4.5.3.3. Flavour

4.5.3.4. Overall Acceptability

4.1 Survey of existing technology

The data on existing technology of *Rasmalai* manufacturing was obtained from randomly selected ten respondents of the Hisar city. The data so collected is presented in Table 1.

4.1.1 Education

The education level of the respondent showed that 40per cent were above matric, 30per cent matric and 30per cent below matric. It was observed that respondents with the education level matric and above were co-oprating more in supplying the correct information.

4.1.2. Source of milk procurement

It was observed that 70per cent respondents depended on milk vendors to meet their requirement while 20per cent and 10per cent depended on private dairies and

Table 1: Survey of Existing Technology of Rasmalai

Particulars	Respondents No. 10
Education	
(a) Matric	3
(b) Above matric	4
(c) Below Matric	3
Source of milk procurement	
(a) Vendor	7
(b) Private dairy	2
(c) Milk plant	NIL
(d) Contractor	1
Type of Milk	
(a) Rasogolla perparation	
(i) Cow milk	10
(ii) Buffalo milk	7
(iii) Mixed milk	5
(b) Concentrated milk preparation	
(i) Cow milk	8
(ii) Buffalo milk	7
(iii) Mixed milk	5
Test conducted	
(a) Fat test	2
(b) Khoa test	10
(c) Any other	—
(d) Non	—

Quantity of milk used/ per day/batch	
(a) Concentrated milk	5-40 lt
(b) Chhana	3-60 lt
Type of Containers and equipments used for production preparation	
(a) Iron containers	10
(b) Steel containers	Nil
(c) Any other	—
Type of heating device	
(a) Gas chullah	2
(b) Diesel Bhatti	10
(c) Kerosine bhatti	–
(d) Coal Bhatti	–
(e) Fire wood bhatti	–
Quantity of fuel used per batch	
(a) Gas	–
(b) Diesel	1.5-2 lt./10 lts.
(c) Kerosine	–
(d) Firewood	–
(e) Coal	–
Additives used/batch	Semolina and sugar
Time consumption of labour per batch	
(a) No. of labours	2/10 lt/batch
(b) Total hours	2/10lts/batch

Yield per batch	
(a)Percent or kg	4/10 kg
Shelf-life of product	
(a) Room temperature	6 to 48 hrs
(b) Refrigerator temp.	1 to 5 days
Any specific information	
Sale rate	
(a) Per kg (Rs.)	80-90
(b) Per piece (Rs.)	5-7
Profit	
(a) Per kg (Rs.)	10-15
(b) Per piece (Rs.)	1-2
Method of service	
At shop	
(a) China plates	1
(b) Earthen pots	–
(c) Steel plates	1
(d) Silver coating paper plates	–
(e) Polythene cups	7
Home Delivery	
(a) Plastic bags	8
(b) Earthen pots	–
(c) Polythene containers	–
Any others	

contractors, respectively. None of the respondents procured milk from the milk plant.

4.1.3. Type of milk

Since *Rasmalai* preparation is consisting of two parts that is *tikki* shaped Rasogolla pressed in and concentrated milk to dip these *Rasogollas*. The preparation survey revealed that all respondents were using only cow milk for the preparation of Rasogolla and seven respondents told that they used buffalo milk (BM) if cow milk is not available. They follow such practices to meet the consumer demand during festival seasons or other heavy market demands. Five respondents also used mixed milk for attaining the desired body and texture in the Rasogolla part. Overall preference of the respondents were for cow milk for the Rasogolla preparation and buffalo milk for the preparation of concentrated milk.

4.1.4. Test conducted

To judge the quality all the respondents were using Khoa making test as a quality measure. As a thump rule yield of Khoa should be around 20per cent of the milk. Results revealed that two respondents were also testing the milk for fat test by Gerber's method as a quality check while other were ignorant about this test.

4.1.5 Quantity of milk per batch/ per day

The survey revealed that for the preparation of the concentrated milk the quantity of milk varied between 5 to 40 ltrs while for *chhana* preparation it varied 3 to 60 ltrs. The respondents also disclosed that quantity of milk used in each batch varied according to the size of the container and market demand. Number of batches to be prepared daily were as per the market demand.

4.1.6 Type of container used for preparation

The type of containers used for concentrating milk and heating milk for *chhana* perpαration was iron karahi and iron palta. None of the respondents used stainless steel containers which is considered to be a safe metal.

4.1.7 Type of heating device

All the respondents were having diesel Bhattis and two of them also had LPG chullahs. None of the respondents used keorosine/coal/firewood bhatti. It seems that respondents go for the convenient source of fuel. Diesel is easily available in the market and also reported to be cheaper as compared to the other sources of fuels.

4.1.8 Quantity of fuel/batch

Most of the respondents were unable to respond the quantity of fuel/batch used. Four respondents inform

that 1.5 to 2 ltrs. diesel is required per 10 kg of milk to be processed into the finished product.

4.1.9 Additives used per batch

Two of the respondents were using semolina as a binding material (100-150 gm/kg of *chhana*). Other respondents were using maida or arrowroot to achieve the desired body and texture when Rasogolla part was prepared from buffalo milk or mixed milk but they were unable to inform the quantity used.

4.1.10 Time consumption of labour per batch

Response to this questionnaire was not specific as the respondents intimated that they are using 2-4 skilled/unskilled labours who were also partly engaged in the preparation of other products as per the consumers demand. Approximately two labour are used for 10 ltrs of batch and they devote 2 hrs/batch in achieving the finished product.

4.1.11 Yield per batch

Only two respondents reported that they were able to achieve yield @ 4 kg per batch of ten kg milk. While other respondents were not specific about this.

4.1.12 Shelf-life of the product

The survey revealed that shelf-life of the product depends on the season and ambient temperature. The shelf

life of the product varied 6-48 hrs at room temperature while at refrigeration temperature (display cabinets) the shelf life varied 2-5 days. The reason for wide variation of the shelf life can be attributed to the quality of raw milk and other ingredients used, hygiene conditions during processing and post processing, storage temperature and the personal hygienic of the workers working with the manufactures. All this factors may contributes to the quality of the finished product and shelf life.

4.1.13 Sale rate

The sale rate with the respondent varied between Rs. 80-90. Per kg while per piece it varied Rs. 5-7.

4.1.14 Profit

As reported by the respondents the profit margin varied Rs.10-15 Per kg and Rs. 1-2 per piece.

4.1.15 Method of service

Most of the respondents inform that mostly consumers prefer the serving of product at the shop itself. As per the serving conducted it was found that 70per cent respondent were served the product per piece in the polyethylene cups while 10 per cent serving it in china plate, 10 per cent in steel plate and 10 per cent in silver foil coated paper plates. Spoons were used made of plastic or wooden.

For home delivery the respondents inform that they are using plastic (polyethylene) LDPE bag.

4.2 Collection and analysis of market *Rasmalai* samples

The samples of *rasmalai* were collected from ten randomly selected respondents under the condition in which they sell the product to the consumers on three different days. Immediately after taking samples these were put into an ice box and brought to the laboratory and stored at 5±2°C in a refrigerator.

4.2.1 Physico-chemical Analysis

To analyze the samples of *rasmalai*, it was divided in to two viz. Rasogolla(R)part and concentrated milk (C) part. These were analyzed separately for proximate composition and physico chemical properties and results are present in Table 2a & b.

Fat percent in Rasogolla part of Rasmalai samples ranged from 9-10 to 10.97. Rasogolla part of Rasmalai sample collected from respondent A had highest fat percent while respondent C had lowest. Venkateshwarlu (2001) reported fat percent in ordinary rasogolla ranged from 7.30 to 12.00 per cent. Fat percent in concentrated milk C part of *Rasmalai* samples ranged from 6.46 to 7.55. Concentrated part of *Rasmalai*

Table 2a: Composition of Rasmalai (market samples)

Shop	FAT		PROTEIN		Total carbohydrates		Total solids		Ash	
	R	C	R	C	R	C	R	C	R	C
A	10.97±0.10	7.55±0.05	10.71±0.39	7.25±0.09	17.38±0.54	17.78±0.47	40.30±0.55	33.88±0.48[a]	1.31±0.007	1.11±0.02
B	9.89±0.06	7.28±0.04	11.30±0.13	6.52±0.21	16.87±0.38	18.41±0.32	39.35±0.20	33.15±0.47[a]	1.29±0.003	1.08±0.010
C	9.10±0.14	6.93±0.12	9.86±0.16	6.82±0.21	18.82±0.04	19.06±0.17	39.08±0.22	33.94±0.43[a]	1.29±0.003	1.28±0.007
D	9.27±0.18	6.80±0.11	10.06±0.33	6.47±0.28	17.27±0.40	17.80±0.34	38.92±0.16	33.01±0.31[a]	1.28±0. 003	1.08±0.003
E	9.27±0.18	6.80±0.11	10.06±0.33	6.47±0.28	18.29±0.29	18.65±0.22	38.92±0.16	33.01±0.09[a]	1.28±0.007	1.09±0.000
F	10.74±0.20	7.51±0.04	10.73±0.28	6.84±0.00	16.61±0.36	18.19±0.22	39.36±0.33	33.64±0.18[a]	1.28±0.003	1.10±0.000
G	9.19±0.19	6.56±0.14	9.99±0.02	6.o0±0.04	16.08±0.32	19.44±0.14	38.54±0.33	33.92±0.12[a]	1.28±0.01	1.14±0.01
H	9.17±0.27	6.49±0.21	9.63±0.03	6.58±0.21	18.26±0.36	18.73±0.40	38.33±0.11	33.88±0.16[a]	1.26±0.00	1.08±0.007
I	10.61±0.04	7.18±0.09	10.03±0.29	7.04±0.08	17.54±0.30	19.60±0.25	39.64±0.46	34.92±0.08[b]	1.29±0.01	1.53±0.003
J	10.14±0.09	6.46±0.04	9.87±0.10	7.02±0.32	17.66±0.32	19.16±0.13	38.95±0.26	33.77±0.48[a]	1.28±0.007	1.130±0.01
CD (<0.05)	0.49	0.33	0.82	N.S.	1.06	0.85	0.92	0.97	0.022	0.03
Range	9.10-10.97	6.46-7.55	9.63-11.30	6.47-7.25	6.08-18.82	17.78-19.60	38.33-40.30	33.01-34.92	1.26-1.31	1.08-1.53

Table 2b: Composition of Rasmalai (market samples)

	Acidity		pH		TBA value	
	R	C	R	C	R	C
A	0.41 ±0.07	0.37 ±0.04	6.51±0.01	6.39±0.06	4.40±0.71	4.58±0.67
B	0.47±0.10	0.36±0.04	6.44±0.02	6.33±0.09	4.20±0.57	4.067±0.98
C	0.30±0.02	0.32±0.02	6.57±0.04	6.46±0.01	4.17]±0.90	4.21±0.86
D	0.43±0.06	0.39±0.04	6.60±0.04	6.44±0.03	3.96±0.65	3.95]±0.64
E	0.43±0.06	0.44±0.07	6.54±0.006	6.42±0.06	4.39±0.73	4.52±0.61
F	0.37±0.03	0.43±0.07	6.51±0.007	6.48±0.01	4.08±0.64	4.33±0.57
G	0.41±0.06	0.43±0.09	6.52±0.03	6.35±0.04	4.51±0.49	4.70±0.51
H	0.40±0.08	0.43±0.10	6.51±0.009	6.37±0.07	4.33±0.77	4.55±0.71
I	0.41±0.80	0.42±0.07	6.52±0.01	6.43±0.03	4.03±0.69	4.15±0.81
J	0.37±0.05	0.45±0.09	6.46±0.04	6.42±0.009	4.20±0.92	4.28±0.83
CD (<0.05)	N.S.	N.S.	0.086	N.S.	N.S.	N.S.
Range	0.30 to 0.47	0.32-0.45	6.44-6.60	6.33-6.48	3.96-4.51	3.95 –4.55

samples collected from respondent A had highest percentage of fat while respondent J had lowest. Gayen (1988) reported the fat percent of *Rabri* with a wide variation of 9.94 to 18.09. Lower fat percent was observed in the concentrated part of *Rasmalai* as compared to *Rabri* may be due to low level of concentration of milk. Analysis of results indicated that significant($P<0.05$) difference was found in fat of Rasogolla as well as in concentrated milk part of Rasmali samples collected from different shops.

Protein percent in Rasogolla part of *Rasmalai* ranged from 9.63 to 11.30. Rasogolla part of *Rasmalai* samples collected from respondent B had highest protein percent while respondent H had lowest. Venkatewarlu (2001) reported protein percent in rasogolla ranged between 5.50 to 9.70. The protein percent in concentrated milk part of *Rasmalai* samples ranged from 6.47 to 7.25 Concentrated part of *Rasmalai* samples collected from Respondent B had highest protein content while respondent H had lowest. Khokhar (1989) reported protein percent in market *rabri* sample ranged from 6.7 to 12.68. Lower protein values in present study were attributed by lower concentration rate in the *rabri* made for *Rasmalai.* Significant ($P<0.05$) difference in protein percent was found in Rasogolla part of *Rasmalai*

while in concentrated milk part of *Rasmalai* samples collected from different shops did not.

Total Carbohydrates percent in Rasogolla part of *Rasmalai* ranged from 16.08 to 18.82. Rasogolla part of *Rasmalai* samples collected from respondent C had highest total carbohydrates while respondent G had lowest. Total carbohydrate percent in concentrated milk part of *Rasmalai* samples ranged from 17.78 to 19.60. Concentrated part of *Rasmalai* samples collected from Respondent I had highest total carbohydrates while respondent A had lowest. Statistical analysis of data indicated that significant ($P<0.05$) difference in total carbohydrate content was found in both parts of *Rasmalai* samples collected from different shops.

Total solids percent in Rasogolla part of *Rasmalai* ranged from 38.33 to 40.30 Rasogolla part of *Rasmalai* samples collected from respondent A had highest total solids while respondent H had lowest. Venkateshwarlu (2001), Suresh (1989) and Soni *et al.* (1980) reported total solids percent in Rasogolla (sponge) ranged from 48.30 to 56.30, 51.69 and 63.0 percent respectively. This wide variation in total solids is due to variation in total solids contents of raw material used for rasogolla prepration or additives used such as semolina, arrowroot, baking powder by different workers.

The total solids percent in concentrated milk part of *Rasmalai* ranged from 33.01 to 34.92 Concentrated part of *Rasmalai* samples collected from respondent I had highest total solids while respondent D and E had lowest. Dharmpal (1997) reported total solids in *Rabri* as 50.80 per cent. Lower values for total solids in present could be study because of concentrated milk used in *Rasmalai* was not concentrated to the level as in case of *rabri*. Analysis of data revealed that total solids contents differed significantly ($P<0.05$) in both the parts of the *Rasmalai* samples collected from different respondents.

Ash contents in Rasogolla part of *Rasmalai* ranged from 1.26 to 1.31 per cent. Rasogolla part of *Rasmalai* samples collected from respondents A had highest ash percent while respondent H had lowest. Suresh (1989) reported ash content in Rasogolla samples ranged from 1.62 to 2.04 per cent. Lower values in present study may be due to use of different raw material and additives used for preparation of Rasogolla. The ash contents in concentrated milk part of *Rasmalai* samples ranged from 1.08 to 1.53 per cent. Concentrated part of *Rasmalai* samples collected from respondent I had highest ash content where as respondents B, D and H had lowest. Khokhar (1989) reported ash content

ranged from 1.48 to 2.28 per cent in *Rabri* samples collected from Hisar market. Gayen (1989) reported 1.99% ash in *Rabri*. Higher ash content observed by these workers was due to the fact that *rabri* is a more concentrated product in comparison to concentrated milk of *Rasmalai*. Statistical analysis of data revealed that significant ($P<0.05$) difference was found in both part of *Rasmalai* samples collected from different respondents.

Acidity per cent in Rasogolla part of *Rasmalai* samples varied from 0.30 to 0.47. Respondent B's Rasogolla part of *Rasmalai* sample had highest acidity per cent while respondent C's sample had lowest. Results of present study are in harmony with Suresh (1989) who reported acidity 0.43 to 0.47 per cent in market samples of Rasogolla. Acidity per cent in concentrated milk part of *Rasmalai* samples varied from 0.32 to 0.45. Respondent J's concentrated milk part of *Rasmalai* sample had highest acidity percent while respondent C's sample had lowest. The results of present study are in accordance with Khokhar (1989) who reported acidity in *Rabri* 0.33 to 0.42 per cent. Analysis of data revealed that acidity per cent in both part of *Rasmalai* samples collected from different respondents did not differ significantly ($P < 0.05$).

pH of Rasogolla part of *Rasmalai* samples ranged from 6.44 to 6.60 Rasogolla part of *Rasmalai* samples collected from Respondent D had highest pH value and respondent B had lowest. pH in concentrated milk part of *Rasmalai* samples ranged from 6.33 to 6.48. Concentrated part of *Rasmalai* samples collected from respondent F had maximum pH value & respondent B had minimum. Khokhar (1989) reported pH 6.04 to 6.41 of *rabri* samples collected from the Hisar market which are in close agreement with the present study. Significant ($P<0.05$) difference was found in pH values of Rasogolla part of *Rasmalai* samples collected from different respondents and in concentrated milk part did not.

TBA values of Rasogolla part of *Rasmalai* samples ranged from 3.96 to 4.5 per cent. Rasogolla part of *Rasmalai* samples collected from respondents G had maximum values and respondent D had minimum. Whereas in concentrated milk part of *Rasmalai* samples it varied between 3.95 to 4.55 per cent. Concentrated part of Rsamalai samples collected from respondent H had maximum TBA value and respondent D had minimum. Analysis of data revealed that both parts of *Rasmalai* samples collected from different respondents did not differ significantly.

4.2.2 Bacteriological quality

Fresh *RASMALAI* samples were collected and tested for osmophilic counts.

Osmophilic counts varied from 4-18 colonies in some petri dishes, as per microbiological method below 30 colonies are not to be taken into account that's why these are presented as nil.

Coliform counts varied from 4-13 colonies. The count was below 30 considered as nil.

4.2.3 Sensory evaluation

Sensory evaluation trials of market samples of *rasmalai* were conducted for evaluating the most acceptable product with in respondents to adopt the manufacture technology for rasamali preparation under laboratory conditions. Sensory scores are presented in Table 3.

Rasmalai sample collected from respondent A was scored highest and respondent F sample was scored lowest for colour and appearance of *Rasmalai.* Analysis of data revealed that *Rasmalai* samples collected from different respondents did not differed significantly for their colour and appearance.

Respondent H was preferred most while respondent C's sample least for body and texture of *Rasmalai.*

Table 3: Sensory scores of Rasmalai for market samples

Sr. No.	Colour and appearance	Body and texture	Flavour	Overall acceptability
A	**7.37±0.067**	7.67±0.167	7.70±0.265	7.60±0.153
B	7.20±0.208	7.57±0.033	**6.47±0.384**	7.17±0.260
C	6.93±0.260	**7.13±0.088**	7.20±0.153	7.33±0.133
D	7.20±0.058	7.27±0.067	7.23±0.233	**7.03±0.260**
E	7.27±0.120	7.60±0.231	7.37±0.328	7.53±0.367
F	**6.87±0.433**	7.27±0.521	7.17±0.406	7.13±0.498
G	7.27±0.441	7.57±0.318	7.80±0.208	7.60±0.252
H	7.23±0.219	**7.70±0.153**	**7.83±0.120**	7.63±0.088
I	7.33±0.297	7.67±0.328	7.50±0.351	**7.67±0.219**
J	7.30±0.306	7.37±0.033	7.23±0.088	7.20±0.100

Analysis of data revealed that *Rasmalai* samples collected from different shops did not differ significantly ($P<0.05$) in body and texture scores.

Respondents H's sample was liked vary much by the judges and respondent B's sample was liked slightly for its flavour. Data analysis revealed that *Rasmalai* samples collected from different shops did not differ significantly in flavour.

Over all acceptability scores of *Rasmalai* samples colleted from different respondents varied between 7.03 to 7.63. Respondent I's sample was liked very much by the judges while respondent D's sample was preferred moderately. Scores analysis revealed that there was no significant difference for overall acceptability between samples collected from respondents

According to analysis of sensory scores revealed that no significant difference in colour and appearance, body and texture, flavour and over all acceptability attributes was observed in *rasmalai* samples collected from different shops.

However, respondent I's sample had highest score for overall acceptability. Hence, the manufacturing steps adopted by this respondents were taken in the form of

photograph and are presented in series from 1-28 along with brief discussion.

Photograph No.1 Receiving of milk for Rasogolla making

Sweet maker received the cow milk from the milk vendors.

Photograph No. 2 Heating of milk

Milk was heated on diesel bhatti in iron karahi to the boiling point. Occasionally stirring was done with the help of palta (Scra per) to avoid the burning to solids.

Photograph No. 3 Cooling of the milk

Milk was cooled to approximately 90°C by transferring it in another karhai.

Photograph No. 4 Temperature Checking

Temperature was being checked by the help of thermometer, but Sweet makers did not follow such practices. They judged the temperature just by experience.

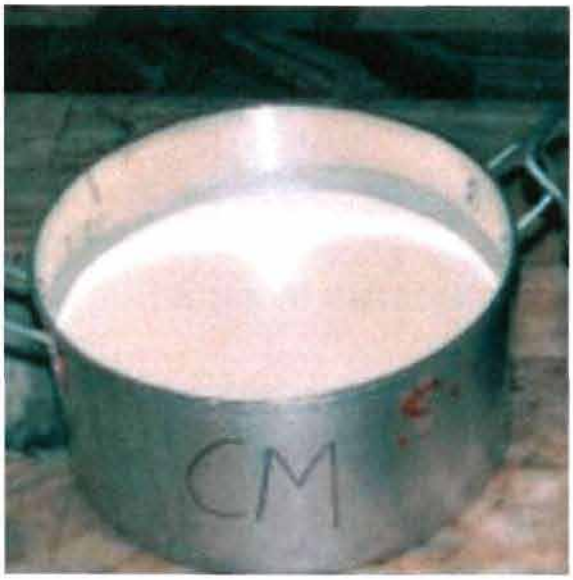
Photograph No. 5 Addition of whey as coagulant

Previous day whey was added in the milk for coagulation.

Photograph No. 6 Coagulated milk holding

Milk was kept undisturbed for 5-10 minutes after adding previous day whey. Holding was done for complete coagulation.

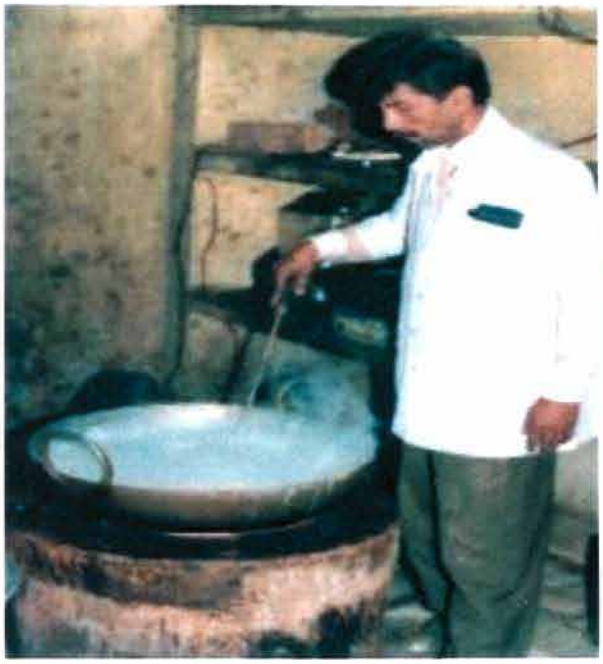
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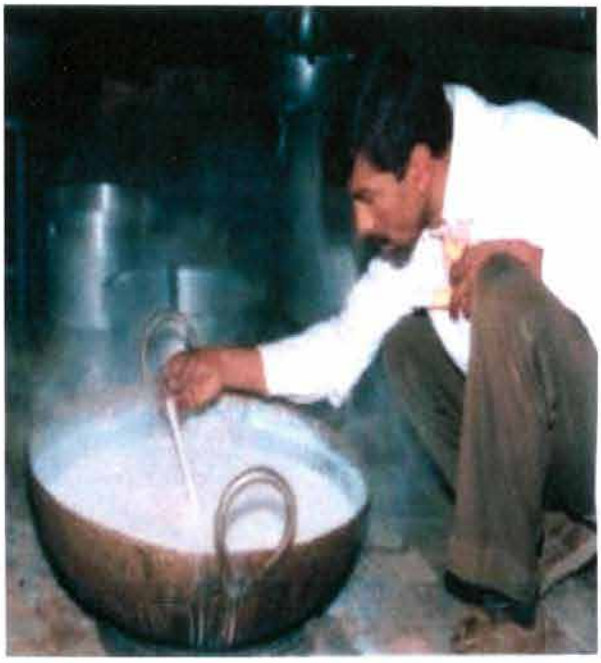
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4



Photograph No. 1: Receiving of milk for Rasogolla making
Photograph No. 2: Heating of Milk
Photograph No. 3: Cooling of the milk
Photograph No. 4: Temperature checking

Photograph No. 7 Transfer of coagulated milk for filtration

After coagulation, coagulated milk was transferred with the help of khunti into muslin cloth, which was spread over a mulberry basket on bucket.

Photograph No. 8 Filtered coagulum mass

Coagulum was left undisturbed for some time to filter the whey. Whey was collected into the bucket and Whey was collected into the bucket and is kept for next day use as coagulant at room temperature.

Photograph No. 9 Hanging of *Chhana* for whey removal

Chhana collected into muslin cloth was hanged for whey removal. *Chhana* mass in muslin cloth was twisted on mulberry basket several times to remove the whey. Texture and moisture of *chhana* was judged by touching the *chhana* by fingers.

Photograph No. 10 Cooling of *chhana*

Chhana was cooled down by dipping it in running tape water for two-three times. During this process excess sourness of *chhana* was also removed.

Photograph No. 11 Pressing of *chhana*

Pressing of *chhana* was done with the help of stone sill for the removal of excess moisture. *Chhana* was kept under stone sill for about 10 minutes.

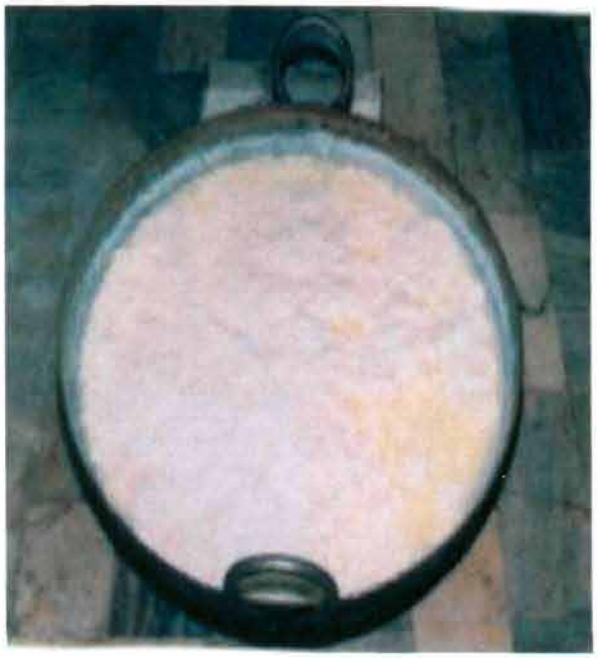
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8



Photograph No. 5: Addition of whey as coagulant
Photograph No. 6: Coagulated milk holding
Photograph No. 7: Transfer of coagulated milk for filtration
Photograph No. 8: Filtered coagulum mass

9



11



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Photograph No. 9: Hanging of chhana for whey removal
Photograph No. 10: Cooling of chhana
Photograph No. 11: Pressing of chhana
Photograph No. 12: Manual rolling of chhana

Photograph No. 12 Manual rolling of *chhana*

After pressing *chhana* was rolled manually on the table holding it in muslin cloth for obtaining smooth texture and removal of moisture.

Photograph No. 13 Testing of *chhana*

Chhana texture was tested by rubbing between the fingers.

Photograph No. 14 Transferring of *chhana* on wooden planks

Chhana was transferred on the wooden plank and devided into two or three part.

Photograph No. 15 Rolling of *chhana* for ball making

Chhana was rolled for several times over wooden plank for making *chhana* balls.

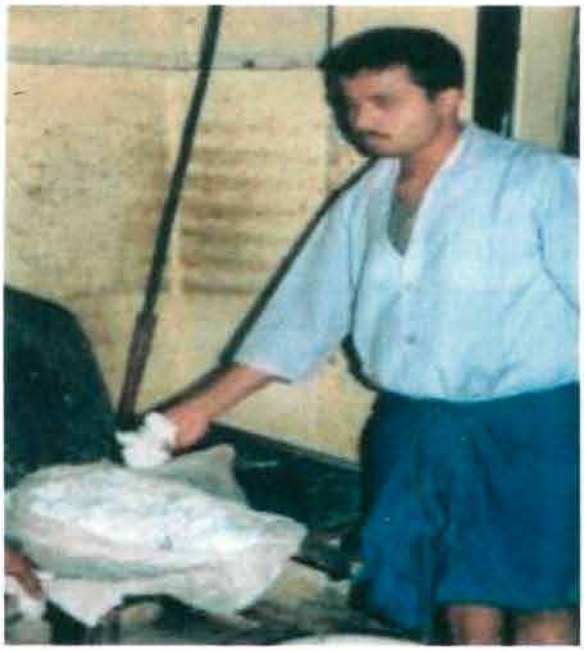
Photograph No. 16 Making of *chhana* balls

Chhana balls were made by taking 13-15 gm *chhana* in one time and then rolled with mild pressure between the palms.

Photograph No. 17 Heating of sugar syrup

Heating of sugar syrup 50 per cent was done in iron Karahi on diesel bhatti. To clarify sugar syrup a small quantity of raw milk was added in it and scum was removed with the help of perforated ladle.

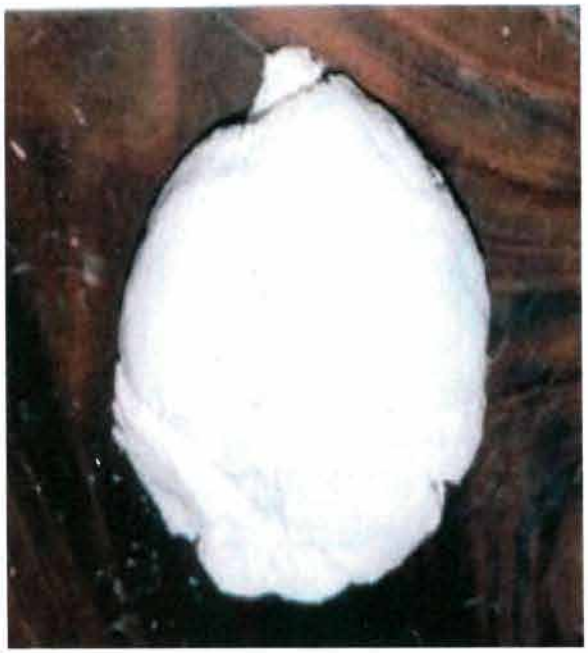
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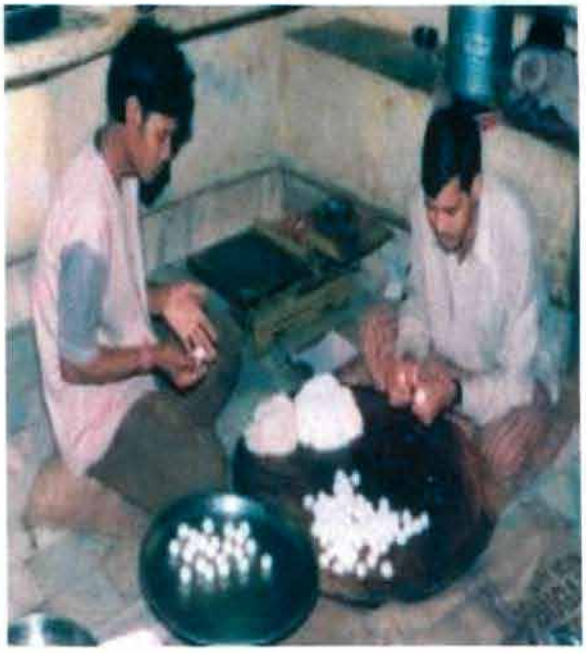
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Photograph No. 13: Testing of chhana
Photograph No. 14: Transferring of chhana on wooden planks
Photograph No. 15: Rolling of chhana for ball making
Photograph No. 16: Making of chhana balls

Photograph No. 18 Transfer of *chhana* balls to boiling sugar syrup

Chhana balls were gently transferred into the boiling sugar syrup for cooking.

Photograph No. 19 Cooking of Rasogolla

Chhana balls were cooked in 50 per cent sugar syrup in the karhai till they gain size *Chhana* balls were cooked by sprinkling reetha water in to sugar syrup for making foam for complete cooking. Occasionally little warm water is also added into the sugar to meet out the evaporated water and the maintain concentration of sugar syrup.

Photograph No. 20 Checking of cooked balls

Checking of *chhana* balls were done to ensure the complete cooking of the balls after complete cooking these balls were come out to the surface of sugar syrup and to judge the complete cooking Appearance of the product was seen. The product was then transferred into 35-40 sugar syrup.

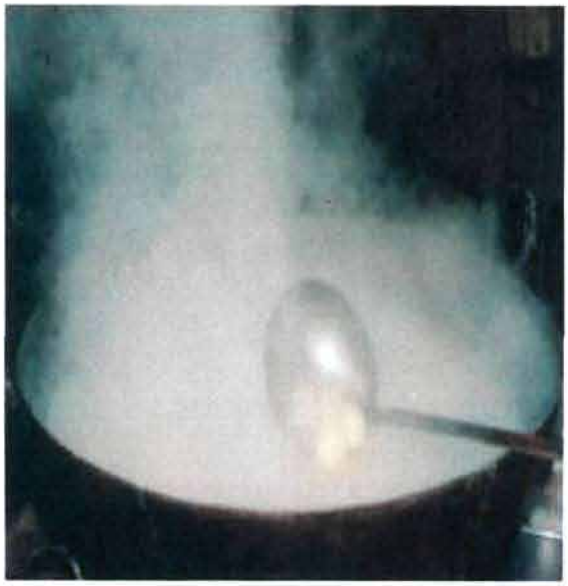
Photograph No. 21 completion of Rasogolla cooking

The completion of cooking was judged by the appearance as well as floating of the Rasogolla balls on the surface of sugar syrup.

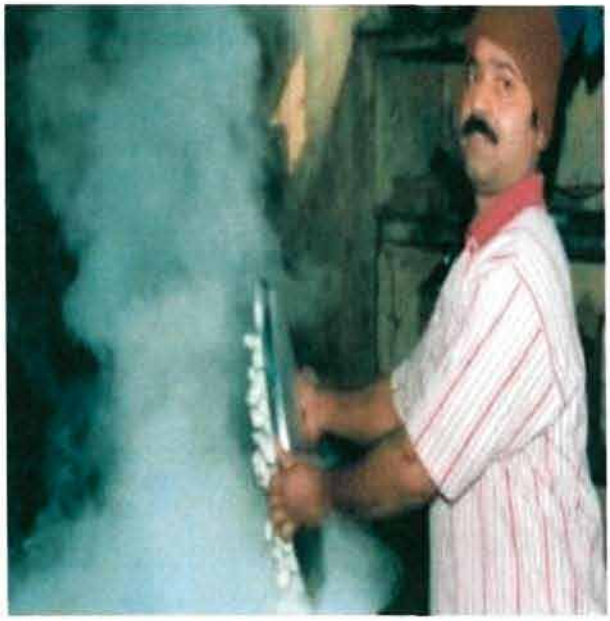
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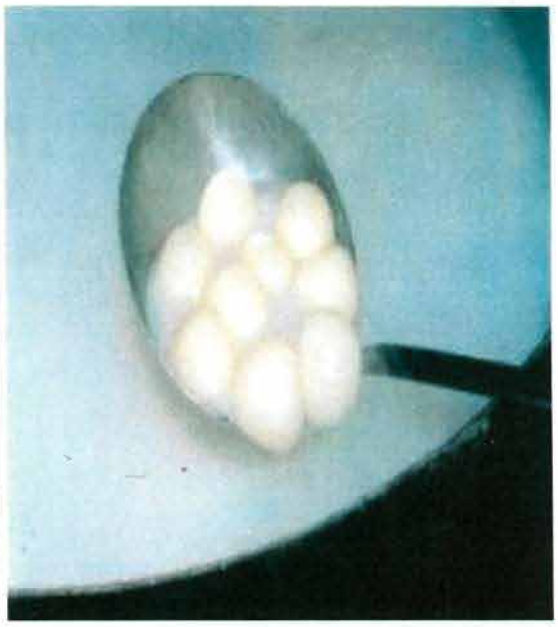
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Photograph No. 17: Heating of sugar syrup
Photograph No. 18: Transfer of chhana balls to boiling sugar syrup
Photograph No. 19: Cooking of Rasogolla
Photograph No. 20: Checking of cooked balls

Photograph No. 22 Transfer of Rasogolla from boiling sugar syrup

After completion of cooking of the Rasogolla were transferred from the boiling Rasogolla syrup.

Photograph No. 23 Sugar Syrup for dipping of Rasogolla

The picture shows the sugar syrup (40 per cent) for dipping the Rasogolla.

Photograph No. 24 Dipping and cooling of Rasogolla

Finally the Rasogolla were transferred into sugar syrup (40 per cent) for dipping and cooking at least for 2 hrs.

Photograph No. 25 Receiving of buffalo milk

Buffalo milk was received from the milk vender.

Photograph No. 26 and 27 Transfer of milk for heating

Buffalo milk was transferred into the iron Karhai for heating.

Photograph No. 28 Boiling of milk to desired concentration

The milk was boiled with continuous staring with the help of iron palta till volume reduced to one third to its original volume.

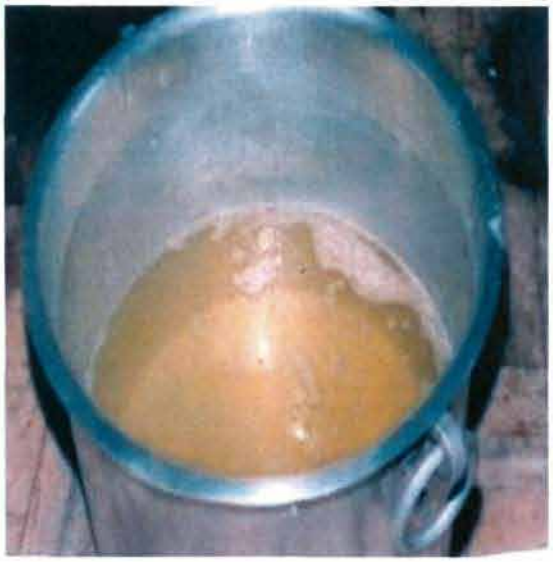
4.3 Technology Standardization.

To standardize *rasmalai* technology at laboratory scale various variables were studied.

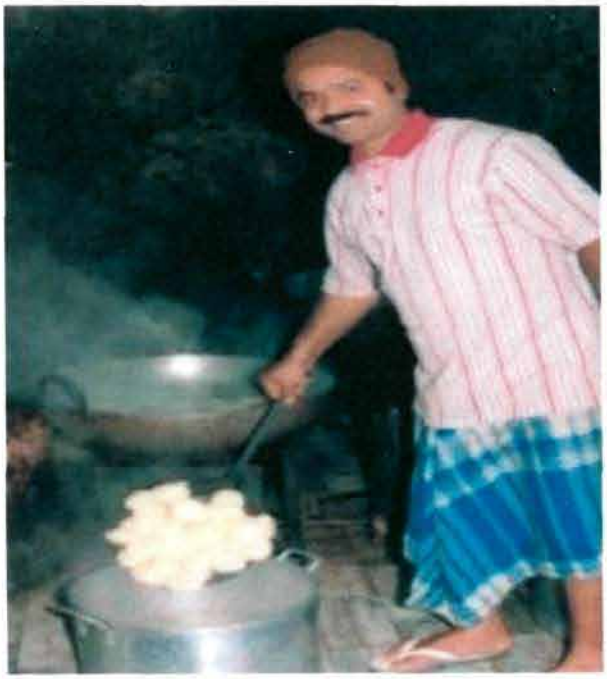
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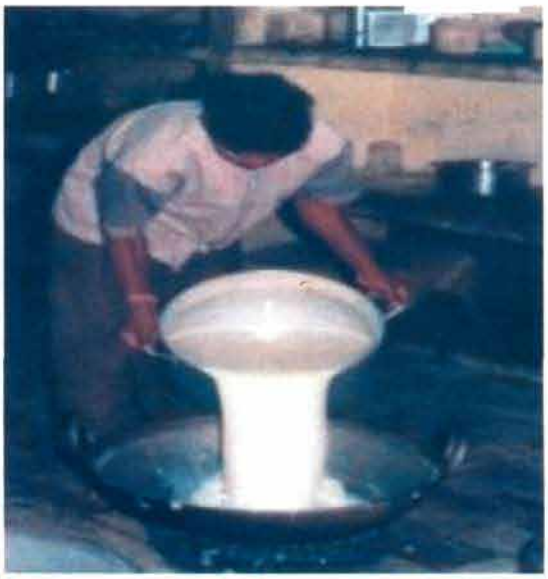


Photograph No. 21: Completion of Rasogolla cooking
Photograph No. 22: Transfer of Rasogolla from boiling sugar syrup
Photograph No. 23: Sugar Syrup for dipping of Rasogolla
Photograph No. 24: Dipping and cooling of Rasogolla

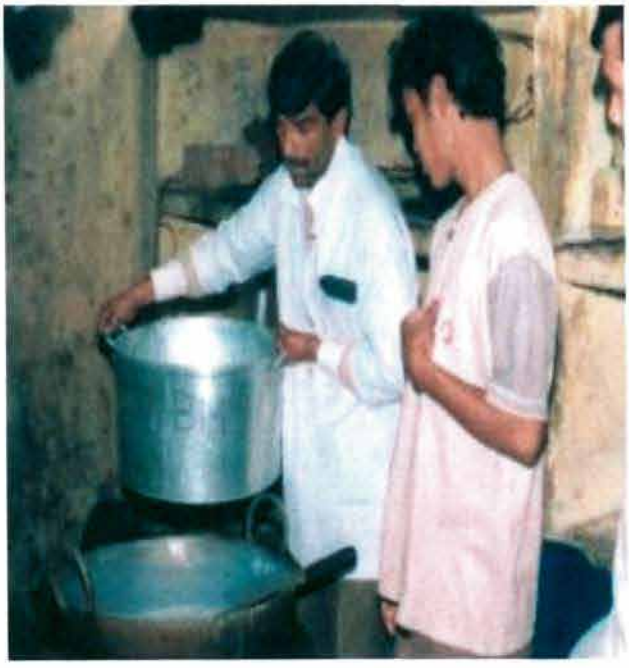
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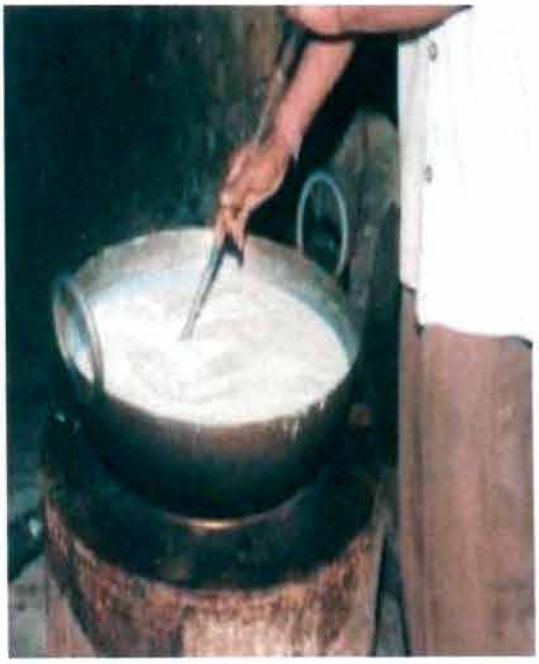
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Photograph No. 25: Receiving of Buffalo milk
Photograph No. 26-27 Transfer of milk for heating
Photograph No. 28: Boiling of milk to desired concentration

4.3.1 Standardization of semolina level to be added in *chhana* for Rasogolla preparation for *Rasmalai*

Different combination of semolina in *chhana* were tried and *rasmalai* offered for judging its sensory quality and results are presented in Table 4.

RASMALAI samples with 0 percent semolina (control) was scored highest followed by 2 percent and 5 percent respectively, for their colour and appearance, body and texture, flavour and over all acceptability. Statistical analysis of data revealed that control sample at significantly ($P<0.05$) higher score than the other two semolina levels studied.

According to sensory judging of *Rasmalai* it was concluded that 0 percent semolina level (control) was the top scorer for all the sensory attributes. Hence 0 percent semolina level in *chhana* was selected for the further study.

4.3.2 Standardization of sugar level to be used in concentrated milk/*Rabri*

Additions of three levels i.e. 1, 2 and 3 percent of sugar respectively were studied in the concentrated milk and judged for sweetness. The results obtained are present in Table 5. Scores showed that 2 percent sugar level was scored

Table 4: Standardization of semolina level in Rasmalai

Semolina level	Colour	Body and texture	Flavour	Overall acceptability
Control %	8.77±0.33	8.83±0.08	8.83±0.33	8.33±0.03
2%	7.80±0.10	7.80±0.10	7.80±0.10	7.80±0.10
5%	6.53±0.03	6.53±0.03	6.53±0.03	6.53±0.03
C.D. (P<0.05)	0.22	0.22	0.22	0.22

Table 5: Standardization of sugar level in Rasmalai

Sugar level	Sweetness
1%	7.73±0.08
2%	9.00±0.00
3%	6.57±0.3
C.D. (P<0.05)	0.09

to the level of excellent followed by 1 percent and 3 per cent respectively. Analysis of data revealed that concentrated milk with 2 percent sugar had significantly ($P<0.05$) higher score then the other levels studied so far.

Base on sweetness scores 2 percent sugar level concentrated milk was most accepted. Hence this sugar level in concentrated milk was selected for further studies.

Based on the variable studied final recipe was adopted for further studies which has been depicted in the form of flow chart Figure 1 and discussed later on.

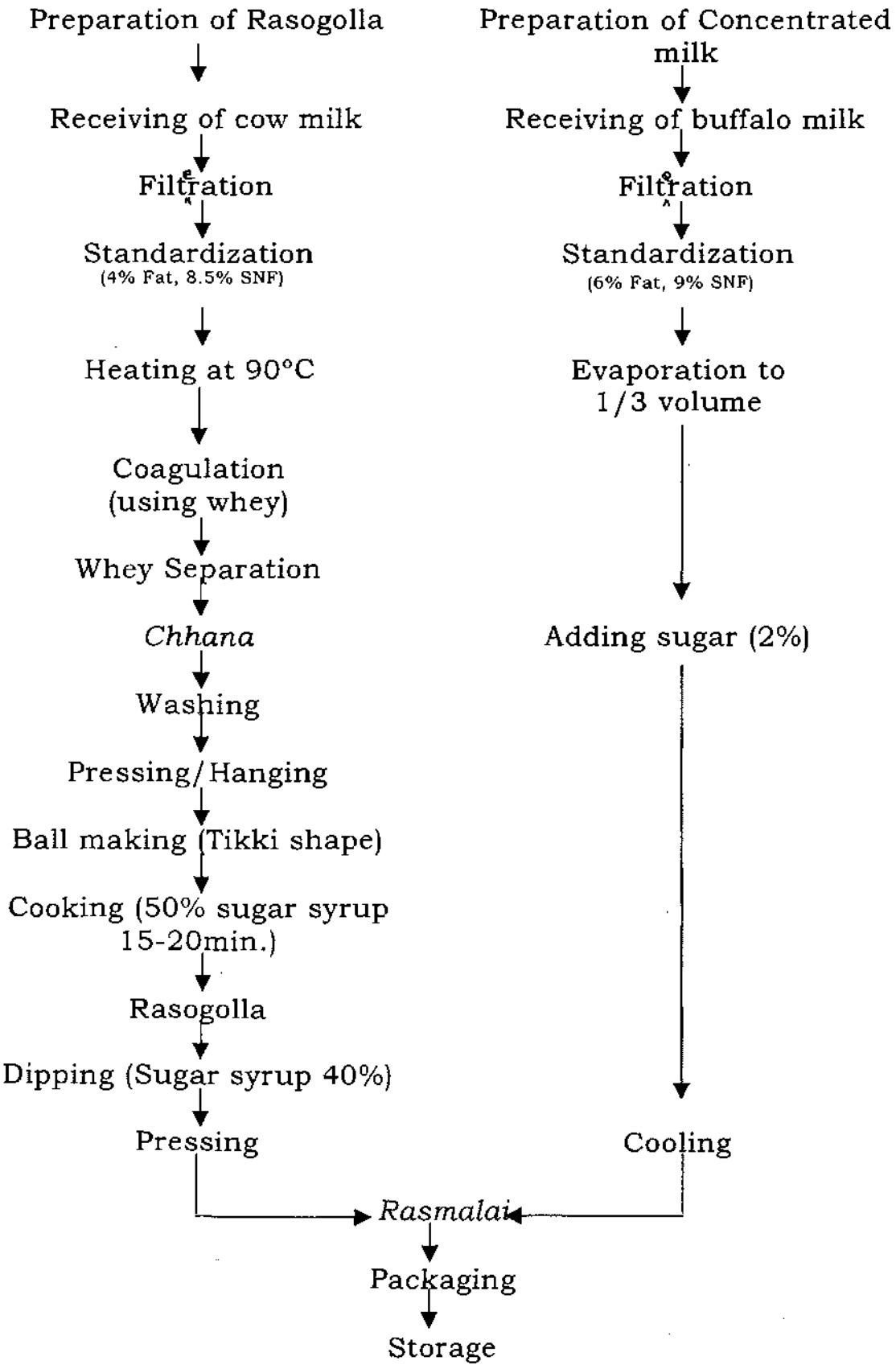


Fig. 1: Flow chart for preparation of Ras-malai

4.4 *Rasmalai*

4.4.1 Preparation of rasogolla

4.4.1.1 Receiving of milk

Cow milk was procured from the milk plant of the Department of Animal Product Technology, CCS Haryana Agricultural University.

4.4.1.2 Filtration

Cow milk was warmed upto 40°C and then filtered through muslin cloth.

4.4.1.3 Standardization

Cow milk was standardized to 4.0 per cent fat and 8.5 per cent SNF.

4.4.1.4 Heating

Cow milk was heated in iron Karahi to achieve the temperature of 90°C for inoculation.

4.4.1.5 Coagulation

After attaining to temperature i.e. 90°C, whey was added in the milk till it get coagulated and hold it for 5-10 minutes for complete coagulation.

4.4.1.6 Whey separation

The whole mass was filtered through the muslin cloth and whey was drained off.

4.4.1.7 *Chhana*

After drainage of whey the *chhana* is collected in muslin cloth.

4.4.1.8 Washing

After collecting *chhana* was washed under tape water for cool down and removal of sourness, if any.

4.4.1.9 Pressing

After washing *chhana* was pressed for 10 minutes or it was hanged for 2 hrs. or till moisture is drained out completely.

4.4.1.10 Ball making

Chhana is put on the wooden chakla for ball making. *Chhana* is divided into very small pieceis (13-15 g). A piece is rolled with mild pressing between the both hand palms.

4.4.1.11 Cooking (50 percent sugar syrup)

For cooking *chhana* balls are gently transferred into the boiling sugar syrup and cooked for 15 to 20 minutes. During cooking foam was maintained by sprinkling ritha solution in the boiling sugar syrup. After 20 minutes *chhana* balls were judged for slightly change in colour, increase in size of balls and balls start floating on the surface of sugar

syrup. Which indicated complete cooking of *chhana* balls. (Rasogolla)

4.4.1.12 Dipping

After cooking Rasogolla were transferred into sugar syrup (40%) maintained at room temperature for soaking.

4.4.1.13 Pressing

After 2 hrs. dipping Rasogolla were taken out from sugar syrup and gently pressed between the palms and then transferred to cooked concentrated milk.

4.4.2 Preparation of concentrated milk

4.4.2.1 Receiving of milk

Buffalo milk was procured from the milk plant of the Department of Animal Product Technology , CCS, Haryana Agricultural University, Hisar.

4.4.2.2 Filtration

Buffalo milk was warmed up to 40°C and then filtered through muslin colth.

4.4.2.3 Standardization

Buffalo milk was standardization to 6.0 per cent fat and 9.0 per cent SNF.

4.4.2.4 Evaporation/Concentration

Buffalo milk was heated and evaporated on bhatti with continuous stirring with the help of iron palta. When

volume of milk was reduced to one third, it was removed from fire and cooled down to room temperature.

4.4.2.5 Adding Sugar

Sugar was added @ 2 per cent.

4.4.2.6 Cooling

After adding sugar concentrated milk was further cooled down to 40°C.

4.4.3 Product (*Rasmalai*)

Pressed/squeezed rasgollas were dipped in the concentrated milk.

4.4.4 Packing

The product was packed in plastic bags sealing was done with the manual sealing machine.

4.4.5 Storage

The packed samples were stored under refrigerator temperature i.e. 5±2°C.

4.5 Storage Study

The *Rasmalai* samples were prepared by adopting selected variable and preserved by using food grade preservatives i.e. Potassium meta-bi-sulphite and Nisin @ 100 ppm each in the concentrated milk part. Microwave heat treatment 800 watt for 2.5 min. was also applied to the packed product (with out preservative). The samples were

stored at 5±2°C. Samples were drawn on 0, 5th, 10th and 15th day of storage. For chemical analysis purpose *Rasmalai* samples were divided into two parts i.e. Rasogolla and concentrated milk to analyze these part separately. Samples were analyzed for moisture, Acidity, pH TBA value and free fatty acids. *Rasmalai* samples were also analyzed for their sensory attributes during storage on the basis of 9 point scale.

4.5.1 Physico chemical parameters

4.5.1.1. Moisture

The moisture content of the samples under different treatments was determined during storage and results are presented in Table 6 & 7 The mean values of moisture contents of Rasogolla part (Table 10) of *Rasmalai* samples with Nisin, Potassium Meta-bi-sulphite, microwave heat treatment and control samples were 56.48, 56.59, 56.78 and 56.74 respectively. Moisture contents of the Rasogolla portion during storage differed non significantly with in treatment while it had shown significant ($P < 0.05$) on 5th day and later on values did not changed significantly ($P<0.05$).

Moisture content of concentrated milk portion during storage did not affect either by treatment or by storage period. The mean values of moisture content of the

Table 6: Changes in mean values of moisture content of the Rasgolla in the product during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	57.10	56.60	56.76	56.58	56.74
Microwave	57.32	56.63	56.18	56.98	56.78
Pot.meta-bi-sulhite	57.33	56.57	56.23	56.21	56.58
Nisin	56.74	56.19	56.52	56.46	56.48
Mean	57.10	56.49	56.42	56.56	

CD (<0.05) Treatment : N.S.

Storage : 0.44

Table 7: Changes in mean values of moisture content of the concentrated milk during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	62.01	61.55	61.58	62.01	61.78
Microwave	61.61	60.71	62.05	61.79	61.54
Pot.meta-bi-sulhite	62.08	62.20	61.82	61.76	61.97
Nisin	61.36	61.66	61.37	61.66	61.51
Mean	61.76	61.53	61.71	61.81	

CD (<0.05) Treatment : N.S.

Storage : N.S.

concentrated milk treated with Nisin, Potassium meta-bi-sulphite, microwave heat treatment and control samples remained almost unchanged.

4.5.1.2. Acidity

Change in acidity (as lactic acid) was noticed during storage in Rasogolla and concentrated milk part of *Rasmalai* samples and results are present in table 8 and 9. Rasogolla portion as well as concentrated milk portion of *Rasmalai* significant ($P<0.05$) mean values had not shown any change in acidity. Analysis of data revealed that neither treatment not storage period had shown any significant effect on acidity of Rasogolla as well as concentrated milk portion.

4.5.1.3 pH

Change in pH value was observed during storage period in Rasogolla part, milk part of *Rasmalai* samples and results are presented in Table 10 & 11. Rasogolla part of *Rasmalai* sample treated with microwave heat treatment had significantly ($P<0.05$) high pH value than control and potassium meta bi sulphite treated samples of 0 day and this trend in pH value was observed upto 10th day of storage. Analysis of data revealed that storage period had not shown any significant pH values of the Rasogolla part of *Rasmalai*.

Table 8: Changes in mean values of acidity (% lactic acid) of the Rasgolla in the product during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	0.216	0.228	0.230	0.225	0.225
Microwave	0.225	0.216	0.225	0.225	0.223
Pt.meta.bi.sul.	0.231	0.231	0.225	0.228	0.229
Nisin	0.228	0.228	0.234	0.228	0.230
Mean	0.225	0.226	0.228	0.226	

CD (<0.05) Treatment : N.S.

Storage : N.S.

Table 9: Changes in mean values of acidity (% lactic acid) of the concentrated milk during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	0.225	0.222	0.222	0.228	0.224
Microwave	0.225	0.225	0.225	0.222	0.224
Pt.meta.bi.sul.	0.237	0.231	0.225	0.225	0.230
Nisin	0.228	0.225	0.231	0.237	0.230
Mean	0.229	0.226	0.226	0.228	

CD (<0.05) Treatment : N.S.

Storage : N.S.

Table 10: Changes in mean values of pH of the Rasogolla in the product during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	6.48	6.48	6.46	6.50	6.47
Microwave	6.60	6.56	6.56	6.53	6.56
Pot.meta-bi-sulphite	6.53	6.46	6.46	6.50	6.49
Nisin	6.56	6.53	6.50	6.50	6.52
Mean	6.45	6.50	6.50	6.50	

CD (<0.05) Treatment : 0.06

Storage : N.S.

Table 11: Changes in mean values of pH of concentrated milk during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	6.50	6.53	6.43	6.46	6.48
Microwave	6.60	6.73	6.50	6.53	6.53
Pot.meta-bi-sulphite	6.50	6.46	6.46	6.50	6.48
Nisin	6.53	6.56	6.54	6.50	6.53
Mean	6.53	6.57	6.48	6.50	

CD (<0.05) Treatment : 0.06

Storage : 0.06

Concentrated part of rsamalai sample treated with microwave treatment had significantly (P<0.05) high pH value as compared to other samples at 0 day. Non significant increase in pH was noticed in all the sample at 5th day of storage except microwave heat treated samples which had shown significant (P<0.05) increase and potassium meta bi sulphite treated sample had not shown any significant change in pH value during entire storage period. Analysis of data revealed that treatments as well as storage period had significant (P<0.05) effect on pH value of concentrated milk part of *Rasmalai* samples.

4.5.1.4 TBA values

Change in TBA value was recoded during storage period in Rasogolla part and concentrated milk part of *Rasmalai* and results are presented in Table 12 & 13. Mean values of the Rasogolla portion had shown that potassium meta bi sulphite treated sample had significantly (P<0.05) high TBA value as compared to other samples. The mean values had shown significant increase in TBA value at 15th day of storage. Analysis of data revealed the treatment as well as storage period had shown significant effect on TBA value of Rasogolla part of *Rasmalai*. Mean values of concentrated milk part of *Rasmalai* had shown that nisin

Table 12: Changes in mean values of TBA value of the Rasgulla in the product during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	2.85	2.86	3.17	3.28	3.040
Microwave	2.92	2.95	2.95	3.40	3.055
Pt.meta.sul.	2.88	3.15	3.25	3.36	3.163
Nisin	2.73	2.89	3.00	3.31	2.944
Mean	2.85	2.96	3.09	3.33	

CD (<0.05) Treatment : 0.14

Storage : 0.14

Table 13: Changes in mean values of TBA value of the concentrated milk during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	3.02	3.08	3.31	3.45	3.217
Microwave	3.02	3.12	3.31	3.70	3.289
Pt.meta.sul.	3.09	3.21	3.32	3.48	3.274
Nisin	2.89	3.02	3.16	3.56	3.158
Mean	3.01	3.11	3.27	3.55	

CD (<0.05) Treatment : 0.07

Storage : 0.07

treated sample had significantly (P<0.05) lower TBA value in comparison to other samples. Mean values had shown significant (P<0.05) decrease in TBA value at 5th day of storage and thereafter, significant (P<0.05) increase was noticed at each stage of analysis.

Analysis of data revealed that treatments as well as storage period had significantly (P<0.05) effect on TBA value of concentrated milk part of *Rasmalai.*

4.5.1.5 Free Fatty Acids

Change in Free fatty acids was noticed during storage in Rasogolla and concentrated milk part of *Rasmalai* samples and results are present in table 14 and 15. Rasogolla protein as well as concentrated milk protein of *Rasmalai* had not shown any changed in Free fatty acids during storage. Analysis of data revealed that neither treatment nor storage period had shown any significant effect on FFAs of Rasogolla as well as in concentrated milk part of *Rasmalai.*

4.5.2 Microbiology

Osmophilic count in Rasogolla part and in concentrated milk part were found nil.

Coliform count in Rasogolla part and in concentrated milk part were found nil.

Table 14: Changes in mean values of free fatty acid (% Oleic acid) content of the Rasogolla in the product during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	0.168	0.168	0.167	0.169	0.168
Microwave	0.167	0.168	0.167	0.168	0.168
Pot.meta-bi-sulphite	0.167	0.168	0.168	0.168	0.168
Nisin	0.167	0.168	0.168	0.168	0.168
Mean	0.167	0.168	0.167	0.168	

CD (<0.05) Treatment : N.S.

Storage : N.S.

Table 15: Changes in mean values of free fatty acid (% Oleic acid) content of the concentrated milk during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	0.140	0.140	0.140	0.140	0.140
Microwave	0.137	0.140	0.139	0.142	0.140
Pot.meta-bi-sulphite	0.139	0.140	0.141	0.140	0.140
Nisin	0.139	0.140	0.141	0.140	0.140
Mean	0.139	0.140	0.140	0.140	

CD (<0.05) Treatment : N.S.

Storage : N.S.

4.5.3 Sensory Evaluation

The *Rasmalai* samples were subjected to the sensory evaluation test using nine point hedonic scale to judging the acceptability during storage period at 0,5,10 and 15th day.

4.5.3.1 Colour and appearance

The data obtained for colour and appearance is presented in Table 16.

The mean score of colour and appearance of the *Rasmalai* samples had shown that Nisin treated samples was scored significantly lower as compared to the other samples. Even though it was liked very much by the judges. The mean value score also shown that there was no significant change in the colour and appearance of *Rasmalai* samples during storage. Analysis of data revealed that treatment had significant effect on colour and appearance of *Rasmalai* whereas storage period did not.

4.5.3.2 Body and Texture

The data obtained for body and texture is presented in table 17.

It was observed from the mean values of body and textures of sensory evaluation scores of *Rasmalai* samples that treatments had significant effect and potassium meta bi

Table 16: Changes in mean values of colour and appearance of sensory evaluation scores during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	8.66	8.66	8.80	8.83	8.74
Microwave	8.72	8.72	8.75	8.70	8.72
Pot.meta-bi-sulhite	8.58	8.44	8.50	8.65	8.54
Nisin	8.23	8.33	8.26	8.33	8.29
Mean	8.55	8.54	8.58	8.63	

CD (<0.05) Treatment : 0.08

Storage : N.S.

Table 17: Changes in mean values of body and texture of sensory evaluation scores during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	8.66	8.90	8.86	8.96	8.85
Microwave	8.35	8.46	8.43	8.46	8.43
Pot.meta-bi-sulhite	8.21	7.98	7.98	8.10	8.06
Nisin	8.53	8.40	8.16	8.43	8.38
Mean	8.44	8.43	8..36	8.49	

CD (<0.05) Treatment : 0.08

Storage : 0.08

sulphite treated sample was scored lowest as compared to other samples whereas control sample judged excellent. The judges liked very much all the *Rasmalai* samples for their body and texture. During storage judges did not found any significance difference in the body and texture of *Rasmalai* samples. Although the analysis of the data revealed that treatment as well as storage period had significant effect on body and texture scores of *Rasmalai* samples.

4.5.3.3 Flavour

The data obtained for flavour is presented in table 18.

It was observed from the mean values of flavor judged by the judges that control samples had significantly high flavor score followed by microwave heat treatment potassium meta-bi-sulphite and nisin. The storage period had not shown any significant effect of flavor of *Rasmalai* samples upto the end of storage. Analysis of the data revealed that treatments had significant effect of flavor of *Rasmalai* samples whereas storage did not.

4.5.3.4 Overall Acceptability

The data obtained over all acceptability is presented in table 19.

Table 18: Changes in mean values of flavour of sensory evaluation scores during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	8.80	8.80	8.80	8.90	8.82
Microwave	8.58	8.55	8.35	8.45	8.48
Pot.meta-bi-sulphite	8.43	8.34	8.27	8.44	8.37
Nisin	8.33	8.33	8.33	8.26	8.31
Mean	8.53	8.50	8.44	8.51	

CD (<0.05) Treatment : 0.07

Storage : N.S.

Table 19: Changes in mean values of overall acceptability of sensory evaluation scores during storage

Treatment	Storage (days)				Mean
	0	5	10	15	
Control	8.46	8.66	8.90	8.93	8.74
Microwave	8.62	8.66	8.49	8.49	8.57
Pot.meta-bi-sulphite	8.40	8.10	7.97	8.36	8.21
Nisin	8.42	8.36	8.32	8.32	8.36
Mean	8.48	8.45	8.42	8.52	

CD (<0.05) Treatment : 0.08

Storage : N.S.

The overall acceptability scores were differed significantly ($P<0.05$) for storage. It was observed from the mean values of over all acceptability judged by the judges that control sample had significantly high over all acceptability score followed by microwave heat treatment, Nisin and potassium meta-bi-sulphite. The storage period had not shown any significant effect on over all acceptability up to the end of storage. Analysis of the data revealed that treatment had significant effect on over all acceptability of *Rasmalai* samples where as storage did not.

CHAPTER-V

Summary and Conclusion

The study was envisaged in the present investigation was to find out the existing technology of manufacture of *Rasmalai* and its market quality. Ten manufacturer shops were selected for collecting information. Samples (in triplicate) were collected from these 10 selected shops.

- it was found that 30 per cent sweet makers were matric, 30per cent below matric and 40per cent above matric.
- Seventy per cent respondents procured milk from vendors, 20 per cent from private dairy and 10per cent procured milk from contractors.
- Eight respondents were using cow milk (preferably), seven respondents were using buffalo milk (if cow milk was not available) and 5 were using mixed milk. But all

were using buffalo milk for preparation of concentrated milk.

- ❖ All respondents conducted Khoa test for quality control for procured milk and two of them also conducted fat test by Gerber's method.
- ❖ Five to 410 l milk is used for concentrated milk production and 3-60 l. milk is used for *Chhana* production using previous day whey.
- ❖ All respondents used diesel Bhatti and two of them also used Gas Chullah as heating device.
- ❖ Yield of the product was 40per cent and shelf-life of the product varied between 6-48h at room temperature and 1 to 5 days at refrigeration temperature.
- ❖ The cost of production per kg of the product varied between Rs. 70–75 and profit margin also varied from Rs. 10 to 15 per kg of the product.
- ❖ Seven respondents served it in plastic cups, one served it in steel plates and one served it in China plates. Eight of them used plastic bags for home delivery.
- ❖ The composition of the Rasogolla for fat, protein, total carbohydrates, total solids and ash varied between 9.1 to 10.97, 9.63 to 11.3, 16.8 to 18.82, 38.54 to 40.30, 1.26 to 1.31per cent respectively, while in liquid

concentrate it varied from 6.46 to 7.55, 6.47 to 7.25, 17.78 to 19.60, 33.01 to 34.92 and 1.08 to 1.28 per cent respectively.

- The acidity (per cent), pH, TBA value of the Rasogolla samples varies between 0.30 to 0.47, 6.44 to 6.60 and 3.96 to 4.51 respectively, while in concentrate part this varied from 0.32 to 0.45, 6.33 to 6.48 and 3.95 to 4.70 respectively.
- The overall acceptability score of market samples varied between 7.03 to 7.67 which differed non-significantly.
- Coliform and osomophillic counts were not detected in any of the market samples.

Standardization and Storage studies on Rasmalai

- The use of semolina for making chhana balls resulted in decreased sensory scores of resultant Rasogolla, so the product was standardized without the use of semolina. The standardized product was aseptically packed after giving treatments i.e. Nisin, Potassium-meta-bi-sulphite and microwave treatment; and stored at 5±2°C.
- Moisture level was found to decrease significantly during storage in Rasogolla part of Rasmalai.
- Change in the acidity was non-significant pH in Rasogolla part differed significantly for the treatment,

but did not differ significantly during storage. pH in concentrated milk showed a significant change.

- ❖ TBA value increased significantly during storage and among the treatments also it differed significantly. FFAs during storage increased significantly in the Rasogolla part.
- ❖ Storage had no significant effect on the body and texture of the product while the treatments had significant effect. Overall sensory scores remained in the range of 8.48 to 8.52 i.e. the product was 'liked very much'. During storage coliform and osmophillic count were not detected.

CONCLUSION

From the results of the present study it can be concluded that no standard technology is presently being followed by the private traders (Halwais) for making Rasmalai. Type of the milk used, quantity of milk per batch, additives used and the cost of production varied widely. But the proximate composition of the market samples was in narrow range, the difference being non significant.

The product, standardized in the laboratory with respect to type of milk, quantity per batch with 2per cent sugar level, resulted in a much improved quality having high

sensory scores in the fresh, which stayed beyond 15 days without spoilage at 5±2°C. The standardized product was found to be chemically and bacteriologically safe for human consumption.

However further investigations are required for finding suitable packaging materials and for laying down the standards under PFA act or BIS.

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QUESTIONNAIRE FOR FINDING EXISTING TECHNOLOGY OF *RASMALAI*

INTERVIEW SCHEDULE

Date:_____
Place:_____

Name and address of respondent

(a) Name

(b) Shop

Education of the respondent

(a) Matric

(b) Above Matric

(c) Below matric

Source of Milk Procurement

(a) Vendor

(b) Private Dairy

(c) Milk Plant

(d) Contractor

Type of Milk used (a) Rasgolla making

(a) Cow Milk

(b) Buffalo Milk

(c) Mixed Milk

Type of Milk used (b) Concentrated milk

(a) Cow Milk

(b) Buffalo Milk

(c) Mixed Milk

Do you conduct any test

(a) Fat test

(b) *Khoa* test

(c) Any other

(d) None

Quantity of milk used

(a) Quantity of milk used for concentrated milk per day.

(b) Quantity of milk used for *Chhana* production per day.

Type of container used for product preparation

(a) Iron container

(b) Steel container

Type of heating device

(a) Gas Chullha– Small

– Large (Commercial

(b) Diesel Bhatti

(c) Kerosine Bhatti

(d) Coal Bhatti

(e) Fire Wood Bhatti

Quantity of Fuel used per batch.

(a) Gas

(b) Diesel

(c) Kerosine

(d) Fire Wood

(e) Coal

Additives used per batch and their quantity.

(a) Ball Making –
  (i) Semolina
  (ii) Other

(b) Concentrated Milk-
  (i) Sugar
  (ii) Other

(c) In over all product-
  (i) Dry Fruits
  (ii) Essence
  (iii) Preservative if any

Time consumption of labour for making one batch

Yield (%) of the product per batch

Approximate cost of the product per batch.

(a)	**Milk**	**Qty.**	**Rate**	**Amount**
(b)	Sugar			
(c)	Additives (Dry fruits)			
(d)	Coagutant			

(e) Essence

(f) Preservatives

(g) Packaging

(h) Labour

(i) Refrigeration cost

Shelf-life of the product

(a) At refrigeration temp. (days)

(b) At room temp. (days)

Any specific information regarding "Rasmalai" manufacture

Sale –rate per kg or per piece

Profit per kg of finished product

Method of service

(i) At shop as immediate service

(a) China Plates

(b) Earthen Pots

(c) Silver coated paper plates

(d) Polythene cups.

(ii) For home consumption

(a) Plastic bags.

(b) Earthen Pots

(c) Polyethylene containers

(d) Any other

Appendix -II

Table A: Hedonic scale for sensory evaluation of paneer.

Name_____ Date_____

(Judge)

Score preparance

9 : Like extremely
8 : Like very much
7 : Like moderately
6 : Like slightly
5 : Neither like nor dislike
4 : Dislike slightly
3 : Dislike Moderately
2 : Dislike very much
1 : Dislike extremely

Code No.	Characteristics				
	Colour and appearance	Body and texture	Flavour	Overall accept-ability	
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

Remarks if any :

295427

Signature

ABSTRACT

Title of Research Project	:	Technological aspect of Rasmalai and indigenous chhana based sweet.
Full name of degree holder:		**Suraj Pal Sharma**
Title of degree	:	**Doctor of Philosophy**
Name and address of Major Advisor	:	**Dr. C.M. Kapoor** Professor & Head Department of Animal Products Technology, College of Animal Sciences, CCS Haryana Agricultural University, Hisar-125 004 (India)
Degree awarding University/: Institute		**CCS Haryana Agricultural University, Hisar-125 004 (India)**
Year of award of degree	:	**2004**
Major subject	:	**Animal Products Technology**
Number of words	:	425 Approx.

(An abstract of the thesis presented in partial fulfillment of the requirements of the degree of Ph.D., Ch. Charan Singh Haryana Agricultural University, Hisar)

A study was conducted to find out the existing technology of manufacture of Rasmalai and its market quality. The study further envisaged to standardized the technology of the product and its storage ability. Seventy percent respondent in the market procured milk from vendors, using cow milk for Rasogolla making and buffalo milk for concentrated milk. Survey further revealed that there was lot of variation in the quality testing, milk used per batch, source of heating device and shelf life.

The composition of market samples of the Rasogolla for fat, protein, total carbohydrates, total solids and ash varied between 9.2 to 10.97, 9.63 to 11.3, 16.8 to 18.82, 38.54 to 40.30, 1.26 to 1.31 per cent respectively while in milk concentrate part it varied from 6.46 to 7.55, 6.47 to 7.25, 17.78 to 19.60, 33.01 to 34.92 and 1.08 to 1.28 respectively. The overall sensory score of samples varied between 7.03 to 7.67.

The technology of Rasmalai was standardized on laboratory scale. It was found that product made without semolina using two percent sugar in the concentrated milk was most acceptable. The sensory scores of the developed product for different sensory attributes was found to be between "liked very much" to "liked extremely" which was much above the market sample's sensory score. However preservation by using microwave treatment, Potassium-meta-bi-sulphite and Nisin resulted in a decreasing trends in the sensory attributes which remained as such during fifteen days storage period.

Mean values of moisture content ion Rasogolla increase from 57.10 to 56.56 which differed significantly while for concentrated milk it was non significant. Increase in the acidity in Rasogolla and concentrated milk was non significant. Changes in the pH during storage was not significant for Rasogolla

part but significant for concentrated milk. The TBA values differed significantly for the storage as well as for the treatments. Increase in the free fatty acids in Rasogolla part differed significantly.

Mean value of the overall acceptability score of the developed product varied between 8.42 to 853 for the storage periods and from 8.21 to 8.74 between the treatments, thereby revealing that the product remained highly acceptable during the storage period. Sensory score for the different attributes under control samples was the highest followed by microwave treated samples. The product was found to be chemically and bacteriologically safe for consumption and the developed technology can be adopted for producing an improve ed product with better shelf-life.