STANDARDIZATION OF THE PROCESS FOR PREPARATION OF FROZEN SOUFFLE



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Certificate

This is to certify that the work recorded in the thesis entitled " ***Standardization of The Process for Preparation of Frozen Souffle"*** *submitted by* ***Mr. Rajeshwar Singh*** *in partial fulfilment of requirement for the Degree of Master of Technology in Dairy Technology in the West Bengal University of Animal and Fishery Sciences, is the faithful and bonafide research work carried out under my personal supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

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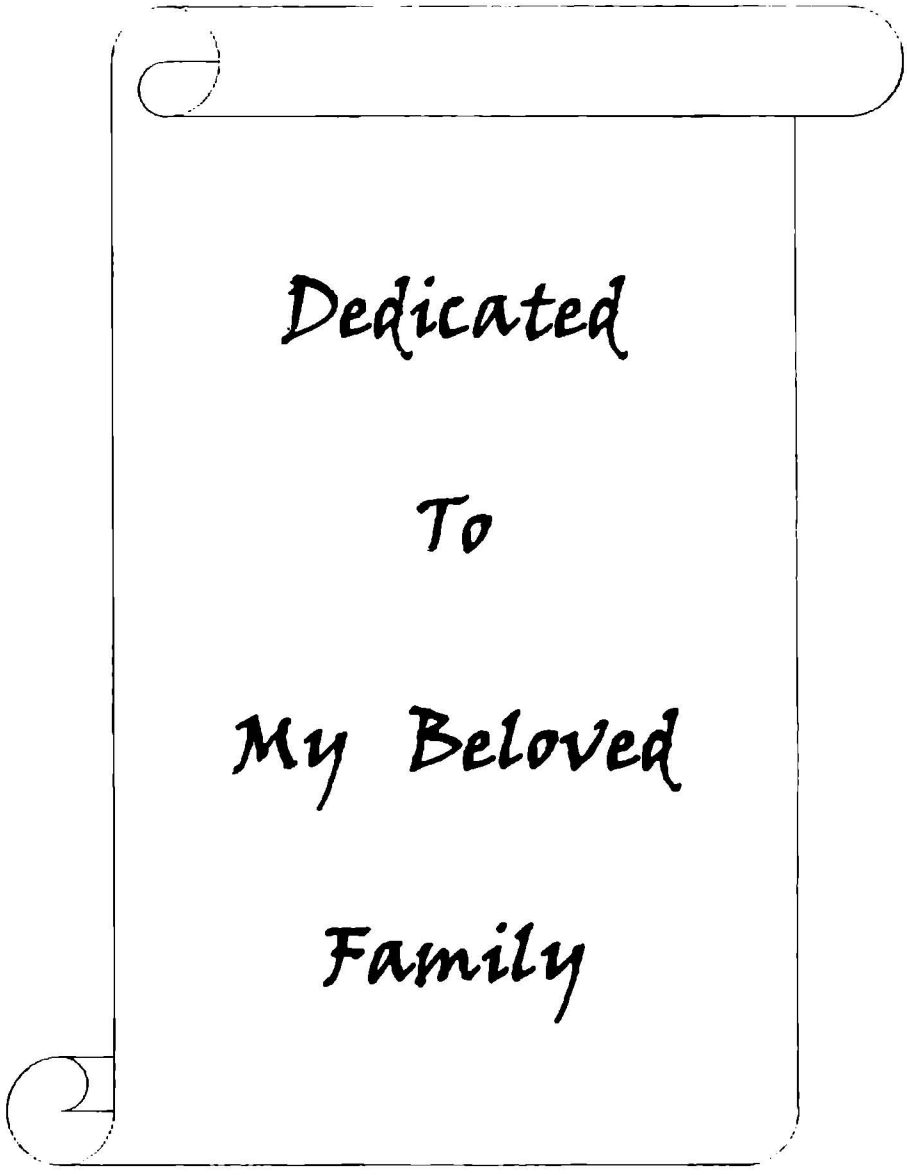
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Dedicated
To
My Beloved
Family

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ABBREVIATION

%	: Percentage
@	: At the rate of
^0C	: Degree centigrade
^0F	: Degree Fahrenheit
Anova	: Analysis of variance
Cal	: Calorie
cfu	: Colony forming unit
CO_2	: Carbon di oxide
d.f.	: Degree of freedom
et. al.	: Other people
etc	: Et cetra
g/gm	: Gram
Hr	: Hour
ie	: that is
ISI	: Indian standard
IU	: Unite international
Kcal	: kilo calorie
lit	: Litter
Ltd	: Limited
mcg	: Microgram
mg	: Milligram
Min	: Minute
Ml	: Millilitre
mm	: Millimetre
N	: Normality
nPar	: Non Parametric
PFA	: Preservation of Food Adulteration Act

pH	: Negative, logarithm of hydrogen ion concentration
psi	: per squire inch
Pt	: pint
SD	: Standard deviation
sq	: Square
MSS	: Mean sum of square
USDA	: United States Department of Agriculture
T.S.	: Total solid
Viz.	: Namely

Chapter-1



Introduction

Introduction

1.1. In cultures around the world, dessert is a course that typically comes at the end of a meal, usually consisting of sweet food. The word comes from the French language as *dessert* and this from Old French *desservir*, "to clear the table" and "to serve." Common Western desserts include cakes, biscuits, gelatin, pastries, ice cream, pies, and candies. Fruit may also be eaten with or as a dessert. Variations of desserts can be found all around the world, such as in Russia, where breakfast foods such as bliny, oladi, and syrniki served with honey and jam are also popular as desserts. Desserts are sometimes eaten with a dessert spoon, intermediate in size between a teaspoon and a tablespoon. (http://en.wikipedia.org/wiki/Dessert)

1.2. Frozen dessert is the generic name for desserts made by freezing liquids, semi-solids, and sometimes even solids. They may be based on flavored water (shave ice, sorbet, snow cones, etc.), on fruit purées, on milk and cream (most ice creams), on custard (frozen custard and some ice creams), on mousse (semifreddo), *etc.* In the UK and Ireland, where the term "dessert" is uncommon, frozen desserts are referred to as "ices". (http://en. wikipedia.org/wiki/Frozen dessert)

1.3. In ancient times, people enjoyed the food that was available. Ancient civilizations enjoyed the occasional treat of fruit or nuts rolled into honey. This, in essence, is considered the first candy. In general however, it wasn't until sugar was manufactured during the middle ages that people began to enjoy more sweets. Even then, sugar was so expensive that it was a treat reserved only for the wealthy on special occasions. However, starting in about 3000BC there is a discernable and traceable history of many of the foods that delight the sweet tooth. (http://gourmet.lovetoknow.com /History of Desserts)

The word souffle is the past participle of the French verve 'Souffle' which means to 'blow up' or 'puff up'. A souffle is a light fluffy, baked

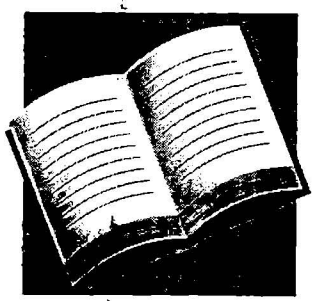
product, popular in France, made with egg yolk and beaten egg whites combined with various other ingredients and served as a dessert. Whereas frozen souffle is a frozen baked product comprising of milk, cream, egg, stabilizer and sugar. Commonly cow milk (3.5% fat & 8.5% SNF) was concentrated to maintain the total solid content of 20% in milk which was desired for proper body and texture of souffle. Then the mixture of egg yolk and sugar (which were already mixed in another container) are added with continuous stirring for 2 to 3 min followed by cooling. The egg yolk is used as an emulsifier whereas sugar improves the flavour as well as functional properties. After cooling gelatin was added in the previously made mixture. After adding gelatin add egg white with continue stirring for uniform mixing. It is then stored at refrigerated condition at least for 12 hours before serving.

1.4. Pudding, custard and custard pudding are the similar product profile on the basis of basic ingredient. The basic ingredients of these entire products are milk/cream egg (egg yolk and/or egg white), stabilizer (starch, gelatine etc). Souffle and souffle like product are available through the world, but its production availability and marketing are very less in India.

1.5. OBJECTIVE:

1. To standardize a level of total solid of milk
2. To standardize the level of sugar
3. To standardize the level of egg white
4. To standardize the level of egg yolk
5. To standardize the level of gelatin

Chapter-2



Reveiew of Literature

2.1. Literatures on souffles are very limited. Few research works carried out on various aspects like type of souffle, basic component, similar products, method of preparation, nutritional attribute of souffle etc. Since available literature of souffle have been collected and reviewed in this chapter.

2.2. HISTORICAL BACKGROUND:

A souffle is a light fluffy, baked product made with egg yolk and beaten egg whites combined with various other ingredients and served as a dessert. Frozen souffle however, frozen instead of baking and served in frozen condition. The word souffle is the past participle of the French verve 'Souffle' which means to 'blow up' or more loosely 'puff up'.

According to food historian, modern souffles were the product of 18th century French cuisine. Beauvilliers (famous French restaurant of that time) was making souffle possibly as early as in 1782, but they did not published his art until 1814 (Alan Davidson,1999).

In 1814 Careme's Patissier Royal Parisien gave a great detail on the technique of souffle (Hal,1968).

"Patrons of La Grande Taverne de Londres" in 1780 were perhaps the first to enjoy this dessert souffle. It came from the repertoire of Beauvilliers, who was for more than fifteen years the most famous restaurant in France (Hal,1968).

The rise and the inevitable falls of every souffle are direct results of temperature. Heat expands the air in egg white, while coolness deflates it. Collapse of a souffle was a common defect caused due to culinary errors in science of souffle making.

Souffle was discovered a few decades after its invention by a French scientist and balloonist J.A.C. Charles. Hence Charles's law is a part of the story, but not the whole story, it accounts for about a quarter of typical souffle rise.

2.3. BASIC COMPONENTS OF SOUFFLE:

2.3.1. French souffle is made from two basic components. A French cream patissier base or flavoured cream sauce or puree and egg white beaten to stuff pea margarine, cream base provides the flavour and while the egg white provides the lift (Puff up). In addition to these two basic ingredients, some other ingredients like a stabilizer to support the body to retain the puff up or to prevent the collapse of souffle, and sugar to make souffle to a palatable product and also used some optional ingredients like jam, fruit (puree or pulp), berries, chocolates and lemon are also used often. The use of basic components of souffle and supporting ingredients like stabilizer and sugar and optional food ingredients in souffle are reviewed hereunder.

2.3.1.1. EGG:

2.3.1.1.1. Egg is the one of the most important ingredient in the manufacture of souffle. Egg yolk and whole egg contain lot of protein and choline (Jui *et al.*, 2004). Egg is high functional food ingredient and has three primary attribute.

2.3.1.1.2. Foaming: Foaming is incorporation of air into products commonly achieved by whipping. Egg and egg products are especially good foaming agents because they produced a large foam volume (Ganguli *et al.*, 2006).

2.3.1.1.3. Emulsification: Emulsification is the stabilization of the suspension of one liquid to another. Egg yolk products are excellent food emulsifier. Phospholipids, certain protein contribute to emulsifier properties of whole egg and egg yolk.

2.3.1.1.4. Coagulation: Coagulation is conversion of liquid egg into solid or semi-solid state, usually accomplished by heating. Coagulation is important in many food products such as souffle, custard and pie filling. In many food products coagulated egg protein bind together with other ingredients. Egg protein coagulated over a wide temperature rang. This temperature is influenced by pH, salt, other ingredients and duration of heating (Bennion and Bamford,1997).

TABLE 2.1. COMPOSITION OF HEN'S EGG

Fraction	%water	Protein	Fat	Protein	Ash
Whole	100	65.5	11.5	11	11.7
White	58	88.0	11.0	0.2	0.8
Yolk	31	48.0	17.5	32.5	2.0

Source- US Department of Agriculture (1973)

Eggs are rich source of high quality protein and good source of unsaturated fatty acids (mainly oleic acid), iron, phosphorus, trace minerals, vitamins A, E, K and B including B_{12} (Bennion and Bamford, 1997). Except fish liver oil, no other natural food contain more vitamin D than egg (Jana *et al.*, 1988) (Table 2.1, 2.3 and 2.4).

TABLE 2.2. MINERAL AND VITAMIN CONTENT OF SOME ANIMAL FOOD PRODUCTS (UNIT/KG)

Constituent	Cow milk	Egg	Beef	Pork	Chicken
Vitamin B_1 (mg)	0.44	1.1	0.09	7.6	0.8
Vitamin B_2 (mg)	1.75	3.0	1.8	1.8	1.9
Niacin (mg)	0.94	1.0	48.0	41.0	67.0
Vitamin B_6 (mg)	0.64	1.1	4.3	3.5	5.0
Vitamin B_{12} (mg)	4.0	20.0	18.0	5.5	4.0
Vitamin A (IU)	1024.0	11800.0	200.0	-	9200.0
Calcium (mg)	1170.0	540.0	120.0	90	100
Magnesium (mg)	120	110	250	180	230
Phosphorus (mg)	920	2050	2030	1750	1760
Zinc (mg)	4	10	34	27	12
Iron (mg)	0.5	23	30	23	16

Source-Jana *et al.* (1988)

TABLE 2.3. NUTRITIONAL INFORMATION OF HEN'S EGG

Nutrient unit	Whole egg	Egg white	Egg yolk
Calories (Kcal)	75	17	59
Protein(g)	6.25	3.25	2.78
Cholesterol(mg)	231	0	231
Vitamin B_{12}(mcg)	0.5	0.07	0.43
Vitamin A (IU)	317.5	0	317
Vitamin E (mg)	0.7	0	0.7
Vitamin D (IU)	24.5	0	24.5
Calcium (mg)	25	2	23
Iron (mg)	0.72	0.01	0.59
Sodium(mg)	63	55	7

Egg nutrition centre, USA

2.3.1.2. FAT:

Milk cream was the conventional source of fat used in the preparation of souffle (pqasb.pqarchiver.com). Use of cream and margarine was reported by Havette and Herbert in 1984.Mc Gee (2004) reported that cream alone or in combination with milk or concentrated milk was used in the preparation of various types of souffle. He further reported that cream type souffle mixture was prepared using ½US cup of milk, 25g sugar, 10g butter and 3 stiffly beaten egg whites. The souffle mix was cooked in a moderately hot oven.

2.3.1.2.1. Plastic emulsion and Pastry emulsion: Rene (1978) reported the use of pastry cream while Chie and Eriko (2010) used a plastic emulsion substance in souffle making.

2.3.1.2.2. Margarine: Havette and Herbert (1984) used margarine for making deep frozen souffle. They also noticed that addition of cream to margarine lowered the chance of collapse or showed moderate collapse on freezing of souffle. Fakes (2004 and 2006) also used margarine/butter, but in combination with vegetable oil in the preparation of souffle.

2.3.1.2.3. Cream: Cream basically a fat source derived from milk used as a shortening agent in souffle. Conventionally cow milk with two folds concentration showing about 8% fat was considered as cream in the process of making souffle.

2.3.1.3. MILK:

Milk has become a part of the human diet for thousands of years. Milk plays an important role in the diet. This is because it contains a wide range of nutrients that are needed for good health. It has an impressive nutritional profile. Milk is a food that can offer benefits to all age groups. It provides protein, fat, carbohydrate, vitamins, and minerals to the diet. In addition, milk is a great source of hydration. This is very important, as water is needed for the proper functions of all the processes in our bodies.

Milk can help to keep one hydrated throughout the day as well as help to meet the nutrient needs.

Milk is often described as the most "nearly perfect" food. The milk of all species is nutrient-rich and well-balanced food (Kon, 1959; du Puis, 2002; Patton, 2004).

The most widespread milking animal in the world is the cow, which is found on all continents and in nearly all countries.

Energy Value: The energy giving milk constituents and their individual contributions are as follows:

TABLE 2.4. ENERGY VAVLUE OF DIFFERENT CONSTITUENTS IN MILK

Milk Fat	9.3 Cal / g
Milk proteins	4.1 Cal / g
Milk Sugar	4.1 Cal / g

The energy value of milk varies with its composition. On average cow milk furnishes 75 Cal/100 g and buffalo milk 100 C/100 g of milk.

Cow milk consists of about 87% water and13% dry substance. The dry substance is suspended or dissolved in the water. Depending on the type of solids, there are different distribution systems of them in the water phase.

The milk of various mammalian species differs in the amount and type of their components. This review focuses on cow milk and those products for which cow milk is a prominent ingredient. Cow milk is mainly composed of water, with approximately 4.8% lactose, 3.2% protein, 3.7% fat, 0.19%

non protein nitrogen and 0.7% ash. The principal families of proteins in milk are caseins and whey proteins. About 80% of total proteins are caseins (Banks and Dalgleish, 1990).

TABLE 2.5. COMPOSITION OF MILK FROM VARIOUS ANIMALS

Animal	T.S.	Fat%	Protein%	Lactose	Ash%
Cow	12.7	3.7	3.4	4.8	0.7
Buffalo	16.8	7.4	3.8	4.8	0.8
Goat	12.3	4.5	2.9	4.1	0.8
Sheep	19.3	7.4	4.5	4.8	1.0
Human	12.2	3.8	1.0	7.0	0.2

Source:-Fox and McSweeney(1998)

2.3.1.4. GELATIN:

2.3.1.4.1. Gelatin is a pure protein food ingredient, obtained by thermal denaturation of collagen (Baily and Light,1989). Dry gelatin swells or hydrates when stirred into water. In confectionary, gelatin is used as a gelling binder in gummy products. In the manufacture of these products gelatine combined with sugar and glucose syrup.

The important attribute of gelatin is its gel strength determined by bloom test (BS757:1975) this is the force in grams required to press a 12.5 mm diameter plunger, 4mm into 112g of standard $6^2/_3$ W/V gelatin gel at 10^0C.

2.3.1.4.2. Safety aspect: Schwimmer *et al.* (1957) reported that the consumption of 7 to 10g/day can significantly improve nail growth rate and strength. In 1988 Silvestrini patented his article "Gelatin promotes hair growth". It has also been shown to be beneficial for arthritis sufferer in long use (Adam,1991).

2.3.1.5. SUCROSE: Sucrose is a disaccharide and is a composed of glucose and fructose. It is non-reducing sugar formed by plant only. It is soluble in water and sweetening agent, can be fermented by microorganism, supplies energy and prevents growth of microorganism at high concentration, caramelized when heated with high temperature and develops brown colour when heated in presence of protein (Norman and loseph, 1996).Sucrose as whole or along with other ingredients used in souffle (Mc Gee, 2004).

2.3.1.6. STARCH: Fakes (2004 and 2006) used starch as flavour paste for making chocolate souffle.

Saito (2009) used starch for making souffle like cake dough contained starchy raw material, a meringue dough and plastic oil in water type emulsion and it contains 56-63% water and the content of the meringue dough may be 18-36% based on whole cake dough.

Fakes and Alberto (2004 and 2009) are reported that the process for making a flavoured souffle dessert product consisting of following steps- first mixing and kneading of eggs, sugar, margarine/butter, flour, baking soda and salt in a mixing hopper to form a cookie dough followed by keeping at refrigerated condition (35^0F to 45^0F) for 24 hour, secondly stirring of a flavouring ingredients corn syrup, vegetable oil, starch and water in another hopper to form a flavoured paste followed by gelling at 50^0F for 12 hr. In third step the cookie dough and flavoured paste filling were encrusted and extruded simultaneously to forma flavoured souffle mix. In the forth step the souffle mix was baked in silicon model cookie tray at 350^0F for 30 min. After baking cooled the product for at least - 20^0Ffor 45 min and packed.

Saito (2009) disclosed the souffle like cake which contains a starchy raw material. This dough contain water may be 56 to 63% and solid is about 18 to 36% based on whole cake dough.

2.3.1.7. MERINGUE: Saito (2009) reported that souffle like cake contains starchy raw material, meringue dough and plastic oil in water type emulsion. The meringue dough may be of 18 to 36% weight based on the whole cake dough.

2.4. TYPE OF SOUFFLE:

2.4.1. Souffle though basically made from cream an egg etc, its recipes and method of preparation are till now modified to make this product more attractive. Thus the type varies from baked type to frozen with numerous variations in the recipe as well as the change in linking through time. Literatures available in these regards are reviewed hereunder.

2.4.2. BAKED TYPE OF SOUFFLE: Souffle mix made from milk, egg, stabilizer and sugar are baked till its volume doubled (Ude,1918). Variations in baked type of souffle were observed through time (Mc Gee,2004). Various recipe of baked type of souffle are listed below:

2.4.2.1. CREAM SOUFFLE: August Escoffier in 1903 reported the preparation of cream-type souffle mixture. The main ingredients for making souffle were milk, sugar, flour, egg yolk and beaten egg white. He prepared the souffle by using deep silver timbale.

2.4.2.2. SOUFFLE OF POTATO WITH LEMON: 12 potatoes were first baked followed by peeling and scooping out of the flouriest part which was then mixed with the half a pint of boiled cream containing peel of a lemon. Little sugar, a large bit of butter, little salt was then added to that preparation. Six eggs were broken and the yolks of four eggs were mixed with potato while six beaten egg whites were poured into a souffle discs along with the potato preparation. Then the souffle dish was put into oven

which was moderately hot. Powdered sugar was spread over the souffle when its baking was almost completed and served immediately (Mc Gee, 2004).

2.4.2.3. SOUFFLE OF ORANGE FLAVOUR: Little flour was diluted with cream and milk followed by boiling. Little amount of salt, sugar and orange flavour were added after sometime and mixed well followed by addition of butter, egg yolk with mixing. At last the beaten egg whites of six eggs were mixed with rest and baked then served (Mc Gee,2004).

2.4.2.4. SOUFFLE BREAD: Boiled some milk with cream to desired concentration followed by the addition of soft part of two or three fresh rolls to soak. The breads are then sieved and souffle mix was prepared with eggs, butter, and sugar as before followed by baking.

2.4.2.5. OMELETTE SOUFFLE: First six eggs were broken followed by collecting the egg whites and egg yolks separately. A little lemon peel or orange flavour was added with beaten egg yolks and sugar and salt are then added to those egg yolks. Lastly the beaten egg whites were mixed with egg yolks lightly. Lump of butter was then put into an omelette pan on the fire for melting after which omelette was poured into pan. When it was firm enough on one side to hold liquid part, it was turned over on the dish, then baked in an oven and served immediately after it was raised(Ude,1978).

The omelette souffle with lemon was made in a similar way except the use of a half grated lemon peel which was spread all side of the omelette baked and served immediately (Gouffe,1869).

Vanilla omelette souffle was also prepared by Cracknell and Kaufman (1979) using 10 min baking time and sprinkling confectionaries sugar 2 min before removing from oven. After cooling it was served with vanilla or rum sauces.

2.4.2.6. CHEESE SOUFFLE: 1¼ oz of flour was taken in a stew pan with 1½ pint of milk for boiling followed by addition of little salt and pepper with stirring till boiling. After completion of boiling 7 egg yolks and grated Parmesan Cheese were added into the mixture. Then whipped the egg whites till they were firm and then added to mixture, filled the mixture in paper case and baked for 15 min (Ude,1828). Cracknel and Kaufman (1903) also prepared cheese souffle in similar way using 20 min time for baking.

2.4.2.7. VEGETABLE SOUFFLE: Three vegetable souffle mix, Spinach puree, Carrot puree and Broccoli puree were used for preparing three-tiered vegetable souffle (Sunset,1990).

2.4.2.8. DRY MIX SOUFFLE: Preparation of dry mix souffle has been patented in US by Kline in 1960. This invention comprised a dry food mix in the form of two components. The first component was coagulated edible protein such as dried egg whites and relatively small portion of mixture of salt and cream of tartar. Second component was dried egg yolk, edible fat, dry milk solid, flour and flavouring material. Cream of tartar was added to souffle to mix the ingredient homogenously to have more tenderness.

2.4.2.9. MERINGUE: Saito (2009) was reported that souffle like cake contains starchy raw material, meringue dough and plastic oil in water type emulsion. The meringue dough may be of 18 to 36% weight based on the whole cake dough.

2.4.3. FROZEN SOUFFLE:

2.4.3.1. Frozen souffle is not a true souffle but a frozen mousse (*souffle glace a l orange.html*). Generally frozen souffle are of two types. In first type the souffle prepared is frozen or deep frozen to minimize the collapse where as in the second type the souffle prepared using the basic

ingredients like concentrated milk, egg yolks, sugar and gelatin with or without colour or additives by boiling/cooking and cooled followed by the addition of beaten egg whites and freezing. The second type of souffle is the target product of the present investigation.

2.4.3.2. Havette *et al.* (1984) and Herbert *et al.* (1985) prepared frozen sweet souffle and cheese souffle successfully which rise during baking and only collapse moderately when served. They reported souffle mix was prepared from base mass composed of baked panada based on fat, flour, water and cream. While a flavouring base compared of vegetable, cheese fish or fruit, egg yolk and texturizing protein by mixing the different ingredient without whipping of protein and incorporating of CO_2 gas in the mass. The composition and the proportion for panada base, aromatic base (for frozen sweet souffle) or cheese base (for frozen cheese souffle) and protein base are shown below in table 2.6. and 2.7.

TABLE 2.6. CHEESE SOUFFLE (EMMENTAL)

Ingredient	Amount (gm)	Types of souffle
Margarine	7	Panda base
Wheat flour	11	
Cream	4	
Spice	0.5	
Water	13	
Grated Emmental	17	Cheese base
Sweet buttermilk	15	
Water	10	
Egg yolk	10	Protein base
Lactic protein	4	
Powdered egg white	2	
Water	20	

Albert *et al.*, (1972)

TABLE 2.7. SWEET SOUFFLE (PEAR)

Ingredient	Amount (gm)	Types of souffle
Margarine	4	Panda base
Wheat flour	6	
Cream	2	
Water	4.5	
Egg yolk	10	Aromatic base
Pear puree	40	
Sugar	10	
Lactic protein	3	Protein base
Egg white	3.5	
Water	15	

Albert *et al.*, (1972)

In another study Campocasso (1997) prepared a frozen souffle product with 100 g fruit, 400g fine sugar and 11g egg white. The sugar and fruit puree were cooked together until the mix reaches a temperature of 100-110°C. It was then cooled to ambient temperature followed by the addition of egg whites and freezing to -18°C. The frozen product may be served as such as cooked in conventional oven for 20 min or microwave oven for 2 min.

Fakes (2004,2006) on the other hand designed a process for making Runny chocolate souffle by mixing and kneading a egg, sugar, margarine/butter, flour, baking soda, salt and coca in the 1st mixing hopper to a form of cookie dough, proofing the cookie dough in a proofing, refrigerating at temperature between 35°F and 45°F for about 24 hour, stirring the flavouring ingredients corn syrup, vegetable oil, starch and water in a 2nd mixing hopper to a form of a flavour past filling and gelling of the paste filling in a refrigerator at a temperature of 5°F for 12 hour, extruding an amount of filling using an encrusting and extrusion machine to form a flavoured souffle dessert, inserting the product in cookie tray with several cavities, baking the dessert product at a temp of 350°F for 30 min and freezing the dessert product at a temp of -20°F for 45 min, removing the frozen dessert from the cookie tray to conveyer or belt.

The baked type of souffle required to be served soon after the product mainly due to the reason of collapsing of souffle. Baking followed by freezing also minimized the collapse rate.

The frozen souffle dessert on the other hand improved the mouth feeling and taste of souffle.

2.5. NUTRIENT INFORMATION OF SOUFFLE:

2.5.1. Souffle contains milk, cream, egg yolk, sugar, gelatin and egg white containing of various energy giving nutrients like protein, fat and carbohydrate, vitamin such as fat soluble vitamin A, D, E and K and minerals. The souffle showed about 190 to 200 caloric value while the protein range 9.2, fat 14.9g, and total carbohydrate 5.94 gm per cup or 136 gm Shifton (2010). The detailed nutritional information is shown in table 2.8, 2.9 and 2.10.

TABLE 2.8. INGREDIENTS PRESENT IN CHEESE SOUFFLE

Ingredient	Amount (gm)
Cheese, cheddar	80.51
Egg	142.5
Wheat flour	22.22
Milk	231.8
Margarine	40.18
Salt	1.42

Source-Dinner's Journal by S. Shifton (2010)

TABLE 2.9. NUTRITIONAL VALUE OF CHEESE SOUFFLE

Constituents	Amount (Per cup)	% Value
Total fat	14.94 g	23
Saturated fat	5.85 g	29
Polyunsaturated fat	2.28 g	
Monounsaturated fat	5.74 g	
Cholesterol	135.38mg	45
Sodium	329.39mg	14
Potassium	124.5 mg	4
Total carbohydrate	5.94 g	2
Dietary fiber	0.115 g	
Protein	9.2 g	18

% Daily value are based on 2000 caloric diet

Source-Dinner's Journal by S. Sifton (Oct6, 2010)

TABLE 2.10. NUTRITIONAL INFORMATION OF SPINACH SOUFFLE

Constituents	Amount (Per cup)	% Value
Total fat	17.6g	27
Saturated fat	8.3 g	41
Polyunsaturated fat	0.8 g	
Monounsaturated fat	4.1 g	
Protein	10.8 g	22
Cholesterol	160 mg	53
Total carbohydrate	7.9 g	3
Dietary fibre	1.0 g	4
Sugar	2.5 g	
Vitamin A	3909 IU	78
Vitamin C	9.9 mg	17
Vitamin D	34.0 IU	8
Vitamin E	1.3 mg	6
Vitamin B_{12}	0.5 mcg	9
Vitamin B_6	0.1	7
Calcium	224 mg	22
Iron	1.6 mg	9
Magnesium	40.8 mg	10
Phosphorus	192 mg	19
Sodium	770 mg	32

% Daily value are based on 2000 caloric diet
U.S. Department of Agriculture (2010)

2.6. SIMILAR PRODUCT:

Souffle the puff type, resembles with cake ingredient wise and product wise. However the frozen souffle somewhat like mousses, recipes of ice-cream. Pudding (Jacobson,2005), custard (Xuemie,2008) and custard pudding (Astusi,1987) are some similar type products as of frozen souffle. The basic ingredients of these entire products are milk/cream, egg (egg yolk and/or egg white), stabilizer (starch, gelatin etc) and sugar.

2.6.1. PUDDING:

2.6.1.1. Rapp (1986) reported that whole milk (3.3% fat) 63%-68% by weight, cream (36 to 40% fat) 7 to 8% by weight, emulsifier (sodium stearoyal-2 lactylate) 0.03to 0.05% by weight, sugar (granular) 13 to 16%,cross linked waxy maize starch 3.5 to 4.5%, vanilla extract (2x) 0.25-0.30%, salt 0.15- 0.25%, K-carageenan0.1-0.2%, total carrageenan 0.07-0.14% and trace amount of colour were used for preparing vanilla pudding. He further stated that the cream about $^1/_3$ of the milk and ½ of sugar were added to 200 gallon and agitated into steam jacketed tank. The colour and carageenan were preblended with small portion of the sugar and added in tank with the high speed agitation. The reminder of the milk was added to the stirring content of the tank followed by the addition of remaining sugar, starch, salt, emulsifier, and water. The content was then heated to about with 140^{0}F. The content was mixed with dilute NaOH solution followed by addition of vanilla flavour, homogenised in two stages 2000 psi in first stage and 500 psi in second stage. The content was heated to 280^{0}F, cooled to 100^{0}F and specially packaged. They chocolate pudding and butterscotch pudding were also prepared by the same method. King and Leshik (1993) prepared a ready to eat low/no fat pudding.

2.6.1.2. Bruce (2003) and Budinoff (2003) prepared rice pudding using precooked rice and egg yolk along with other ingredients as discussed

earlier. In another attempt Lo *et al.,* (2003) prepared ready to eat refrigerated rice pudding comprising of 45-75% water, 0.5-25% sweetener, 0-10% milk fat, 1.5-10% non fat milk solid, 0-10% egg yolk 0.2-1.5% thickening agent and 2-16% parboiled rice and the mix was cooked at 230^{0}F and cooled thereafter to a temperature of 32-140^{0}F and packed.

2.6.2. CUSTARD:

2.6.2.1. Yasu (1991),Inayoshi*et al.*(1996) and Testsuo (2007) prepared various type of custard cream, the low viscous custard cream to vacuum pouch, followed by the sterilization of the vacuum pouch custard cream with heat and freezing the resultant custard. They suggested that the method for producing low viscous custard cream comprised of the following process: stirring and heating custard cream mixture raw material containing starch, sugar, milk, egg yolk, vegetable oil and fat to be formed in cream state followed by cooling the mixture to obtain a custard cream product. Cutting, emulsifying, pulverising the mass resulted the low viscosity custard which could be vacuum packedin pouch and sterilized. Wenzhan (2009) prepared egg custard from fresh egg, salt, dried shrimp husk, ginseng, sesame oil and warm water. Corbett*et al.* (1980) worked to find an egg replacer for baked custard. They reported that 75% of whole protein could be replaced by 40-60% whey protein concentrate containing 0.5 to 5% carboxymethylcellulose60% to 40% of latylated shortening. They further reported that there was no change in product quality but gained an economic and advantage over other type of custard like freeze dried rice custard (Xiaoli,2006), frozen raw custard (Croyle,1982 and 1984)and instant complex type egg custard (Chunhe, 2008)and their method of preparation were reported.

2.6.3. CUSTARD PUDDING:

2.6.3.1. Atsushi (1987), Tsuguyuki (1987), Tokuaki (1994) and Keji (2002) prepared custard pudding egg liquid using dairy product,

saccharide as main raw materials. The egg liquid was homogenized, blended with other raw materials and sterilized the resultant blend while heating.

2.6.3.2. Tomotoshi (1985) prepared soybean milk custard pudding. He reported that soybean milk was blended with muscovado, boiled and cooled, which was then mixed with whipped egg put in a container, heated by proper method and solidified to give the desired custard pudding.

2.6.3.3. Tadashi (1992) prepared long term preservable custard pudding by heating a thermally coagulable custard pudding raw material packed in pudding container by a continuous heater, while changing a heating condition of every part of custard pudding container.

2.6.3.4. Pudding, custard and custard pudding contain milk, cream, egg product, starch and sugar more or less same as of souffle. However the methods of preparation of these three products are different than that souffle. The quality of frozen souffle though comes closer to its similar types of products pudding, custard and custard pudding but the overall acceptability has no match with them.

2.7. DIFFICULTIES IN SOUFFLE MANUFACTURING AND MEASURE TO OVERCOME THAT:

2.7.1. A hot, well risen souffle, fresh from the oven always impresses dinner guests. However, many people think souffles are difficult to cook. Perhaps this belief stems from some recipes that are more likely to result in disaster than in a beautifully risen, stable souffle. The basis of all souffles is foam made from beaten egg whites. During cooking some steam is generated and the air in the foam expands causing the soufflé to rise. As the egg whites cook so the foam sets. All you need to be able to make perfect soufflés is to understand what ingredients and processes will tend

to make the egg white foam collapse, and to avoid using them as far as possible. (Barham, 2001)

2.7.2. LIMITATION OF SOUFFLE PREPARATION:

The main problem of making souffle was collapse. It's collapse for many reasons. The most usual causes are

1. Too much fat making the egg white foam collapse

2. Not beating the egg whites enough to make really stiff foam

3. Using too runny a filling so that it cannot reinforce the egg foam

4. Not cooking the souffle long enough. Souffles, even when they have risen properly can sometimes have a rough appearance. The usual cause is that the top of the souffle was not smoothed off well enough before it was put in the oven (Braham, 2001).

2.7.3. Often souffles raise more in the middle than at the edges and the tops break open. This happens when the souffle dish is not properly greased and the souffle mixture sticks to the sides and so prevents the souffle from rising properly. Occasionally, a soufflé will only raise from one side which results in a lopsided finish. There are two possible causes:

1. Some of the mixture has stuck at one place on the rim of the dish where it was not cleaned away properly before putting in the oven or the soufflé has been cooked in an oven with a heating element at the back

2. The more risen side would have been closer to the heat and would have risen more quickly leading to the lopsided finish.

2.7.4. Braham (2001) summarised the problem, cause and their solution of making souffle as below:

TABLE 2.9 PROBLEMS, CAUSE AND THEIR SOLUTION OF MAKING SOUFFLE:

Problem	Cause	Solution
Souffle does not rise	The bubbles in the egg foam burst before cooking started Insufficient 'soap like' molecules to Too much fat or oil in flavourings	Beat egg whites more, make stabilise foam sure there is no yolk in egg whites Avoid using fatty or oily fillings
Souffle rises, but it is all air inside	Bubbles in the egg foam burst during cooking, after the top has cooked Insufficient 'soap like' molecules to stabilise foam	Beat egg whites more, make sure there is no yolk in egg whites Avoid using fatty or oily fillings
Souffle collapses as soon asit is taken out of oven	Cooked foam unable to support its own weight, insufficient cross linking of egg white proteins or the filling is not having a reinforcing effect. Not cooked long enough	Increase cooking time and/or temperature Use more filling Use drier filling, or thicken with corn-flour.
Souffle rises at first in the oven but collapses during cooking	The bubbles burst when the steam pressure becomes too great, the foam does not cook quickly enough to become strong before the steam is generated Egg whites not beaten enough to provide small bubbles (small bubbles withstand higher pressures). Filling too runny	Beat eggs longer Use drier filling, or thicken with flour or corn flour.

Problem	Cause	Solution
Top browned but inside raw	Oven too hot so that top cooks too quickly	Reduce oven temperature, or cook in larger dish
Souffle has chewy texture	Oven too cool, middle overcooked before outside brown	Oven too cool, middle overcooked before outside brown
Souffle has chewy texture	Oven too cool, middle overcooked before outside brown	Increase oven temperature or cooked in larger dish
Top of souffle splits or its rise unevenly	Souffle prevented from rising by sticking to side of dish	Make sure dish is well greased
Uneven side to souffle	Mixture not filling dish properly so that some large air pocket are left behind	Make sure knock the dishes on a hard surface to get rid of any large air bubbles before putting in oven

Braham (2001)

2.7.5. The collapse of souffle may be due to various reasons, the simplest way to counter it is to serve immediately after raising souffle or to freeze and/or baked it. The increase in the level of egg white and gelatin to some extent delay the collapse of souffle.

2.8. The available literature regarding to this historical background, basic component of souffle, types of souffle, similar products and difficulties in souffle manufacture and measures to overcome that have been reviewed in this chapter. Based on these information the objective laid down and the plan of work were formed.

Chapter-3



Materials and Methods

3.1. This chapter deals with the various materials used, methodology employed for standardization of various parameters, process development for the preparation o frozen Souffle, analytical techniques employed for estimation of physicochemical, rheological and sensory attribute and the statistical analysis the data obtained at various stages.

3.1.1. MILK:

Milk sample were procured from the nearby local dairy farm in Mohanpur, Nadia, W.B.

3.1.2. EGG:

Egg was collected from the local market at Mohanpur Nadia, W.B.

3.1.3. SUGAR:

Sugar was also collected from nearby local market at Mohanpur Nadia, W.B.

3.1.4. GELATIN:

Gelatin was procured from Merch Specialities Pvt. Ltd. from Kolkata market.

3.2. TECHNOLOGICAL ASPECTS:

3.2.1. Standardization of various parameters like level of concentration of milk (or total solid), level of sugar, egg yolk, gelatin and egg white are discussed hereunder.

3.2.1.1. STANDARDIZATION OF THE LEVEL OF CONCENTRATION OR T.S. OF MILK: Three level of milk concentrate (viz 15, 20, 25% T.S.) were attempted with a view to study, the effect the level of milk concentration on the quality of souffle. Optimum level of concentration was adjusted through sensory evaluation by a panel of trained judge in the faculty.

3.2.1.2. STANDARDIZATION OF THE LEVEL OF SUGAR: Sugar tenderizes a starch gel and reduces paste viscosity because it retards gelatinization. Due to hydroscopic nature of sugar, the temperature required for gelatinization is raised thus delaying the process. Sugar can attract and hold water molecules. Three level of sugar (viz.5, 7, and 9%) were studied with a view to evaluate an optimum level of gel strength as well as palatability of souffle. Sensory evaluation in a 9-Point hedonic scale was employed to evaluate the optimum level of sugar (Appendix-I)

3.2.1.3. STANDARDIZATION OF THE LEVEL OF EGG YOLK: Different level of egg yolk such as 2, 4, and 6% level were used in the preparation of souffle. This was done to increase the palatability of the product. The palatability was assessed through sensory evaluation of the prepared sample of souffle.

3.2.1.4. STANDARDIZATION OF THE LEVEL OF GELATIN: Different levels of gelatine (viz. 3.5, 4, and 4.5%) were attempted in the preparation of souffle to obtain the desired texture and gelatinization of the product which was assessed through sensory evaluation.

3.2.1.5. STANDARDIZATION OF THE LEVEL OF EGG WHITE: Three level of egg white such as 8, 10 and 12% were attempted to evaluate the optimum gelation and body of the product. The optimum level of egg white was assessed through sensory evaluation.

3.2.2. METHOD OF PREPARATION:

One litter of fresh cow milk (3.5% fat and 8.5% SNF) was taken. It was then heated to boil until 20% T.S. was reached. In a separate container egg yolk and sugars are mixed thoroughly. This mixture was added to the concentrated milk at 80^{0}C and mixed well which was again heated to 90^{0}C followed by cooling to 40^{0}C. Gelatin which was heated along with water to have homogeneous solution was added to the above mix at 40^{0}C and mixed thoroughly. Finally, egg white was properly mixed to the mixture and the mixture was kept in refrigerated condition for

cooling for 4 to 6 hours. The frozen souffles thus prepared are ready for serving and also kept for analytical purpose.

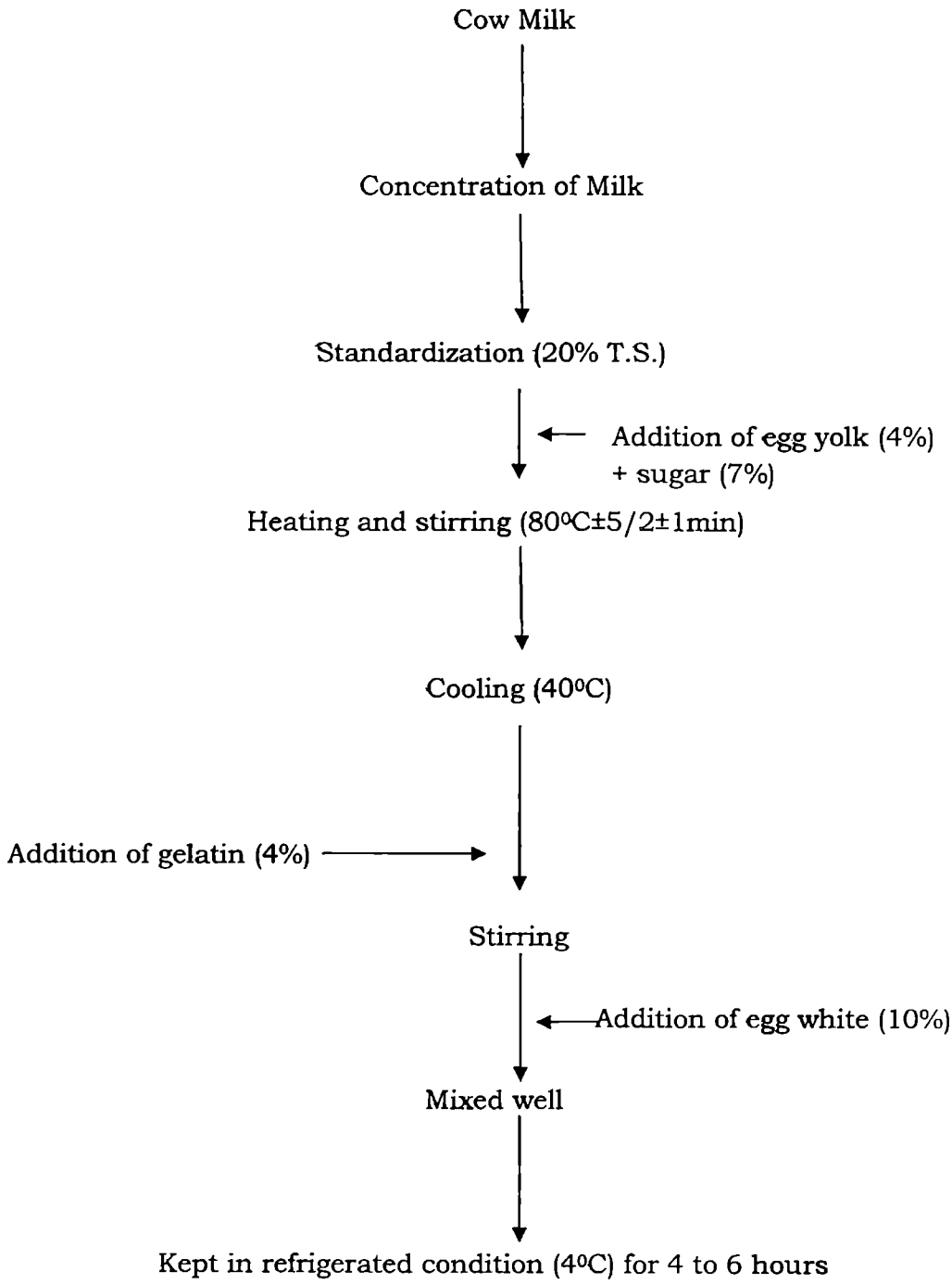


FIG.3.1. SCHEMATIC REPRESENTATION OF THE PROCESS FOR PREPARATION OF FROZEN SOUFFLE

3.3. ANALYTICAL ASPECTS:

Several methodologies were employed for analysing the physico-chemical rheological and sensory attribute of milk and prepared sample of frozen souffle.

3.3.1. PHYSICOCHEMICAL CHARACTERISTIC:

3.3.1.1. ESTIMATION OF MOISTURE FOR PREPARED SAMPLE OF SOUFFLE: The method of determination of moisture content was based on the principle of evaporating the moisture content from given products (as per the method of AOAC, 1995). The dish was accurately weighed before taking of the sample. 5ml of the sample was then taken in the dish. The dish was then placed on the water bath for at least 30 minutes after removing the moisture of the sample. The dish was then placed into hot air oven for 3-4 hrs at 100 ± 2°C. The dish was then transferred into a desiccator for cooling purpose. Finally the dish was weighed and calculated for the percentage of moisture.

Calculation:

$$\text{Percentage of moisture} = \frac{\text{Loss of weight } (W_2 - W_3)}{\text{Weight of sample } (W_2 - W_1)} \times 100$$

Where,

W_1 = Weight of dry and empty dish, in gm

W_2= Weight of dish+ souffle before heating, in gm

W_3= Weight of dish+ souffle after heating, in gm

3.3.1.2. FAT AND SNF:

3.3.1.2.1. Raw milk: Fat and SNF content of raw milk were determined by the methods described in the Manual in Dairy Chemistry (1972).

3.3.1.2.2. Estimation of fat for souffle: The fat content of souffle was determined by Rose Gottlieb Method. Sample approximately of 1 gm was taken into an extraction tube. Concentrated ammonia solution

(1ml) was added and mixed properly by shaking. Ten (10) ml of ethyl alcohol was added to the solution. 25 ml of di-ethyl ether and 25 ml of petroleum ether were taken in Rose Gottlieb tube. The tube was then closed with a cork or stopper and shake and vigorously for at least one minute. In this method, fat was separated from organic solvents such as ethyl alcohol and diethyl ether and petroleum ether after breaking of fat globule membrane with concentrated ammonia solution. Ethyl alcohol facilitates the separation of fat from aqueous phase and mixed ether solvent was used to dissolve entire fats present in milk and milk products.

The cork or Stopper was replaced again and shacked vigorously for at least 30 seconds. The tube was then allowed to stand until ethereal layer was clearly separated from the aqueous phase, usually not less than half an hour was required for this separation. Cork or Stopper was then removed and a siphon was inserted and transferred the ethereal layer to a suitable conical flask (already cleaned and weighed). The siphon and pressure device tube were removed from the fat extraction tube and extraction of milk residue was repeated using 15 ml of petroleum ether and 15 ml of diethyl ether. The above whole process was repeated again. The conical flask was put on boiling water bath for evaporation of solvent. Fat was deposited on the bottom of conical flask after evaporation of the content. This conical flask was kept in the hot air oven at 98 to 100^{0}C for at least one hour. The conical flask was then cooled to room temperature in desiccator and weighed accurately.

Calculation of fat % in the sample:

$$\text{Percentage fat} = \frac{W2-W1}{W} \times 100$$

Where,
W = Weight in gm of the sample taken for the test.

W1= Weight in gm of the conical flask.

W2= Weight in gm of the residue after heating +conical flask

3.3.1.3. ESTIMATION OF TOTAL SOLIDS CONTENT: The total solids content was determined according to the procedures given in AOAC (1995). Five gm of sample was weighed in an aluminium dish and evaporated by keeping in hot air at 100 ± 2°C for 3 hrs. The weight of solids after drying was calculated in terms of percentage.

Calculation

$$\text{Percentage of moisture} = \frac{\text{Weight of solid (W2–W3)}}{\text{Weight of sample (W2–W1)}} \times 100$$

Where,

W_1 = Weight of dry and empty dish, in gm
W_2= Weight of dish+ souffle before heating, in gm
W_3= Weight of dish+ souffle after heating, in gm

3.3.1.4. PROTEIN: Protein is important complex nitrogenous organic constituents of milk. Higher concentration of protein in milk results into high curd tension and helps in the formation of hard curd.

During the studies of chemical analysis, the protein was determined by (KELPLUS-CLASSIC DX, Pellican equipment Chennai Employing Kjeldhal Principle) Kjeldhal's method described in AOAC (1995).

Firstly calculated the weight of sample i.e. 1 gm was transferred to a kjeldhal flask containing 10 ml of concentrated sulphuric acid, 0.2g of copper sulphate and 10 gm of potassium sulphate or anhydrous sodium sulphate. The contents were digested in a fume chamber till the liquid was clear. The liquid was then allowed to cool and diluted with 200 ml of ammonia free distilled water and transferred into a 100 ml flask. The whole amount was then distilled with 75-80 ml of 50% sodium hydroxide (NaOH) and the ammonia liberated was absorbed in 50 ml of N/10 sulphuric acid in a 250 ml of conical flask. About 150 ml of distillate was collected and excess acid was titrated against N/10 sodium hydroxide using mixed indicator (methyl red). The nitrogen

content was calculated, which on multiplying by a suitable factor (6.38) gave the protein content of the products.

$$\text{Percentage of Nitrogen } (N_2) = \frac{14.01\times (BR) \times 100\times N}{\text{Weight of sample taken}} \times 1000$$

Where,
BR= No of ml of 0.1N hydrochloric acid required for complete titration

N= Normality of hydrochloric acid

Percentage of Protein = $N_2 \times 6.38$

Where 6.38 is a constant factor used for converting N_2 to protein.

3.3.1.5. ASH: Ash contents were the total concentration of minerals present in milk (AOAC, 1995). Souffle contains various types of minerals such as sodium, Iron and Calcium.

Three gm of sample was weighed in a dried and empty porcelain dish. The exact weight of the porcelain was noted before adding the sample. The sample was first evaporated to dryness on a hot water bath and then the evaporated sample was ignited in a muffle furnace at temperature 550°C for 4 to 5 hours and ash became free from carbon and all constitutes except minerals in the porcelain dish. The weight of dish with the ash was quickly measured without absorption of any moisture from outside. Finally, the weight of the ash was expressed in term of percentage.

3.3.1.6. CARBOHYDRATE: The total carbohydrate content was calculated by different method as described in AOAC (1995)

3.3.1.6.1. Estimation of Total Carbohydrates:

The total carbohydrates (%) were calculated by subtracting the values of moisture, total protein, fat and ash contents from 100 as described below:

Percentage of total carbohydrates= 100-(A+B+C+D)

Where,

A = Percentage of moisture
B =Percentage of total protein
C =Percentage of total fat
D= Percentage of total ash

3.3.4. MICROBIOLOGICAL ANALYSIS:

3.3.4.1. STANDARD PLATE COUNT (SPC): Standard plate count of the Souffle sample was done according to the methods of APHA (1984). The sample of Souffle was aseptically drawn in a sterilized chamber of U.V.radiation.10 gm of Souffle sample was weighed aseptically and transferred to a 90 ml sterile blank (0.9% sodium chloride solution) to obtain the first (10^{-1}) dilution. Subsequent dilutions were prepared with 9mlof sterile 0.9% sodium chloride solution to 1ml of the mother solution. Appropriate dilutions of several souffle samples were transferred into petridish in duplicate. Then 15ml of melted and cooled nutrient agar was poured into each petridish and allowed to solidify. On solidification petridishes were incubated at 37±0.5^{0}C for 48hr. And result were expressed as colony forming unit (cfu/ml). Transferred to a 90 ml sterile blank (0.9% sodium chloride solution) to obtain the first (10^{-1}) dilution. Subsequent dilutions were prepared with 9mlof sterile 0.9% sodium chloride solution to 1ml of the mother solution. Appropriate dilution so several Souffle samples were transferred into petridish in duplicate. Then 15ml of melted and cooled nutrient agar was poured into each petridish and all owed to solidify. On solidification petridishes were incubated at 37±0.5^{0}C for 48hr. and result were expressed as colony forming unit (cfu/ml).

The suspended Nutrient Agar (Table 3.1) 28.0 gm in 1liter of distilled water was boiled for dissolving medium completely. Sterilize by autoclaving at 15 lbs pressure (121^{0}C) for 15min.

TABLE-3.1.COMPOSITION OF NUTRIENT AGAR

Ingredients	Quantity
Peptic digest of animal tissue	5.0g/lit.
Sodium chloride	1.50g/lit.
Beef extract	1.500g/lit.
Yeast extract	15.00g/lit.
Agar	5.0g/lit.
pH at (25^{0}C)	7.4±0.2

3.3.4.2. COLIFORM COUNT: Coliform count of Souffle sample was enumerated by APHA (1984). After appropriate dilution, 1ml of the diluted sample was transferred into petridish in duplicate. Then 15ml of melted and cooled MacConkey Agar (Table-3.2) was poured into each petridish and was allowed to solidity. On solidification another layer of 8-10ml of media was poured in each petridish. On solidification of the second layer, the petridishes were incubated at 37±0.5°C for 48 hr and results were expressed as coliform count per ml of sample.

The suspended MacConkey Agar (51.5gm) in 1 lit. of distilled water and boiled for dissolving medium completely sterilize by autoclaving at 15lbs pressure (121°C) for 15min.

TABLE-3.2. COMPOSITION OF MACCONKEY AGAR (HI-MEDIA)

Ingredients	Quantity
Pancreatic digest of gelatin	17.00g/lit
Peptic digest of animal tissue	1.5g/lit
Casein enzymic hydrolysate	1.5g/lit
Lactose	10.0g/lit
Bile salt	1.5g/lit
Sodium chloride	5g/lit
Neutral red	0.03g/lit
Crystal violate Agar	0.001g/lit
Agar	15g/lit
pH	7.1±0.2

3.3.5. SENSORY EVALUATION OF SOUFFLE:

Sensory properties of souffle samples were evaluated by a panel of judges using a 9-point hedonic scale giving scores for Colour &appearance, Flavour, body &texture and overall acceptability. This technique was employed for standardizing various parameters like level of concentration or T.S. of milk, sugar, egg yolk, gelatin, egg white towards the standardization of the method for preparing of frozen souffle.

3.3.6. RHEOLOGICAL ANALYSIS:

3.3.6.1. A texture analyzer model number TAHDi (Stable Micro System, U.K.) fitted with a 5 kg load cell was used for two bites linear compression of souffle. A cross head pre test speed of 2.0 mm/s, test speed 5.0 mm/s, post test speed 5.0 mm/s and 5 seconds interval between two successive bites was employed for 50% compression of samples.

A cylindrical probe of 75 mm diameter (P75) was used for textural study. The Texture-Analyzer having separate software (Texture Expert) for its operation was run under Windows environment (Windows 98). A microprocessor (IBM, Pentium II) has been coupled with Texture Analyzer to run the Texture Expert Programme. In the Texture Expert, result file has been programmed to calculate the Texture Profile Analysis (TPA) data from the measurement. The rheological parameters were directly calculated from Force-Time curve and microprocessor.

3.3.7. STATISTICAL ANALYSIS:

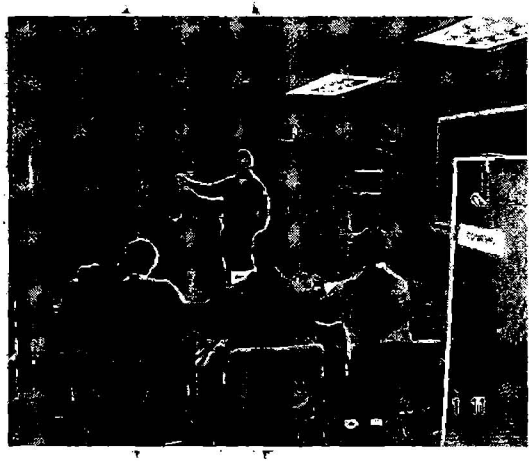
3.3.7.1. The proper statistical analysis of the data obtained was done for meaningful interpretation of the results.

The result obtained during standardization of various parameters as well as the process of preparation of frozen souffle was analysed statistically as suggested by Snedecor and Cochran (1961). However the variations in sensory score were analysed for non-parametric Anova (NPAR Anova) as suggested by Kruskal, W.H & Wallis, W.A(1952) .Use of ranks in one criterion variance analysis, journal of American Statistical association, 47;583-621.

3.3.8. Frozen souffle was prepared by using various ingredients like milk, egg, sugar and gelatin. The level of concentration or T.S. of milk, egg yolk, sugar, gelatin and egg white were standardized for the preparation of frozen Souffle. The manufacturing process was also standardized in regards. Finally the sample of frozen souffle as

obtained at various stage were analysed for physicochemical, rheological and sensory attribute. The results thus obtained during this investigation were analysed statistically.

Chapter-4



Result and Discussion

4.1. The results obtained during the standardization of the level of milk solids, egg yolk, gelatin, sugar, and egg while so as to the standardization of the process for the preparation of frozen souffle are discussed below. The proximal composition, sensory score, rheological attribute and microbiological count of the frozen souffle prepared are also discussed below. The results obtained during these studies are also discussed in respect to the statistical analysis of the data.

4.2. EFFECT OF THREE LEVELS OF THE MILK SOLID LEVELS ON THE SENSORY SCORES OF THE FROZEN SOUFFLE:

4.2.1. Three levels of milk solid cow milk such as 15, 20, and 25% were attempted with a view to evaluate the optimum level of milk solids in the concentrated milk for the preparation of acceptable quality of the frozen souffle. The prepared samples of frozen souffle were subjected to evaluation of sensory attribute like colour and appearance, flavour, body and texture and overall acceptability by a panel of five judges.

4.2.2. The result pertaining to the various sensory attributes viz. colour and appearance, flavour, body and texture and overall acceptability are presented in table 4.1. The result showed that the highest sensory score for all above sensory attribute were obtained for the sample having 20% T.S. representing 8.3, 8.0, 8.1 and 8.4 respectively for colour and appearance, flavour, body and texture and overall acceptability while it was least for 15% level showing 7.4, 6.8, 6.4 and 6.8 respectively. The difference between 20 and 25% level were marginal for these sensory characteristics. Mc Gee, 2004 reported the use of concentrated milk for souffle manufacture. In this investigation the concentration of milk upto 20% T.S. is thus in accordance to the reported literature.

TABLE 4.1. EFFECTS OF THE THREE DIFFERENT LEVEL OF MILK SOLID (VIZ.15% 20% AND 25%) OF CONCENTRATED MILK ON THE SENSORY CHARACTERISTIC OF PREPARED SAMPLE OF FROZEN SOUFFLE:

Level of milk solid (in %)	Mean sensory score			
	Col & App	Flavour	B & T	OA
8	7.4	6.8	6.4	6.85
10	8.3	8.0	8.1	8.4
12	7.7	7.0	7.4	7.3

Average of three samples)

4.2.3. The statistical analysis of the data obtained during the study is shown in table 4.2. The nPar ANOVA showed that the 20% T.S. level gained highest mean rank value showing 10.9, 12.0, 12.2 and 12.6 respectively for colour and appearance, flavour, body and texture and overall acceptability. The variations in sensory score were significant for flavour and overall acceptability ($p \leq 0.05$) whereas it was highly significant for body and texture ($p \leq 0.01$).

TABLE 4.2. NON PARAMETRIC ANOVA FOR EFFECTS OF THE THREE DIFFERENT LEVEL OF MILK SOLID VIZ. (15% 20% AND 25%) OF CONCENTRATED MILK ON THE SENSORY CHARACTERISTIC OF PREPARED SAMPLE OF FROZEN SOUFFLE:

S.C.	N	Df	Highest mean rank value	Level of T.S. (in %)	Chi square (x^2)	Asymptotic sig. level
Colour	5	2	10.9	20	3.629	0.163
Flavour	5	2	12.0	20	6.589	0.037*
B&T	5	2	12.2	20	9.877	0.007**
OA	5	2	12.6	20	6.386	0.041*

* Significant ($p \leq 0.05$)

** Highly significant ($p \leq 0.01$)

4.2.4. It may thus be concluded from above result that 20 % T.S. level of cow milk (3.5% fat and 5 % S.N.F.) are concentrated upto 20% level yield acceptable quality of frozen souffle, hence considered for the subsequent standardization of the process of frozen souffle in the present investigation.

4.3. EFFECT OF THREE DIFFERENT LEVEL OF EGG YOLK ON THE SENSORY SCORE OF FROZEN SOUFFLE:

4.3.1. Egg yolk being the source of unsaturated fatty acid namely oleic acid, phospholipids and fat soluble vitamin, impart different functional properties likes emulsification, foaming etc. Three different level of egg yolk like 2.0%, 4.0% and 6.0% were attempted with a view to evaluate its optimum level for rising of souffle.

4.3.2. The result related to different sensory characteristics such as colour and appearance, flavour, body and texture and overall acceptability for the three level of egg yolk attempted viz. 2.0%, 4.0% and 6.0% are presented in table 4.3. The result showed that 4.0% level of egg yolk gained the highest sensory score being 8.0, 8.2, 8.3 and 8.0 respectively for colour and appearance, flavour, body and texture and overall acceptability. Shifton (2010) used 8.53% of egg yolk for the preparation of Cheese Souffle. The level of egg yolk standardized in this investigation is closed to reported value.

TABLE 4.3. EFFECT OF THE THREE DIFFERENT LEVEL OF EGG YOLK VIZ 2% 4% AND 6% OF THE SENSORY CHARACTERISTIC OF PREPARED SAMPLE OF FROZEN SOUFFLE:

Level of Egg yolk	Mean sensory score			
	Col & App	Flavour	B & T	OA
2	7.0	6.7	6.8	6.7
4	8.0	8.2	8.3	8.0
6	7.2	7.5	7.3	7.0

(Average of three samples)

4.3.3. The statistical analysis of the data showed that the highest mean rank value was obtained for 4.0% level of egg yolk 7.3, 7.1, 7.8 and 8.00 respectively for colour and appearance, flavour, body and texture and overall acceptability (Table 4.4). The variations in the sensory score were significant for flavour, body and texture and overall acceptability ($p \leq 0.05$). While, it was insignificance for colour and appearance (Table 4.4).

TABLE 4.4. NON PARAMETRIC ANNOVA FOR THREE DIFFERENT LEVEL OF EGG YOLK ON SENSORY CHARACTERISTICS, SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE:

S.C.	N	Df	Highest mean rank value	Level of Egg Yolk (in %)	Chi sq (x^2)	Asymptotic sig. level
Colour	3	2	7.3	4	3.471	0.176
Flavour	3	2	7.7	4	6.386	0.041*
B&T	3	2	7.8	4	6.099	0.047*
OA	3	2	8.0	4	6.222	0.045*

* Significant ($p \leq 0.05$)

4.3.4. It may thus conclude that a 40% of egg yolk obtained highest mean rank volume. Thus this level of egg yolk was selected for the subsequent process standardization of frozen souffle

4.4. EFFECT OF THREE DIFFERENT LEVEL OF GELATINE THE SENSORY CHARACTERISTIC OF FROZEN SOUFFLE:

4.4.1. The Gelatin is a stabilizer from animal origin, act as stabilizer. It bind free water and other hydrophilic constituents form gel, gives the body of souffle. Three level of gelatin viz. 3.5%, 4.0% and 4.5% were

attempted in this investigation with a view to evaluate the optimum level for adequate body and fluffiness of frozen souffle.

4.4.2. The result obtained through sensory evaluation on 9-point-hedonic scale is presented in table 4.5. It is evident from the tables that 4.0 % level of gelatine gained highest sensory score for colour and appearance, flavour, body and texture and overall acceptability being 7.8, 7.8, 8.3 and 8.1 respectively. On the other hand 3.5%level of gelatine showed the lowest value being 7.3, 6.5, 6.8 and 6.6 respectively for respective sensory attributes. It is further evident that there is a marginal difference in the sensory score for body and texture between 3.5 and 4.0% level of gelatine in frozen souffle. It was evident from the literature that for the preparation of chocolate souffle was used (McGee). The level of gelatine standardized in this investigation (10%) is closed to the reported value. Further Schwimmer *et al* (1957) reported that consumption of gelatine 7 to 10 g/day could significantly affect nail growth rate while Silvestrini (1988) and Adam (1991) reported the benefit of gelatin in hair growth and arthritis in long use. The level of gelatin used in this investigation is thus well within the safe limit.

TABLE 4.5. EFFECT OF THE THREE DIFFERENT LEVEL OF GELATIN 3.5% 4% AND 4.5% OF THE SENSORY CHARACTERISTIC SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE:

Level of gelatin	Mean sensory score			
	Col & App	Flavour	B & T	OA
3.5	73	6.5	6.8	6.6
4.0	7.8	7.8	8.3	8.1
4.5	7.0	7.3	7.6	6.6

(Average of three samples)

4.4.3. The data obtained were analysed statistically. The nPar ANOVA showed that 4.0% level of gelatin gained highest mean rank value for all four sensory attributes being 8.3, 9.3, 10.0 and 10.5 respectively for colour and appearance, flavour, body and texture and overall acceptability (Table 4.6). The variation in sensory scores given by a panel of five judges were significant for flavour, body and texture and overall acceptability ($p \leq 0.03$).while it was significant for colour and appearance (Table 4.6).

TABLE 4.6. NON PARAMETRIC ANOVA FOR THREE DIFFERENT LEVEL OF GELATIN (3.5, 4.0 AND 4.5) ON SENSORY CHARACTERISTICS OF PREPARED SAMPLE OF FROZEN SOUFFLE.

S.C.	N	df	Highest mean rank value	Level of gelatin	Chi sq (x^2)	Asymptotic sig. level
Colour	4	2	8.3	4.0	1.710	0.424
Flavour	4	2	9.3	4.0	6.096	0.047*
B&T	4	2	10.0	4.0	7.710	0.021*
OA	4	2	10.5	4.0	7.662	0.022*

* Significant ($p \leq 0.05$)

4.4.4. from the result discussed above it may thus be concluded that gelatin at 4.0% level showed more acceptable frozen souffle from sensory evaluation point of view, hence selected for the subsequent process standardization for frozen souffle.

4.5. EFFECT OF THE THREE DIFFERENT LEVELS OF SUGAR ON THE SENSORY ATTRIBUTES OF FROZEN SOUFFLE:

4.5.1. Sugar especially cane sugar or sucrose imparts sweetness and palatability of any product. It also help the building the body and texture and networking with egg white and gelatin. Three level of sugar such as 5.0%, 7.5% and 9.0 %was attempted in this study with a view

to evaluate approximate level of sugar for desire palatability and body and texture of the frozen souffle.

4.5.2. The result partaining to the sensory score, for colour and appearance, flavour, body and texture and overall acceptability given by five judges are presented in table 4.7. It is observed that with the increase in the sugar level, there was corresponding increase in sensory score for all the four sensory attribute upto 7.5% level of sugar which fall thereafter. Further 7.5% of sugar showed highest sensory score being 7.8, 8.1, 8.1 and 8.1 respectively for colour and appearance, flavour, body and texture and overall acceptability. It is evident from the literature that Havette *et. al.*(1984) and Herbert *et al* (1985) used 10% level of sugar for the preparation of Cheese Souffle and Sweet (pear) Souffle. The level of sugar selected in this study is thus at par with the reported value.

TABLE 4.7. EFFECT OF THE THREE DIFFERENT LEVEL OF SUGAR VIZ 5.0% 7.5% AND 9.0% OF THE SENSORY CHARACTERISTIC SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE:

Level of sugar (in %)	Mean sensory score			
	Col & App	Flavour	B&T	OA
5	7.0	6.5	6.8	6.6
7.5	7.8	8.1	8.1	8.1
9	7.0	7.6	6.5	7.3

(Average of three samples)

4.5.3. The statistical analysis of the sensory score is shown in table 4.8. From the nPar ANOVA it is evident that 7.5% level of sugar obtained highest mean rank value being 8.0, 7.3, 8.0 and 8.0 for colour and appearance, flavour, body and texture and overall acceptability respectively (table 4.8). Significant difference in sensory score were

observed only in case of flavour, body and texture and overall acceptability ($p \leq 0.05$) (table 4.8).

TABLE 4.8. NON PARAMETRIC ANNOVA FOR THREE DIFFERENT LEVEL OF SUGAR ON SENSORY CHARACTERISTICS, SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE.

S.C.	N	Df	Highest mean rank value	Level of sugar (%)	Chi sq (x^2)	Asymptotic sig. level
Colour	3	2	8.0	7	1.717	0.424
Flavour	3	2	7.3	7	6.043	0.049*
B&T	3	2	8.0	7	6.058	0.048*
OA	3	2	8.0	7	7.057	0.029*

* Significant ($p \leq 0.05$)

4.5.4. It may thus be concluded that 7.5% level of sugar resulted most desired level of palatability and approximate body for frozen souffle, hence selected for the subsequent process standardization of frozen souffle.

4.6. EFFECT OF THREE LEVEL OF DIFFERENT LEVEL OF EGG WHITE ON THE SENSORY CHARACTERISTIC OF FROZEN SOUFFLE:

4.6.1. Egg white is the principle body builder in souffle. Three level of egg white viz 8.0%, 10.0% and 12.0% were attempted in the present investigation with a view to evaluate the appropriate level of egg white for adequate body and texture and test of the frozen souffle.

4.6.2. The result obtained through sensory evaluation study is presented in table 4.9. It is evident from the result that amongst three levels of egg white attempted (8.0%,10.0% and 12.0%). 10% level of egg

white gained highest sensory score in all four sensory characteristic such as colour and appearance, flavour, body and texture and overall acceptability being 8.3, 8.0 and 8.4 respectively.

TABLE 4.9. EFFECT OF THE THREE DIFFERENT LEVEL OF EGG WHITE VIZ 8% 10% AND 12% OF THE SENSORY CHARACTERISTIC SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE:

Level of egg white	Mean Sensory Score			
	Col & App	Flavour	B & T	OA
8	2.3	7.2	6.7	6.8
10	7.5	8.3	8.0	8.4
12	5.2	6.7	7.5	7.3

(Average of three samples)

The variation in the sensory score for body and texture and overall acceptability are only marginal (table4.9). Shifton (2010) reported the use of 15.96% of egg white for chocolate souffle. In this investigation 10.0% level of egg white is found most acceptable which is almost closed to the reported volume.

4.6.3. The statistical analysis of the data interprets that the highest mean rank volume were obtained only for 10.0% level of sugar showing 5.7, 8.0, 7.5 and 7.7 respectively for colour and appearance, flavour, body and texture and overall acceptability (table4.10). The variation in sensory score on the other hand were only significant for flavour, body and texture and overall acceptability ($p \leq 0.05$) (table 4.10)

TABLE 4.10. NON PARAMETRIC ANOVA FOR THREE DIFFERENT LEVEL OF EGG WHITE OF SENSORY CHARACTERISTICS, SUCH AS COLOUR AND APPEARANCE, FLAVOUR, BODY AND TEXTURE AND OVERALL ACCEPTABILITY OF PREPARED SAMPLE OF FROZEN SOUFFLE:

S.C.	N	Df	Highest mean rank value	Level of egg white (%)	Chi sq (x^2)	Asymptotic sig. level
Colour	3	2	5.67	10	0.033	0.846
Flavour	3	2	8.0	10	6.557	0.038*
B&T	3	2	7.5	10	6.065	0.048*
OA	3	2	7.67	10	6.095	0.047*

* Significant ($p \leq 0.05$)

4.6.4. The result discussed above may therefore conclude that 10.0% level of egg white provided best quality of frozen souffle and hence selected for subsequent process standardization of frozen souffle in this investigation.

4.7. STANDARDIZATION OF THE PROCESS FOR THE SOUFFLE:

4.7.1. Frozen souffle is a dessert like mouse, prepared from concentrated cow milk, egg yolk, gelatin, sugar and egg white. The levels of these ingredients were standardizing in preceding section (sec. 4.2 to 4.6). The total solid of the cow milk (3.5% fat and 8.5% SNF), egg yolk level, level of gelatin, level of sugar and egg white were standardize to 20% T.S., 4%, 4% 7.5% and 20% respectively. In the standardization of process for making frozen souffle cow milk was concentrated up to 20% T.S. by heating. After concentration of milk added require amount of egg yolk and sugar (which was already mix tougher) stir for homogenous mixture then cool the mix and added gelatin solution. After adding gelatin added egg white and slowly stir the mix till

homogenous mixing then kept in refrigerated condition for at least 6 hour.

4.8. EVALUATION OF THE QUALITY ATTRIBUTES OF FROZEN SAMPLES PREPARED EMPLOYING THE PROCESS STANDARDIZED IN THE PRESENT STUDY:

4.8.1. The final product i.e. frozen sample prepared in preceding section 4.7 was subjected to evaluation of quality attributes employing proximate analysis, sensory evaluation, rheological studies and microbiological evaluation.

4.8.2. The samples of frozen shuffle were analysis of proximate composition such as moisture, protein, titratable acidity, fat and total calorie contents. The result related to these attributes is presented in table 4.11. The moisture, protein, fat, total carbohydrates, total ash, titratable acidity and total calorie contents were found to be 56.50%±0.46, 11.75%±0.29, 11.80%±0.22, 13.18±0.59%, 6.85±0.13%, 0.16±0.01% LA and 203.92 kcal per 100 gm (table 4.11). The statistical analysis of the data showed that the variation in replicates in each attributes were significant (table 4.12). The result obtained in this study further showed that it was at par with the reported literatures.

TABLE 4.11. PROXIMATE COMPOSITION OF SOUFFLE

parameter	Per 100 g (Mean±SD)
Moisture	56.50±0.46
Protein	11.75±0.29
Fat	11.80±0.22
Total carbohydrate	13.18±0.59
Total ash	6.85±0.13
Titratable acidity	0.16±0.01

TABLE 4.12. ANOVA OF CHEMICAL COMPOSITIONS OF DIFFERENT SAMPLES OF FINISHED PRODUCT (FROZEN SOUFFLE):

PARAMETERS →	Moisture	Fat	Protein	Carbohydrate	Ash	Acidity	Total Solids
MSS BETWEEN GROUPS	3.226**	0.158	0.341	0.168	4.00×10^{-2}	3.333×10^{-5}	0.316
MSS WITHIN GROUPS	0.253	4.722×10^{-2}	8.306×10^{-2}	0.220	1.222×10^{-2}	5.556×10^{-5}	8.861×10^{-2}
F VALUE	12.734	3.335	4.104	0.765	3.273	0.600	3.564

Degree of freedom = 2

Error = 9

** Highly Significant ($p<0.01$)

4.8.3. SENSORY EVALUATION:

4.8.3.1. The results pertaining to the sensory evaluation of the frozen shuffle prepared are presented in table 4.12. It is evident from table that the sensory score for the colour and appearance, flavour, body and texture and overall acceptability are 7.7, 7.8, 7.5 and 7.7 respectively (table 4.13). The higher score was obtained for sample III (replicate 3) while, the lowest sensory score was for sample I (replicate 3).

TABLE 4.13. SENSORY SCORES OF FROZEN SOUFFLE:

Frozen souffle (Final product)	Sensory Scores			
	Col & App	Flavour	B & T	OA
	7.7	7.8	7.5	7.7

The highest mean rank was observed as 10.25 for all the four characteristic studies and chi square analysis showed the significant variation ($p \leq 0.05$) (Table 4.13) in the sensory score for respective sensory characteristic except colour and appearance, which may be due to the variation in individual liking of the judge. The overall acceptability of the product was however, excellent.

TABLE 4.13. ANOVA OF DIFFERENT SAMPLES OF FINISHED PRODUCT

S.C.	N	Df	Highest mean rank value	Chi sq
Colour	4	2	9.3	4.460
Flavour	4	2	10.25	6.875*
B&T	4	2	10.50	8.069*
OA	4	2	10.0	8.565*

* Significant ($p \leq 0.05$)

4.8.4. RHEOLOGICAL STUDIES:

4.8.4.1. The frozen shuffle prepared in this investigation was subjected to the rheological analysis studies by texture analyser, the value obtained for hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess and chewiness are presented in Table 4.15. It is evident from the table that the values for hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess and chewiness were found to be 1095.45±134.93 g, 40.37±0.72 g, -137.75±39.42 gs, 0.94±0.006, 0.71±0.01, 787.53±97.88 and 744.43±87.80 respectively. The product was found to be soft and mellow having optimum rheological characteristic.

4.8.5. MICROBIOLOGICAL EVALUATION

4.8.5.1. The samples of frozen souffle were analysed for SPC and coliform count. The results obtained in this study were presented in table 4.16. It may be observed from the table that the SPC and coliform of frozen souffle are 200×10^3 cfu/gm and 8×10^1 cfu/gm (table 4.16). Further these standard shows that the product safe for consumption.

TABLE 4.16. MICROBIOLOGICAL ANALYSIS OF FINISH PRODUCT

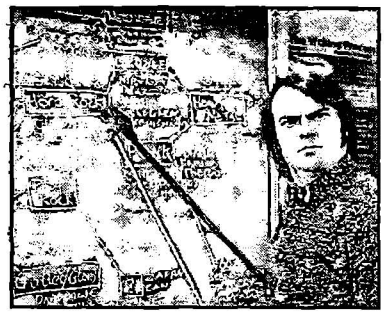
Characteristic	Microbiological count in cfu/ gm
SPC	200×10^3
Coliform	8×10^1

TABLE 4.15. RHEOLOGICAL STUDIES OF FROZEN SOUFFLE

Product	Hardness (g)	Fracturability (g)	Adhesiveness (gs)	Springiness (g)	Cohesiveness	Gumminess	Chewiness
Ave ±SD	1095.46 ±134.94	40.38 ±0.72	-137.76 ±39.42	0.946 ±0.006	0.719 ±0.011	787.531 ±97.880	744.437 ±87.805

4.9. The result partaining to the standardization of T.S. level of cow milk (35% fat and 8.5% SNF), egg yolk level, sugar level, gelatine level and egg white level and the proximal composition, sensory scores, values for the rheological attributes and microbiological counts are presented and discussed in this chapter. The cow milk was concentrated to 20% T.S. level. The egg yolk (4%) and sugar (7.5%) were mixed and whipped and mixed with the concentrated was mixed. The egg white (10%) was then added to the mix, stirred gently and placed in refrigerated condition (0-5 ^{0}C) for 6-8 hours before serving. The product was found to be very delicious.

Chapter-5



Summary and Conclusion

Summary and Conclusion

5.1. Souffle is a creamy egg based pudding like product. Originated in France but gaining popularity in worldwide. The contents discussed in this thesis are summarized hereunder,

5.2. Frozen souffle is a milk cream based dessert where egg yolk and gelatin and egg white gives the body of the souffle while sugar impart sweetness so as the palatability. This investigation was therefore undertaken with the following objectives

1. To standardize a level of total solid of milk
2. To standardize the level of sugar
3. To standardize the level of egg white
4. To standardize the level of egg yolk
5. To standardize the level of gelatin

5.3. The available literature are reviewed in this section under various sub heading like historical background, components of souffle where milk, cream, sugar, gelatin and egg yolk and egg whites are reviewed. The type of souffle, nutritional information of souffle and similar types products such as pudding, custard and custard pudding, difficulties in souffle making are also reviewed in this chapter.

5.4. The material like milk, cream, egg yolk, gelatin, sugar and egg white are used in souffle preparation. Three levels, of T.S. of cow milk (15%, 20% and 25%), three levels of egg yolk (2%, 4% and 6%), three levels of gelatin (3.5%, 4.0% and 4.5%), three levels of sugar (5.0%, 7.5% and 10%) and three levels of egg white (15%, 20% and 25%) were attempted with a view to standardized their appropriate level for frozen souffle. Finally cow milk having 3.5% fat and 8.5% SNF was concentrated to optimum level of T.S. mixed with other ingredients to prepare frozen souffle.

5.5. The result preparing to the standardization of the level of T.S. of cow milk, egg yolk, gelatin, sugar and egg white are presented and discuss in this chapter.

5.5.1. The level of T.S. of cow milk (3.5% fat and 8.5% SNF) was standardized as 20% of the preparation of frozen souffle.

5.5.2. The egg yolk level was standardized as 4.0% level for preparation for frozen souffle in this investigation.

5.5.3. Four percent level of gelatin was found optimum for the preparation of frozen souffle in this investigation and selected for subsequent process standardization in this study.

5.5.4. The level of sugar was standardized as 7.5% for the preparation of frozen souffle.

5.5.5. The egg white level was standardized as 10% level in this investigation

5.5.6. The cow milk (3.5% fat and 8.5% SNF) concentrated to 20% T.S. to which a mixer of egg yolk (4%) and sugar (7.5%) was added. Gelatin solution was prepared using 4.0% level of gelatin, and then mixed thoroughly with souffle mix as prepared before. This was followed by the addition of 10% of egg white, mixed gently and placed under refrigerated condition for 6 to 8 hour before serving.

5.5.7. The frozen souffle thus prepared showed a proximate composition being 56.50%±0.46 for moisture, 11.75%±0.29 for protein, 11.80%±0.22 for fat, 13.18±0.59% for total carbohydrate, 6.85±0.13% for ash, 0.16±0.01% for titratable acidity (as Lactic Acid) and 203.92 kcal calorie content.

5.5.8. The prepared sample of frozen souffle gained sensory score being 7.7, 7.8, 7.5 and 7.7 colour and appearance, flavour, body and texture and overall acceptability. The product is general was found excellent from palatability point of view.

5.5.9. The prepared sample of frozen souffle was also analysed for rheological characteristic hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess and chewiness values were found as 1095.4±134.94, 40.38±0.72, -137.7±39.4, 0.946±0.006, 0.719±0.011, 787.5±97.9 and 744.4±87.8 respectively.

5.5.10. The microbiological evaluation of the prepared of frozen souffle was carried out with a view to access its acceptability. The product showed SPC as 200 cfu/gm and coliform count as 8 Cfu/gm. Hence the product was safe for consumption.

5.6. The investigation deals with the introduction, review of literature, material and methods and result and discussion. The product as a developed through standardization of several parameters and process was found acceptable from the point of its physicochemical, sensory, rheological and microbiological characteristic point of view

Chapter-6



Future scope of study

Future Scope

6.1. Souffle baked or frozen gaining popularity day by day. The work carried out in the present investigation was a limited one only. The various research that could be carried out for its successful commercial manufacture.

6.2. Attempts could be made to prepare eggless and gelatin less soufflé as a large number of people are vegetarian worldwide.

6.3. Attempts could be taken to minimize collapse by several innovative approaches.

6.4. Different types of milk buffaloes or sheep's milk could be tried for making soufflé.

6.5. Egg powder could be used to make soufflé safer product.



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APPENDIX I SENSORY SCORE CARD (A 9-POINT HEDONIC SCALE)

Score	Numerical	Score Objective
1	9	Extremely liked
2	8	Liked very much
3	7	Liked moderately
4	6	Liked slightly
5	5	Neither liked nor disliked.
6	4	Disliked slightly
7	3	Disliked moderately
8	2	Disliked very much
9	1	Disliked extremely