# "STUDIES ON DEVELOPMENT AND STANDARDIZATION OF STERILIZED CARROT BASED FLAVOURED MILK AND CARROT KHEER"

**M. Tech. (Dairy Tech.) THESIS**

**by**

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# "STUDIES ON DEVELOPMENT AND STANDARDIZATION OF STERILIZED CARROT BASED FLAVOURED MILK AND CARROT KHEER"

*Thesis*

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*Dedicated to*
*my*
*beloved parents*
*and*
*well wishers*

## CERTIFICATE- I

This is to certify that the thesis entitled **"Studies on Development and Standardization of Sterilized Carrot based Flavoured Milk and Carrot Kheer"** submitted in partial fulfilment of the requirements for the degree of **"Master of Technology in Dairy Technology"** of the **Indira Gandhi Krishi Vishwavidyalaya, Raipur ,(C.G.)** is a record of the bonafide research work carried out by **Ms. Mehar Afroz Qureshi** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or published / published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

Date: 6/12/09

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## CERTIFICATE – II

This is to certify that the thesis entitled **"STUDIES ON DEVELOPMENT AND STANDARDIZATION OF STERILIZED CARROT BASED FLAVOURED MILK AND CARROT KHEER"** submitted by **Ms. Mehar Afroz Qureshi** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfilment of the requirements for the degree of **Master of Technology (Dairy Tech.)** in the **Department of Dairy Technology** has been approved by the Student's Advisory Committee after oral examination in collaboration with external examiner.

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Date: 03/03/05

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Date: 6/12/04

Mehar

Mehar Afroz Qureshi

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## List of Symbols and Abbreviations

| | | |
|---|---|---|
| % | - | Precentage |
| e.g. | - | Example |
| et.al | - | Etlii and others |
| g | - | gram |
| ISI | - | Indian Standards Institution |
| $^{o}$B | - | Degree Brix |
| IS | - | Indian Standard |
| PFA | - | Prevention of Food Adulteration Act |
| TSS | - | Total Soluble Solids |
| IGAU | - | Indira Gandhi Agricultural University |

# CHAPTER I
# INTRODUCTION

India has emerged as the largest milk producers in the world with a record production of 89 million tonnes during 2003-2004, which represents 13% of world's production. A remarkable progress has been made in enhancing the milk production during the last three decades. In order to sustain the high growth rate in milk production, it is essential to process and preserve it most effectively and economically.

The several work been engaged in evolving appropriate milk processing technologies to suit Indian conditions and has been successful in developing, upgrading and modernizing process for varieties of milk products and formulated foods which will ensure utilization of available raw material and provide a wide range of products for various income and dietetic groups.

Nutritionists recognize milk and its products as important constituents of a well balanced, nourishing human diet. Milk has been described as natures nearly perfect food in that it provides vital nutrients like proteins essential fatty acids, vitamins, minerals and lactose in balanced proportions. Milk has high nutrient density because it provides

high concentration of major nutrients at relatively low calorific value (Aneja *et al.*, 2002).

Now a day's people are very aware about consuming the healthy, tasty, safe and nutritious food. They want to consume the food, which fulfills all these requirements in single ones and are natural origin.

Traditional Indian Dairy Products contains a significant proportion of milk nutrients and therefore are highly nutritious. It is a common practice in Indian continent to consume milk alongwith cereals and fruits. The addition of cereals fruits, fruit pulps and vegetables in the milk results into value addition in terms of nutrition. It is tastier, healthier and nutritious also.

Milk desserts/puddings, based on cereals such as rice and wheat, fruits and vegetables, occupy a prominent position in the Indian diet, not only for their taste and delight of eating but also for their high nutritional quality. Such type of products are also very useful for infants and growing children's because of its flavour and its nutritional value which provides nourishment essential for the body growth and maintenance in infants.

The several type of foods or milk products are developed based on cereals, fruits ,and vegetables like *kheer, payasam*, fruit based payasam, mango and pineapple shakes; vegetable based products like *Lauki kheer*

*Kaddu ki kheer, Sabudana kheer, Gajar ka halwa* etc. which are very nutritious and healthy foods.

Since, there is a need of development and standardization of milk products based on cereals, fruits, fruit pulps and vegetable etc. to fulfill the requirements of tasty safe and healthy foods.

Carrot is an important root crop of India. Carrot was well known for its nutritional and therapeutic properties. It posses natural flavour and color also. Carrot is available in the winter for very short period. The processing and preservation of carrot is necessary for its availability throughout the year. Carrot can be preserved in various forms such as canning, drying and dehydration, pickles, shredded dried forms. Carrot has pleasant flavour and color. *Gajar ki kheer* and *Gajar ka halwa* is a very popular sweet dish of north and central India It is also used as a vegetable and salad.

Inclusion of carrot juice in the diet has been a very important problem in a contemporary feeding of infants. Moro (1907) in his researches pointed out that feeding piglets (unweened infants) on a carrot juice or pig milk prevented them from a disease similar to an infantile diarrhea observed while fed on cow milk. Ohta *et al.,* 1971 observed a very distinct influence of feeding carrot on the growth of Bifidobacterium bifidum (100 fold) in infant's feces.

A bifidogenic factor isolated from carrot is regarded as a superior growth-stimulating factor for *Bifidobacterium bifidum* compared to pancreatin, liver extract and yeast extract (Ohta *et al.,* 1971).

In this manner the development of Carrot based milk products are very important because the carrot mixed with milk gives a better taste and fulfill the requirements of nutritious and safe food.

The study is conducted with the following objectives

- To formulate and standardize the carrot based flavoured milk and carrot kheer.
- To study the shelf life behavior of the sterilized products.
- To study the physicochemical and sensory properties of carrot based flavoured milk and carrot kheer.

# *Review of Literature*

# CHAPTER II
# REVIEW OF LITERATURE

## 2.1 Introduction

This chapter covers information and literature related to the background; information recent status, composition and work done on various types of flavoured milk, cereal based milk products like *kheer*, *payasam*; fruit based milk product and vegetable based milk products.

Milk is considered as natures nearly perfect food. It contains almost all those essential human body, especially for children, which otherwise are not available in any other single food. The addition of ingredients like cereals, fruits, and vegetables in milk improves its nutritional profile and palatability of the final product. The consumption of milk alongwith cereals is an old tradition in the Indian food habit. Milk shakes containing fruit pulp and juice are also very popular. Milk products containing vegetables imparts a variety of taste and flavour to the product.

## 2.2 Flavoured milk

Flavoured milk is gaining popularly day by day because it is a cheaper cold drink as compared to non-milk based drinks and posses more nutritive value (Arora and Kalra, 1984).Flavoured milk is a product, which is very nutritious, and energy rich product by adding the some natural or synthetic flavour and colour. Preparation of flavoured milk is becoming an

integral part of any market milk plant because these milks have good consumer acceptance as refreshing and nourishing milk beverage and also act as great sales builder.

### 2.2.1 Introduction

According to the PFA rules, flavoured milks may be defined as cow or buffalo milk or any one of the designated milks (i.e. single toned, double toned, recombined or standardized) to which flavour either natural or synthetic has been added. Sugar and colour may or may not be added depending on the requirements. If the flavoured milk is prepared from such milk which does not conform to any minimum legal standard in respect of fat and SNF, it is called as flavoured drink or flavoured dairy drinks. The flavoured milks may be either pasteurized or sterilized.

### 2.2.2 Purpose

- To make milk more palatable to those who do not relish as such;
- To stimulate the sale of milk;
- To put skim milk to profitable use.

### 2.2.3 Types

- Artificially flavored milks
- Chocolate flavoured milk
- Fruit flavoured milk
- Sterilized flavoured milk

### 2.2.4 Method of manufacture of Flavoured Milk

#### 2.2.4.1 Artificially flavoured milk

An artificial flavour is added for manufacturing these flavoured milks. Fat of milk is normally adjusted to about 2%but SNF content is increased upto 10% by addition of reconstituted skim milk powder or buttermilk powder. Standardized milk is homogenized at 65 $^{0}$C by two-stage process. Homogenization is an inevitable step while manufacturing sterilized flavoured milk but could be eliminated in the preparation of pasteurized flavoured milk. Then sugar is mixed properly with hot milk followed by pasteurization at 71$^{0}$C for 30 min. or 80$^{0}$C for 15 sec and cooling to about to 4$^{0}$C. Finally, desired flavour @1ml/kg milk should be added at this stage. For the preparation of sterilized flavoured milk, flavour @1.5-2.0 ml/kg of milk should be added before sterilization. A suitable thickener such as sodium alginate, carrageenan or CMC (upto 0.2%) may also be added for improving the consistency of flavoured milks. Partial or complete replacement of sucrose with corn syrup has also been recommended.

Flavoured milks could also be enriched with milk proteins, minerals and vitamins. Various types of artificial flavours such as vanilla, banana, pineapple, rose, raspberry, strawberry, mango, orange, etc. are available in market. The choice of flavour should depend on consumer's preference. In certain parts of India cardamom, rose, pista, and badam are used as a

natural flavouring material in the preparation of sterilized flavoured milk. These flavours are more expensive than the artificial flavours, and consumers like it very much.

**2.2.4.2 Chocolate flavoured milk**

Chocolate milk is most liked flavoured milk in many countries. Different types of chocolate milks can be prepared depending upon its composition and the raw material used. The manufacturing process is described by using flow chart in Fig.2.1. The different trends in utilization of different ingredients for its preparation involve:

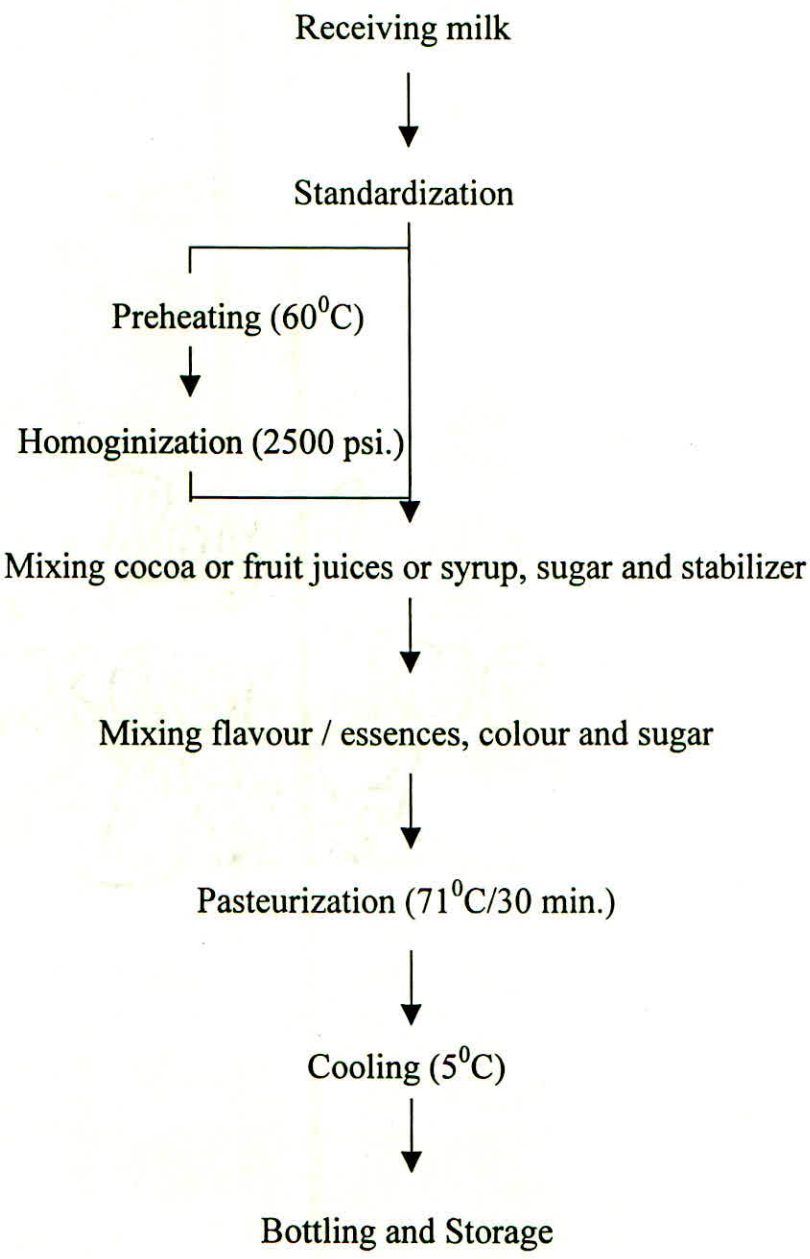
- Cocoa powder - 1 to 1.5 %
- Sugar - 5 to 7 %
- Stabilizer - 0.2 %
- Fat level in milk – Min. legal standard

(S. De, 1985)

**2.2.4.3 Fruit Flavoured milk**

For manufacturing of fruit based flavoured milk, permitted fruit flavoures or essences, together with permitted colours and sugar are used. The method of preparation is similar to that used for chocolate milks /drinks. The some common flavoures used are: Strawberry, Orange, Lemon, Pineapple, Banana, Vanilla, Carrot juice, Apricot, and Peaches.

**Fig.2.1 Flow chart for manufacturing of Chocolate flavoured milk**




(**Source**: De, 1976)



T · 1753

Pure fruit juices or syrups can be satisfactorily combined with milk to form milk shakes". In India mango and banana are commonly used in preparation of milk shakes, particularly in the summer months.Fruit flavoured milks are manufactured by adding either the fruits pulp or fruit juices along with sugar to milk. When fruits pulp is used as such a suitable pretreatment to avoid discoloration of pulp is essential. Use of fruit juices is now preferred over natural fruits in the manufacture of milk beverages. The general procedure of manufacturing these beverages involves: blending milk solids (either liquid whole/ skim milk, whey, buttermilk or their counterpart concentrated or anhydrous form) which fruit juice, sugar solution, stabilizer (generally pectin, carrageenan, CMC, gelatin, etc.) and an edible acid (citric, lactic, malic or tartaric acid). The choice of various ingredients and their quantity depend on the preference of consumers. Apple, grape and pineapple juices have been more widely used in preparation of these beverages. A low $p^H$ normally varying between 3.5 - 4.5 is mostly preferred.

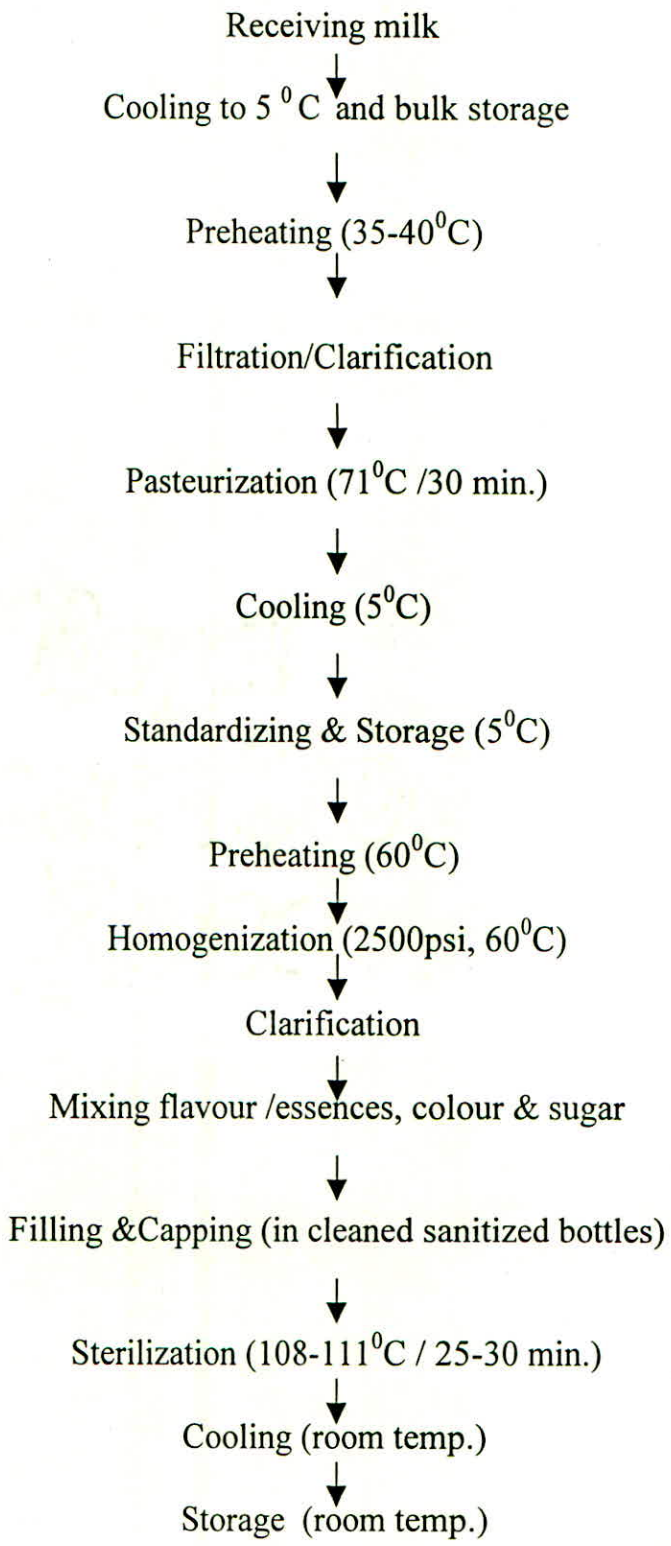
Asl-AK (1999) reported on production of flavoured and coloured milks using fruit and vegetable juices and study of their consumer acceptability. He prepared three samples of flavoured milk by using, strawberry and a mixture of strawberry and red beet juice as coloring and flavouring agents.

### 2.2.4.4 Sterilized flavoured milk

Sterilization of a product means subjecting it to such powerful heat treatment that all the microorganisms present in it are killed. Sterilized products have excellent keeping properties and can be stored for longer periods at relatively high temperatures Flavoured milks are the most common sterilized dairy product. This type of milk combined the advantages of both sterilized and flavoured milk. The shelf life of sterilized flavoured milk is very high. As per PFA, sterilization when used in association with milk means heating milk continuously to a temperature of $115^0$Cfor 15 min or $145^0$C for 3 sec, or equivalent temperature time combination to ensure preservation at room temperature for a period of not less than 15 days from the date of manufacture. Sterilized milk shall show absence of albumin by a negative turbidity test, sterilized milk shall be sold in the container in which the milk was sterilized.

Sadek et.al., (1974) reported on sterilized flavoured milk drinks. They reported that the addition of 3-5 % dates syrup to skim milk increased acidity, TS, sugar and soluble protein N contents of the final product. In bottle sterilization of the prepared drinks decreased the contents of reducing and non-reducing sugars. During storage, the non-reducing sugar of the sterilized drinks decreased gradually with an increase in reducing sugar contents.

**Fig.2.2 Flow Chart for manufacturing of Sterilized Flavoured Milk**




(**Source**: De, 1976)

## 2.3 Cereal based milk products

The Traditional Indian Dairy products are the products of masses being made in India since time immemorial and have great social, religious, cultural, medicinal and economic importance. The traditional milk products provide the means of preserving precious milk solids for a comparatively longer time than the fluid milk whose shelf life under Indian tropics conditions is only 5-6 h at ambient temperature. Thus the cereal based milk products are one of the important part of the traditional Indian milk products not only for their taste, aroma and delight of eating but also for their nutritional quality (Pal, 2000).

Traditionally cereal based milk products have been produced for centuries in many countries. Most of these products are home made and prepared by using varieties of cereals such as rice, cracked wheat *(daliya), sabudana* (pearl tapioca), *makhna,* vermicelli *(seviah)* and semolina *(suji)* apart from milk, sugar and dry fruits.

The ratio of cereals to milk may differ depending upon the type of the cereal used. The product is highly nutritious and the minor constituents that are deficient in milk are supplemented by cereals and vice versa. In such type of products cereal and milk are blended to compensate for deficiency of lysine. Proteins from cereals and millets in combination with milk make up deficiency in the protein quality. Cereals also constitute a source of calcium, iron and the B vitamins. Addition of pulses in milk-

based desserts can make up the deficiency of methionine in the proteins of pulses. (Aneja *et al.*, 2002).

Cereal based delicacies are extremely liked by almost all age groups through out the country. Among the cereal based milk products, *kheer* and *payasam* occupy a place of prominence in Indian diet in every part of the country, not only now, but since the days of kings and nobles. These are prepared on auspicious occasion like marriages, festivals and other social and religious functions.

### 2.3.1 *Kheer*

*Kheer* is a very delicious cereal based indigenous milk product. It is popular throughout the country, and enjoyed by all sections of the society, because of its good taste, higher nutritional value and relatively lowers cost. It is prepared by partial dehydration of whole milk in a *karahi* over a direct fire with sugar and usually rice or occasionally semolina (De *et al.*, 1976).

*Kheer* is known by different names, in different parts of the country, such as '*Kheer*' in Northwestern region, '*Payasam*' in Southern region, '*Payas*' in Eastern region, '*Firni*' in Northern region, '*Kheech*' in Mewar region of Rajasthan (Thompkinson, 1995). It is used as a sweet at all ceremonial occasion and festivals and relished by all age groups and is thought to be a very nutritious food (Cited by Narwade *et al.*, 2003).

*Kheer* is rice based milk products, is obtained by cooking of rice in milk while simultaneously concentrating the later. Sugar and other additives such as coconut, pistachio, cashew nut, almonds, resins and saffron etc. are also added at the completion of cooking and condensing process. It is characterized with sweet, nutty and pleasant flavour, which is highly acceptable to the Indian palate.

Jha *et al,* (2002) reported on Instant *kheer* mix –a value added convenience product for Indian dairy industry. They discusses about the functional properties, cost of manufacture and advantages of instant *kheer* mix.

**2.3.1.1 Method of Manufacture: -**

While *kheer* is a typical Indian traditional product, certain processes developed in the west relate to similar or related products such as milk rice and rice pudding. Galle *et al,* (1984) exposed rice grains (broken or whole) to saturated steam at a pressure higher than atmospheric pressure in an autoclave for sufficient time to gelatinize major portion of starch. The rice grains are than reconstituted with milk for consumption in the form of *kheer* like product. Another product named "creamed rice" which is very similar to *kheer* is prepared from short grained rice, which releases starch on cooking, and is used in combination with homogenized milk and sugar (Keogh, 1970&1971).Choudhary, (1989) studied effect of fat content of milk, sugar level, rice variety, rice level and total solids on the sensory

acceptability of *kheer*. Process standardized for the manufacture of *kheer* is schematically shown in flow diagram (Fig. 2.3).

**2.3.1.2Chemical Composition**

The average chemical composition of *kheer* as reported by different workers is given in table.2.1

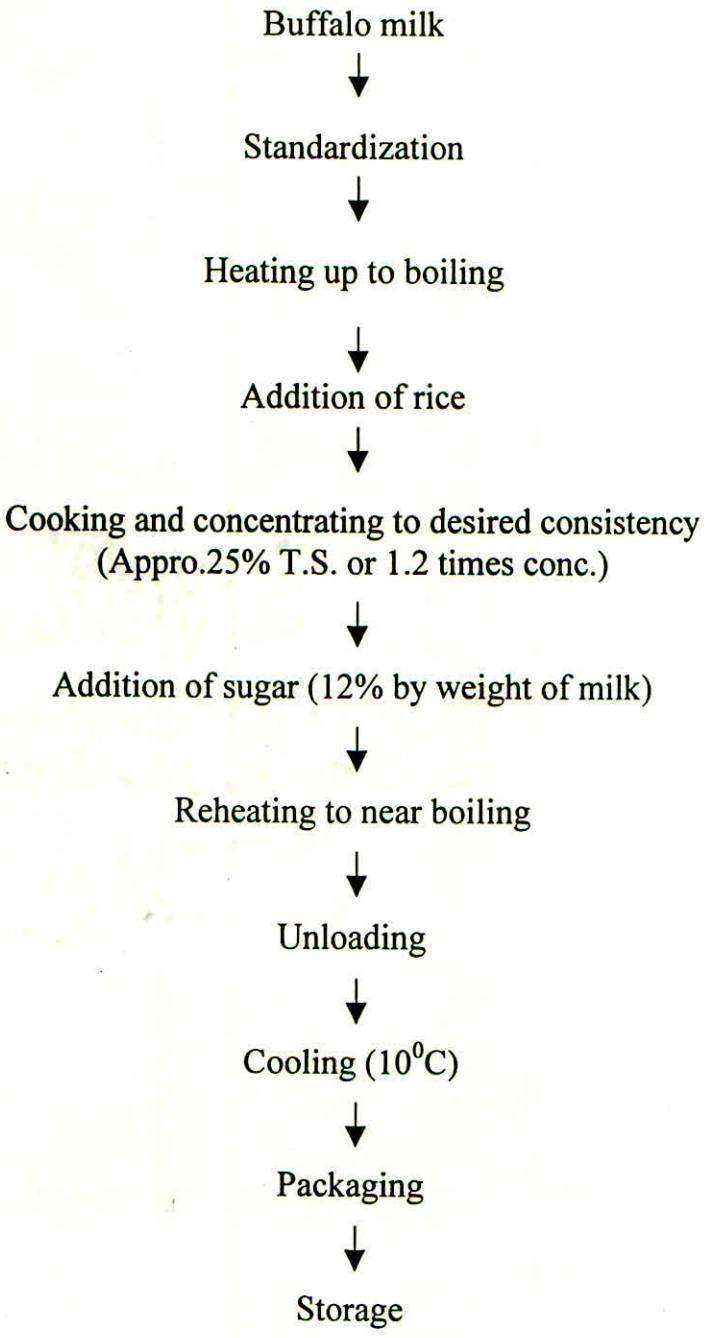
**Table 2.1 Chemical Composition of *Kheer***

| Constituent | Mani et.al[1], 1955 | De et. al.[2], 1976 | Choudhary[3], 1989 |
|---|---|---|---|
| Moisture | 69.0 | 67.02 | 61.77 |
| Total Solids | 31.0 | 32.98 | 38.23 |
| Fat | 12.2 | 7.83 | 6.38 |
| Protein | 11.3 | 8.45 | 6.49 |
| Ash | 2.3 | 1.41 | 0.74 |
| Sucrose | - | 8.95 | 14.74 |
| Other carbohydrates | - | - | 4.45 |

1. *Kheer* made from cow milk of 4.1% fat and 12.5 % T.S.
2. *Kheer* made from milk of 4.1% fat using 2.5% rice and 5% sugar.
3. *Kheer* made from milk containing 5% fat and 9.7% SNF and using 5% rice and 12% sugar.

(**Source**: Aneja *et al*, 2002).

**Fig. 2.3 Flow Chart for manufacturing of *kheer***




**(Source:** Choudhary, 1989)

### 2.3.1.3 Nutritive value

*Kheer* is a rich source of proteins, minerals, vitamins and other nutrients. Mani *et al,* (1955) in perhaps the earliest work on *kheer* studied the nutritional value of traditional product made from rice and milk containing 4.1% fat and 12.5% total solids. It was reported that 100 gm. of *kheer* contain calcium 388 mg, phosphorus 237 mg, ascorbic acid 3.4mg, thiamine118mg, vitamin A 242 IU, nicotinic acid 277µg. and riboflavin 353µg.

### 2.3.1.4 Shelf life of *kheer*

The shelf life of *kheer* at $30^0$ C is about 7-8 h where as it keeps well for about 6-7 days under refrigeration temperature Singh *et al.* (1987) reported an increase in shelf life of thermally processed *kheer* to more than six months at room temperature by using Nisin at a concentration of 200 IU/gm. of the product. Recent work on improvement of shelf life of *kheer* in retort pouches has established that shelf life of more than four months at $37^0$C could be achieved, without any preservatives, if a heat treatment equivalent to $F_0$ = 12-14 is ensured (Jha *et al.,.*, 2000).

### 2.3.2 *Payasam*

*Payasam* is the south Indian counter part of *kheer*. It is a traditional sweet delicacy prepared on auspicious occasion like marriage and social function. It has many verities with specialties and distinct characteristics attributed to area specific traditional methods of preparation. The

ingredients in more common varieties are rice, vermicelli, green gram and sago in addition to milk and sugar. The consistency varies from free flowing to semi solid or corresponding to total solids content of 30-40%. The colour of these *payasams* are varies white, light cream, cream, light brown to brown. Some varieties also give added nutty/fruity flavour. Cardamom is one of the most popular flavorings used in *payasams*. Caramel flavour is also used.

Unnikrishnan *et al.,* (2003) developed a dry mix for convenient preparation of *palada payasam*. The development of *palada payasam* dry mix with a long shelf life has improved the commercial viability of the product in addition to helping the consumers to prepare the *payasam* in a convenient way. The *payasam* prepared, by using the dry mix, which had been stored for one year, was observed to have good sensory properties.

**2.3.2.1 Different types of *payasams***

The different types of *payasams* and its characteristics are shown in following Table 2.2

**Table 2.2 Different Types of *Payasam***

| Type | Name | Characteristics |
|---|---|---|
| Cereal based | Rice *Payasam* (*Halu kheer*u Type) | A viscous free flowing, non-homogenous product with rice settling at the bottom, contains liberal amount of raisins and cashew nuts. |
| | *Pal Payasam* | A highly viscous slightly pasty homogenous product, rice uniformly distributed, light brown in colour, pleasant caramelized flavour. |
| | *Gil- A-Firdaus* | Creamy rich, very high viscous homogenous product, light brown in colour, pleasant nutty flavour, garnished with high levels of fruits and nuts. |
| | Wheat *Payasam* (*Godhi* type) | Highly viscous, pasty, semi solid product with visible coconut gratings, brown in colour, nutty cardamoms flavour. |
| Cereal Product Based | Beaten Rice *Payasam* | Low viscous, free flowing white product with visible coconut gratings, cooked flavour. |
| | RiceSuji *Payasam* (*Akki Nutchu Payasam*) | Homogeneous, thick, viscous product with suspended dry fruits, light cream in colour, cooked and pleasant flavour of added spices. |
| | Wheat Suji *Payasam* (*Rave Payasam*) | Thick, viscous homogenous product with suspended raisins and cashew nuts. |
| | Vermicelli *Payasam* | Low medium viscous, non homogenous, free flowing product with large amounts raisins, nutty/spicy flavour |
| | *Shir Kurma* | Creamy rich, homogenous product having liberal amounts of nuts and raisins, light brown in colour, pleasant caramelized/ nutty flavour. |
| | *AdaPayasam* (*PaladaPayasam*) | Medium viscous product with Ada flakes uniformly distributed, brown colour, cooked flavour. |
| | *Firni* | Highly viscous homogenous product, light yellowish brown, nutty/fruity flavour. |

(**Source**: Unnikrishnan, 1997)

## 2.4 Fruit based milk products

Different types of fruit based milk products are now available like shakes, fruit yogurt etc. The various forms of these products only make it more acceptable by all types of people and all the regions of the country. Technology of making some mouth-watering delicacies remain confined to domestic level in the absence of any viable alternative for their commercial manufacture. The fruit not only enhance the taste of the product but also increases the nutritional quality of the product.

### 2.4.1 Milk Shakes

The fruit based flavored milk, i.e., milk shakes are very nutritious and tastier. Many fruits such as mango, sapota, and banana are used for preparation of milk shakes. Due to its flavor and color, children like and attract to such products, which is beneficial for their health and growth.

### 2.4.2 Fruit Based *Payasam*

Mango and jack fruit are commonly used in fruit based *payasam*. In Kerla, the mango *prathaman* and *chakka prathaman* make use of coconut milk, milk and the respective fruits. In Karnataka, *mavino payasam* is made by boiling one liter of milk with 500 grams each of mango juice and sugar. When cooked it garnished with powdered cardamom and served hot or cold. Alternatively, for making *halasina payasam*, in place of mango juice, cut pieces of jack fruits may be used. (Aneja *et al.*, 2002).Mango and jackfruit are used for fruit based *payasam* preparations. While juice extract of the former is used for *payasam*

preparation, fruit pieces of latter are fried in ghee and subsequently used for preparation of *Halasina payasam*. Both varieties of *payasam* are flavoured with cardamom powder (Unnikrishnan *et al.*, 2000).

## 2.5 Vegetable based milk products

Traditionally vegetable based milk products have been produced for centuries in many countries. Most of these products are home made and prepared by using varieties of vegetables. Despite their nutritional significance and popularity, the milk- vegetables have remained confined to the domestic kitchen, and not yet available in Indian market. The different types of vegetable based milk products are *Sabbaki payasams*, *Sabudana kheer, Kaddu ki kheer*, *Lauki kheer,Gajar ki kheer*, *Gajar halwa, Lauki halwa,* etc.

### *2.5.1 Sabudana kheer*

Sago granules, called *sabudana* in India, are used to make food for invalids; translucent milk based *payasam* and extruded products like *phalooda*. It is very popular in Southern region of India. It is consumed traditionally during fasts such as those of Navratris and Ekadashi. It is prepared by cooking milk with *sabudana* granules and sugar with suitable thickening to suit the household preferences (Aneja *et.al.,* 2002).

### *2.5.2Kaddu ki kheer*

*Kaddu ki kheer* is a vegetable based milk product that is similar to the *kheer* but shredded *kaddu* is used instead of rice. The product is

medium viscous with smooth body and suspended granular particles; light cream in colour and added cardamom flavour (Unnikrishnan *et al.*, 2000).

### 2.5.3 *Lauki kheer*

*Lauki kheer* (bottle gourd dessert) is one of the most popular vegetable based milk delicacies in North India. It is generally prepared at the domestic level. It is a good source of carbohydrates, vitamin A, vitamin C and minerals. Typically, *Lauki kheer* consists of light greenish-yellow, shredded and cooked bottle gourd interspersed in slightly viscous milk. Grated bottle gourd, which becomes tender during cooking, imparts a characteristic crunchy texture to the product. Milk and other ingredients provide a creamy product consistency. Depending upon regional preferences, the ingredients and manufacturing procedure of *Lauki kheer* differ. In North India, particularly in Kashmir, rice flour and custard powder are also added to make the product smoother and creamier (Aneja *et.al.*, 2002).

### 2.5.4 Carrot *halwa*

Carrot *halwa* (*Gajar ka halwa*), a popular dessert of North India, is specially flavored during the winter season. Carrot (*gajar*) is valued for its growth promoting nutrients such as carotenoids (source of vit A) and fiber. It is called *"Gajrella"* in certain parts of Punjab and Kashmir, where saffron is used as coloring material. It is mostly prepared at the household level and by local sweet makers on cottage scale. Carrot milk based sweets

like carrot *halwa*, carrot *burfi*, carrot *kheer*, *gajrella* have gained popularity by virtue of their pleasing aroma, chewy texture and attractive colour. *Gajar ka halwa* is bright reddish brown with certain darkened but glossy fragments of grated carrot. It has a lumpy body with a few pieces of shredded carrot and bits of *khoa* that may be some times used for garnishing. Its texture is crunchy but with typical mellowness. The characteristic aroma of *gajar ka halwa* is a blend of cooked carrots, heat concentrated milk and caramelized sugar. Invariably, the product is garnished with *khoa*, crushed cardamom, cashew nuts, almonds and raisins. In some regions, ground rice is used to provide it thickness, and saffron is used both as flavorings as well as coloring agent (Srinivasan and Anantakrishnan, 1964).

Pataki and Arya (1996), developed Instant carrot halwa mixes at the Defence Food Research Laboratory (DFRL), Mysore with a low moisture range (2.0-2.6%). The method consists of washing, peeling, and grating carrots, cooking under pressure, drying in a fludized bed dryer, blendingwith other ingredients (like sugar, milk powder, cardamom) and conditioning and packaging. The product stores well for a year in PFP (Paper, Aluminium-foil, and Polyethylene) packs.

### *2.5.5 Lauki Halwa*

A vegetable based milk sweet; *Lauki halwa* is popular in North India. For preparing *Lauki halwa*, ghee is melted in a pan and grated bottle

gourd is fried in it for about 20 minutes until light brown. Sugar and edible grade yellow colour are added and mixed thoroughly with the fried grated bottle gourd. Remaining ingredients such as *khoa* and cardamom powder are added and heated with constant stirring till free fat starts separating and a uniform lump is formed. Before serving, the *halwa* is evenly spread on a plate and garnished with sliced almonds and pistachio, thus further enriching the product. (Aneja *et al.,* 2002).

**2.6 Carrot as a vegetable**

**2.6.1 Introduction**

It is native of Europe, Asia, North Africa, and possibly America. However, Afghanistan is the primary centre of origin of carrot, largest diversity in morphological characters of this species exists there. The botanical name of carrot is *Daucas Carota* Linn. and it belongs to the family Umbelliferae (Bose *et al.,*, 2001). Carrot is highly valued for its highest content of carotene (2400to3000 ug/g).Carrot requires a long growing season and its harvesting period is limited (Machewad *et al.,* 2003).

It finds wide application in day-to-day use for making carrot juice, carrot powder, fermented carrot and carrot flakes etc (Banga and Bawa, 2002). Carrot is known for its nutrient contents viz. carotene and carotenoids besides appreciable amounts of $\beta_1$, $\beta_2$, $\beta_6$ and $\beta_{12}$ vitamins and minerals (Walde *et al.,*., 1992) or by fermenting, pickling, canning or cold

storage. Carotenoids are important micronutrients for human health (Castemiller and West, 1998). The biological function of carotenoids is primarily as vitamin A precursors (Institute of Medicine 2000). In addition to their provitamin A activity, carotenoids may have several other important biological functions (Van Vliet, 1996). The high intake of carotenoid rich vegetables and fruits and blood levels of β – carotene are associate with decreased incidence of some cancers ( Torronen *et al.,* 1996) , age related macular degeneration, characters, coronary heart disease or cardiovascular disease and other diseases and pathological processes (cited by Sulaeman *et al.*,,2002).

Naturally occurring carotenoids are responsible for attractive yellow to red colour of a variety of fruits and vegetables and other plant products. Besides having pro vitamin A activity, dietary intakes of carotenoids have also been shown posses anti ageing and anti ulcer properties (Speek *et al.*,, 1988) (cited by Sharma *et al.*,, 2000).Since, carrot is one of the most nutritious vegetables assumed in the raw and processed form, which is rich in the carotenoids content.

**2.6.2 Composition**

The compositional profile along with nutritive value of edible portion of carrot is presented in Table 2.3 (per 100gm of edible portion).

**Table 2.3 Composition of Carrot**

| PARTICULARS | QUANTITY |
|---|---|
| Moisture | 86 gm |
| Fat | 0.2gm |
| Carbohydrates | 10.7 gm |
| Phosphorus | 0.05gm |
| Calories | 47 gm |
| Thiamine | 0.04gm |
| Riboflavin | 0.02 gm |
| Vitamin $B_6$ | 0.12 gm |
| Biotin | 1.4 ug |
| Inosital | 48 mg |
| Protein | 0.9 gm |
| Fibre | 1.1 gm |
| Calcium | 0.08 gm |
| Iron | 1.5 mg |
| Carotene | 1890ug |
| Niacin | 0.4 mg |
| Ascorbic Acid | 3 mg |
| Pantothenic Acid | 0.27 mg |
| Choline | 13 mg |

(Source: Bose et.al., 2001)

**Other Constituents in Carrot in Per 100 gm**

| PARTICULARS | QUANTITY (In mg) |
|---|---|
| Magnesium | 14 |
| Copper | 0.13 |
| Sodium | 47 |
| Potassium | 482 |
| Oxalic Acid | 5.6 |

**Amino Acid Contents in protein in carrot (gm/16gmN):**

| PERTICULARS | QUANTITY |
|---|---|
| Tryptophan | 0.8 |
| Lucin | 5.4 |
| Cysine | 2.5 |
| Tyr | 1.7 |
| Histidine | 3.6 |
| Lysine | 4.3 |
| Isolencine | 3.8 |
| Methionine | 0.9 |
| Phenylamine | 3.5 |
| Valine | 4.7 |
| Methionine+Cysine | 3.4 |
| Arginine | 3.5 |

(Source: Bose *et al.*, 2001).

### 2.6.3 Processing and Preservation of Carrot

#### 2.6.3.1 Canning and Blanching

Carrots for canning should have a smooth contour free of wrinkles, a tender texture, and an attractive orange colour. The canning and blanching consists of washing, grading, peeling, and cutting processes. These pieces of carrots are usually blanched in live steam or in water at $87^0$C for 2-4 min. Whole pieces of carrots are packed into cans by hand, cut carrots rare filled by machines. Dispenser to the cans, which are then filled with hot water; add salt tablets or the cans are filled with brine at 6-$8^0$ C salometer (1.5-2 %). If cold brine is used, the cans are exhausted at 93-96 $^0$ C and then sealed hot. Pre vacuumizing and vacuum sealing or steam flow sealing can also be used (Luh and Woodroof, 1988).

Chiang *et al.,* (1971) reported that carrots canned with water containing 800 ppm EDTA retained better colour and firmness then controls. Jalen and Chan (1981) recommended the addition of lactose to the brine to improve firmness of carrots. Edwards and Lee (1986) reported the changes in the concentration of various carotenoids in carrots and peas during canning. Baloch *et al.,* (1977a) reported that β- carotene in carrots was almost 1.9 times more susceptible to heat damage than α-carotene during blanching and cooking processes. Arya *et al.,* (2000) reported that losses of total carotenoids were higher in unblanched carrots as well as in fluidized bed dried samples than cabinet dried ones.

**2.6.3.2 Dehydration**

Drying and dehydration of carrots carried out by sun drying or dehydration methods like cabinet drying, contact plate drying, freeze drying etc. drying dehydration are highly effective and practicable under agro-climatic conditions of Maharashtra which provide an asset to boost the preservation industry in the region( Machewad et. al. , 2003).

Carrots are first dry-washed in a rotating slatted cylinder, which removes dirt, trash and undersized carrots, this dry wash, is followed by high-pressure water washing. Steam or lye methods can be used for peeling. Peeled carrots pass over an inspection belt where they are trimmed to remove defects and discolored areas. Immediately after cutting, the dice are blanched by spreading on a continuous stainless steel mesh belt at a loading of about 4 lb/ft$^2$and heating in flowing steam for 6-8 min. a sulfite

solution of 0.9-1.0 % concentration, or sufficient to give a concentration of 500-1000 ppm. $SO_2$ in the final product is sprayed over the dice at the discharge end of the blancher (Luh and Woodroof, 1988).

Hendel *et al.,* (1953) reported that careless application of sulfite might result bleaching losses of 5-12% of the dry product weight. Alternatively, the blanched dice can be sprayed or coated with a 2-5% cornstarch suspension at $79^0$C. This latter procedure is now used commercially. Carotene is easily oxidized and carrots packed in air even through blanched and sulfite, loose much more carotene in few months.

Arya *et al.,* (2000) reported that steam blanching before drying of carrot sample helps in higher retention of carotenoids as compared to microwave and water blanching. Also fluidized-bed-drying was found to be beneficial with lowest rate of non-enzymatic browning as compared to cabinet drying.

Machewad *et al.,* 2003 observed that while studying the effect of pre-treatments and drying methods on chemical composition and reconstitution ratio of carrot shreds, cabinet drying was most efficient than open air drying as far as the retention of nutrients and reconstitution ratio are concerned. In both the drying methods, the reduction of all the nutrients was found significantly higher in mechanically peeled blanched and sulphited and lye peeled, blanched and sulphited than untreated samples. It is also indicated that among the pretreatments, lye peeling

followed by blanching and drying in cabinet drier were found most optimum with regard to chemical characteristics and reconstitution ration of carrot shreds for the preparations of carrot *halwa* and a base material for production value added sweetmeats.

**2.6.3.3. Freezing**

Another method of preservation of carrot is freezing. Intensity and uniformity of colour are important in determining the grad of processed carrot products. Beta-carotene is the principal carotenoids pigment in carrot and usually constituents 85-90% of total carotenoids. The colour, total carotene content and the ratio of beta to alpha carotene in carrots are affected by pre-harvest temperature and age of the root.

In the freezing plant, carrots are washed in a presoak tank followed by a tumble washer. Washed carrots are mechanically separated into small, medium and sliced or diced carrots. Aligned on a belt, the carrots pass between rotating knives, which cut off the tip and the butt ends; the trimmed carrots then are water-flumed to storage hoppers. After inspection, trimming and peeling in an abrasion peeler or a steam peeler, large carrots mechanically diced or sliced. The slices or dices pass first into an air cleaner, where chips and small pieces are removed by air blast, and then to a blancher. While water blanching is sometimes used, carrots are usually blanched by steam. Blanch time range from 2-8 min depending on size, maturity, and texture (Luh and Woodroof, 1988).

Diced and sliced carrots lend to themselves well to fluidized freezing or other techniques such as carbon dioxide freezing (Smith, 1976). The grading operation takes place after freezing in a cold room held at about $-1^0$C .Frozen slices of crinkle out carrots pass over grading screens that divide them into their diameter sizes: small, medium and large. Frozen diced carrots pass over screens that remove chips and small pieces; these are sold separately for use in soups or stews. Carrots are marketed in various containers including 0.3 and0.5 kg cartons, boil in bag packages, 0.9 kg polyethylene bags, 0.9-9.1 kg cartons or cases for food service and bulk containers for remanufacturing (Luh and Woodroof, 1988).

**2.7 Carrot based products**

Carrots, the most important source of dietary carotenoids in western countries including the United States (Block 1994), contain the highest amount of β- carotene of the common fruits and vegetables (Desobry *et al.,* 1998). To maximize the use of carrots as a source of provitamin A as well as appropriate processing method to manufacture products that are not just highly preferred by consumers but also are good nutritional sources of provitamin A. In recent years, researchers have developed carrot chips from carrot slices, using lactic acid fermentation to decrease reducing sugars, and deep-frying in palm oil. Skrede *et al.,* 1997 reported that the carotenoids levels of carrots were well retained during the processing of carrot chips. In addition due to deep-frying, the product contains lipids that

may further improve the ability of carrot chips to serve as a source of provitamin A for humans.

Suleman *et al.,* (2001) worked on the influence of deep-frying using different oil and temperatures on carotenoid content and physico-chemical and sensory characteristics of carrot chips. They reported that increasing temperature lowered redness value, which correlated with decreased carotenoid content, color darkening, and decreased hardness value.

Carrots have high β-carotene content, and carrot juice has high potential as a natural source of β-carotene (Senti and Rizek, 1975). Canned carrot juice is a low acid food of about 6 pH and requires severe heat treatment (115-121$^0$C) for protection from food spoilage (Desrosier, 1976). Such high temperatures especially retorting temperatures could destroy in carrot (Khan *et al.,* 1975). Therefore, sterilization of carrot juice will most probably depend on a combination of high pressure and mild treatment. Kim *et al.,* (2001) reported that HHP (high hydrostatic pressure) has faced obstacles like pressures-resistant enzyme and spore forming bacteria. In this study, additional mild heat increased the effects of HHP on inactivation of enzymes and microorganisms while retaining the nutritional value of carrot juice. Carrot juice has a high potential market stabilility, due to its high nutritional values. They reported that combining mild treatment with HHP is a feasible technology with practical uses in the food industry.

In the manufacturing of *kheer* the two important and nutritious ingredients are used i.e. ghee and dry fruits.

**2.8 Ghee**

Fat is a concentrated source of energy (9 kcal/g). It represents about 48% of the calories of whole milk and protects organs and insulates body from environmental temperature effects. The fat flavour adds to enjoyment of foods comprising milk and dairy foods. Ghee, the main fat product, has beneficial effects when consumed in moderate amounts as a component of balanced diet. It supplies essential fatty acids like archidonic acid. These fatty acids cannot be synthesized fast enough by the body and must be supplied by our diet. Ghee furnishes fat-soluble vitamins A, D, E, and K. one g of milk fat/ghee furnishes 38 IU of other fat-soluble vitamins. Vitamin A performs important roles in vision, body growth, reproduction, bone formation and immune functions. Vitamin D is essential for healthy skeleton, and is involved in absorption of calcium and phosphorus in the gastrointestinal tract. Vitamin E works as an antioxidant protecting cell members and lipoproteins from oxidative deterioration by free radicals. It also stimulates the immune system and helps maintain cell integrity. Vitamin K is vital for blood clotting function and may play bone protection role. Cholesterol performs important functions in the body because it is involved in the synthesis of steroids and hormones. As fat is reduced in

dairy products, the cholesterol content is progressively reduced (Aneja, *et al.,* 2002).

In India, Ghee, the anhydrous milk fat of cow and buffalo, has been considered superior to other edible fats apart from increasing the mental powers (Rangappa and Achrya, 1974). In recent years, it is well established that milk fats contain anticarcinogenic fatty acids which are derived from linoleic acids (Yeong, *et al.,* 1989) and which was effective in partially inhibiting the initiation of mouse epidermal carcinogenesis (Ha *et al.,* 1987).

The anticarcinogenic fatty acids in milk fat contain a conjugated double bond system and its isomers are designated as CLA. The CLA's are formed in milk fats either during microbial enzymatic reactions involving linoleic acid in the rumen (Parodi, 1977) (Cited by Aneja and Murthi, 1990).

### 2.8.1 Chemical Composition of Ghee

**Table2.4 Chemical Composition of Ghee**

| Particulars | Buffalo Milk | Cow Milk |
|---|---|---|
| Fat% | 99-99.5 | 99-99.5 |
| Moisture | <0.5 | <0.5 |
| Carotene (mg/g) | 3.2-7.4 | - |
| Vit.A (IU/g) | 19-34 | 17-38 |
| Cholesterol (mg/100g) | 302-362 | 209-3125 |
| Tocopherol (mg/g) | 26-48 | 18-31 |
| FFA (%) | 2.8 | 2.8 |

(Source: Aneja *et al.,* 2002).

**Average analytical constants of Ghee**

| Constant | Buffalo milk | Cow milk |
|---|---|---|
| Butyrorefrectometer reading | 42.0 | 42.3 |
| Saponification value | 30.1 | 27.3 |
| Reichert-Miessl value | 32.3 | 26.7 |
| Polenske value | 1.41 | 1.76 |
| Kirshner value | 28.5 | 22.1 |
| Iodine value | 29.4 | 33.7 |
| Melting point | 32-43 | 28-41 |

Since milk fat is a rich source of fat-soluble vitamins, essential fatty acids and other growth promoting factors. It is believed that ghee improves mental power, physical appearance and longevity. It increases the capacity of work and enhances the bodies resistant to stress such as cold and undernourishment. Ghee is used as a curative agent for wounds, ulcers and eye ailments. The conjugated linoleic acid content of milk fat, which is known to be anticarcinogenic, increases substantially during the manufacture of ghee. Addition of ghee to foods improves the satiety value and consumers enjoy the feeling of eating.

# Materials and Methods

# CHAPTER III

## MATERIAL AND METHODS

This study has been conducted in the Dairy Technology Laboratory and Dairy Chemistry Laboratory, Department of Dairy Technology and Dairy Chemistry, College of Dairy Technology, Indira Gandhi Agriculture University, Raipur (Chhattisgarh.). The present investigation involves: Preparation of carrot based (flavoured milk) i.e. flavoured milk prepared using shredded carrot or carrot juice as a natural flavour. (ii) Preparation of carrot kheer i.e. kheer prepared by using shredded carrot as a natural flavour. (iii) Standardization of certain technological parameters. (iv) Evaluation of the shelf life of sterilized product. (v) Prediction of the physico-chemical properties in preparing most acceptable carrot based milk products. This chapter deals with the materials used and methodologies employed during present study. It also describes the methods, which have been used for the analyisis of fresh and stored carrot based milk products. All the analysis was replicated and only analytical grade reagents were used in the study.

## 3.1 Raw Materials used for preparation of products

Various ingredients used for the preparation of carrot *kheer* and carrot based flavoured milk are briefly described as follows.

### 3.1.1 Dairy Ingredients

The following dairy ingredients were selected in the manufacture of carrot based milk products.

#### 3.1.1.1 Milk

Fresh cow milk was collected from a private dairy farm located near the college of selected cows to prevent the variations in composition.

#### 3.1.1.2 Ghee

Ghee of commercial grade (Sanchi) brand manufactured by Raipur Dugdh Sangh was used.

### 3.1.2 Non Dairy Ingredients

The non-dairy ingredients used in the manufacture of carrot based milk products were cane sugar, dry fruits and fresh carrots.

#### 3.1.2.1 Cane sugar

Cane sugar of commercial grade obtained from the local market of Raipur was used.

#### 3.1.2.2 Dry fruits/Nuts

Good quality dry fruits/nuts such as almond (badam), cashew nut (Kaju) and resins (kishmish) of commercial grade available from the local market of Raipur were used.

### 3.1.2.3 Fresh carrots

Fresh carrot (*Daucus Carota*) was procured from the local market at Raipur.

## 3.2 Preparation of carrot juice

Carrot juice was extracted from the freshly peeled and cut carrot through a clean fruit and vegetable juicer. The carrot juice was collected and filtered by using muslin cloth.

## 3.3 Preparation of shredded carrot

The carrot was peeled and shredded using a domestic hand grater.

## 3.4 Preparation of sterilized carrot based flavoured milk

The two types of carrot based flavoured milk was prepared i.e. flavoured milk by using carrot juice and flavoured milk by using shredded carrot. The flavoured milk was manufactured by using three different concentration of carrot juice and shredded carrot i.e.10%, 20%and 30%. The flow diagram for preparation is shown in fig. 3.1 and 3.2 respectively.

### 3.4.1 Method of preparation of carrot based flavoured milk

The milk used in manufacture of flavoured milk was analyzed for their composition i.e. fat, total solids, and titrable acidity. The flavoured milk were prepared by using different concentration of carrot juice and shredded carrot i.e 10%, 20%, and 30%, and 15% sugar with respect to the quantity of milk. The various ingredients for each concentration were weighed, mixed and blended thoroughly.

**Fig.3.1 The flow chart for preparation of carrot based flavoured milk (By using carrot juice)**

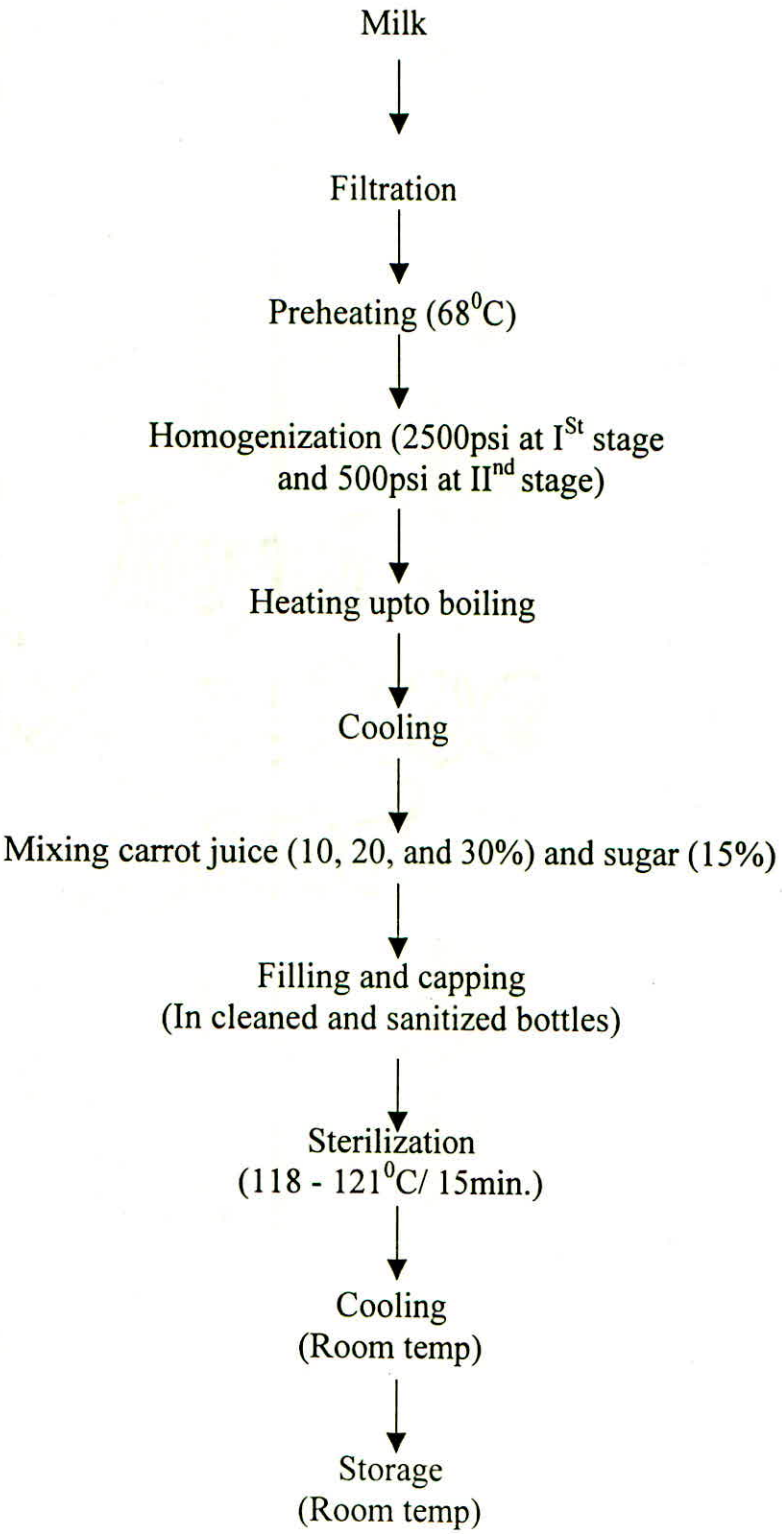
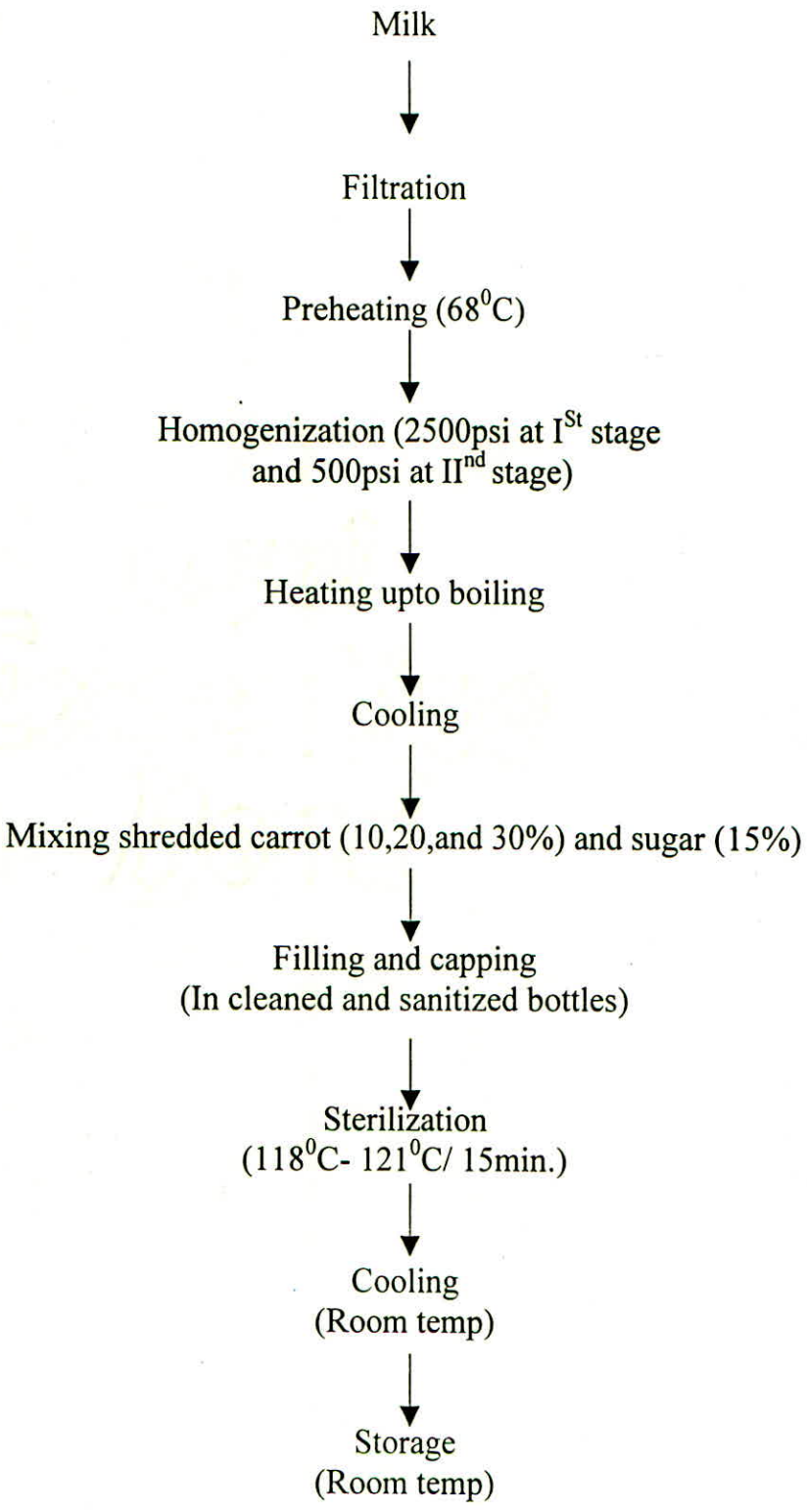


**Fig. 3.2 The flow chart for preparation of carrot based flavoured milk (By using shredded carrot)**



The sugar and carrot (juice or shredded) mixed with milk at the temperature of $60^0$C. Then flavoured milk was filled in cleaned glass bottles and sealed by using bottle cap-sealing machine. These bottles were sterilized at 118-$121^0$C/15 min. and stored at room temperature after labeling it. Check the shelf life of flavoured milk at regular interval.

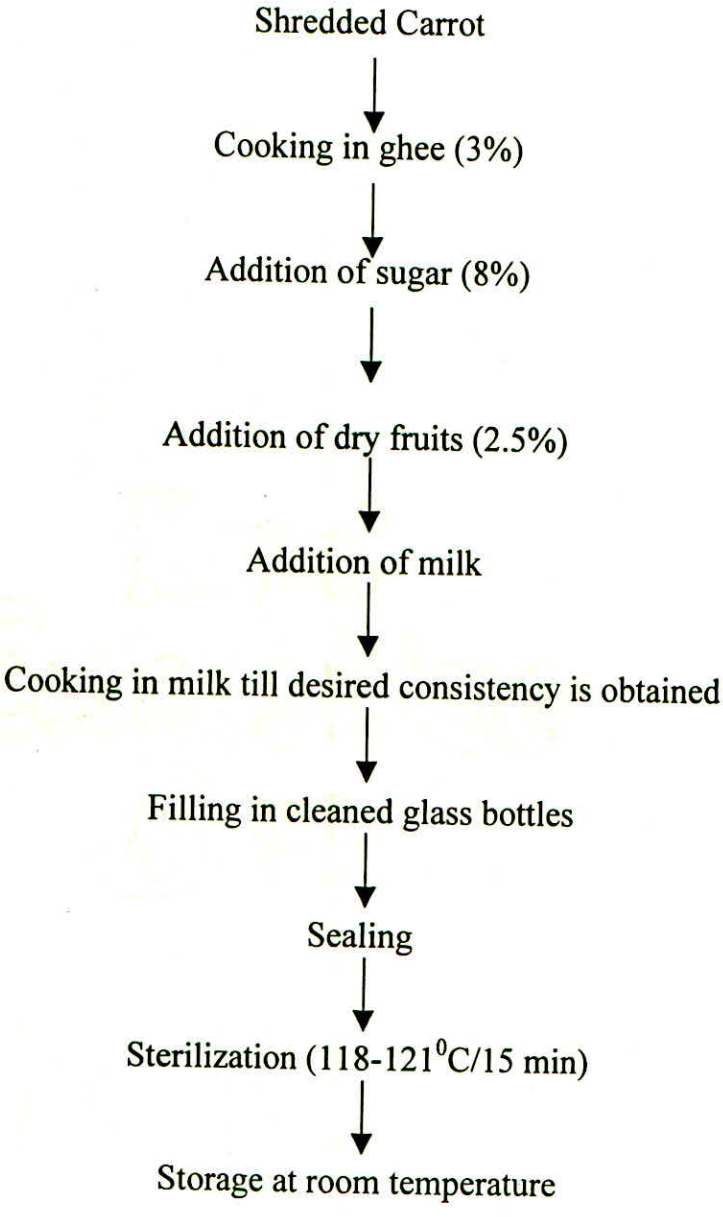
### 3.5 Preparation of sterilized carrot kheer

The carrot kheer was prepared by using ingredients such as shredded carrot, milk, sugar, ghee, and dry fruits. The method for manufacturing of carrot kheer was shown in flow chart of fig.3.3.

#### 3.5.1 Preparation of carrot kheer

The milk used in manufacture of carrot kheer was analyzed for their composition i.e. fat, total solids and titrable acidity. The three batches of carrot kheer were prepared by different concentration of shredded carrot i.e. 20%, 30%, and 40% with respect to quantity of milk. The sugar 8%, ghee 3% and dry fruits 2.5% were used with respect to the quantity of milk. For manufacturing carrot kheer shredded carrot was weighed and place it in a karahi on an open fire with required quantity of ghee till the shredded carrot was cooked. Then add dry fruits and sugar and again cooked with milk till the required concentration and consistency of product was obtained. Then kheer is filled in cleaned glass bottles and sealed it by using bottle cap sealing machine.

**Fig. 3.3 The flow chart for preparation of sterilized carrot kheer**



These sealed bottles are sterilized at 118-121$^0$C /15 min. Then it is cooled and stored at room temperature for checking the shelf life of the product.

### 3.6 Analysis of milk

The representative samples of milk were analyzed for the following chemical parameters.

#### 3.6.1 Fat

The content of milk was estimated by Gerber method. The fat percentage on the graduated scale of the butyrometer can be read directly and noted (ISI Hand book, 1981).

#### 3.6.2 Total solids

The total solids of milk were determined by gravimetric method. In this method a known quantity of milk is dried at 100+/-2$^0$C for 3 hours. From the weight of residue total solids content was calculated by formula (ISI Hand book, 1981).

$$\text{T.S.} = \frac{w_1 - w_2}{w} x\ 100$$

Where,

$w_1$ = weight of dish after drying

$w_2$ = weight of empty dish before drying

w = weight of sample

### 3.6.3 Titrable acidity

The titrable acidity of milk was determined by the method described in ISI Handbook (1981). Acidity of milk was analyzed by titration a known volume of sample (10ml) against the standard 0.1 N NaOH solution using phenolphthalein as an indicator and was calculated by using following formula and was expressed in terms of % lactic acid.

Titrable Acidity (%lactic acid) = $\frac{9NV}{W}$

Where

V = Volume in ml of standard NaOH consumed for the titration.

W = Volume in ml sample taken

N = Normality of the standard NaOH.

### 3.6.4 $p^H$

The pH of milk was determined by using a systronic digital $p^H$ meter, at $25^0$C.

## 3.7 Chemical Analysis of carrot based flavoured milk & carrot kheer

### 3.7.1 Fat

The fat content of product was determined by the standard method described in section (3.6.1) using flavoured milk and kheer samples.

### 3.7.2 Total solids

The total solids of carrot kheer and flavoured milk were determined by the procedure as employed for milk. The method described under the section 3.6.2.

### 3.7.3 Titrable acidity

The titrable acidity of product was determined by the standard titration method suggested in ISI Hand Book (1981).

### 3.7.4 $p^H$

The $p^H$ of a product was determined by using a systronic digital $p^H$ meter, at $25^0$C.

### 3.7.5 Total Soluble Solids

The TSS value is defined as the amount of sugar and soluble minerals present in milk and milk products. For manufacturing TSS in $^0$Brix, a hand refractometer was used. The refractometer should be checked for accuracy before use. This is done by placing a few drops of distilled water on the prism in the specimen chamber of the refractometer. The distilled water reading should be zero. For determining the TSS, a drop of sample is placed on the prism and the $^0$Brix of dry substance in it read directly. The refractometer was directed towards light and observed through eyepiece to see the boundary line separating the light and dark areas of the images on the screen given with the calibrated scale. The

number given parallel to this separating line gives the TSS of the sample in $^{0}$Brix (Rangana, 1986).

### 3.8 Sensory Evaluation for fresh and stored carrot based flavoured milk and carrot kheer

The sensory evaluation of flavoured milk and carrot kheer based on a 9-point hedonic scale (PFA) with some modifications were performed by the panel of six trained judges. The samples were stored at room temperature for sensory evaluation of the products. The sensory evaluation of the product was done at a regular interval of 7 days.

### 3.9 Statistical Analysis

Data obtained during the course of investigation were subjected to statistical analysis to test the effect of different levels of carrot concentration and storage periods on the sensory quality of the product. Statistical analysis technique of split plot design in RBD with three replications and six combination of carrot (three levels of carrot juice and three levels of shredded carrot) in the main plot and five levels of interval of days in subplot was used in carrot based flavoured milk and split plot design in RBD with three levels of shredded carrot in the main plot and five levels of interval of days in subplot was used in carrot kheer.

# *Results and Discussion*

# CHAPTER IV

## RESULTS AND DISCUSSION

This chapter deals with the results regarding chemical and sensory properties of carrot based flavoured milk and carrot kheer prepared using different levels of carrot juice or shredded carrot. The properties are presented in compiled, tabulated form **augmented with graphical presentations.** Results obtained during the investigation are described in this chapter under appropriate headings and subheadings along with Tables and suitable illustrations.

### 4.1 Product development

An attempt has been made in the present investigation to develop carrot based milk product i.e. carrot based flavoured milk and carrot kheer. In carrot based flavoured milk two types of flavoured milk have been developed which are flavoured milk using carrot juice and flavoured milk using shredded carrot, each type was prepared by adding 15% sugar and three levels of carrot juice or shredded carrot, the levels being 10%, 20%, and 30% with respect to milk. Carrot kheer was prepared by adding 8% sugar, 3% ghee, and 2.5% dry fruits, each to all the three levels (i.e. 20%, 30%, and 40%) of shredded carrot taken with respect to milk. Each treatment was replicated three times for flavoured milk and seven times for carrot kheer. The prepared product was packed in the glass bottles and

sterilized at 118-121$^0$C for 15 min. It was then stored at room temperature. Physico-chemical and sensory tests of the products were carried out at regular interval of seven days to monitor the quality of the products. The storage study was carried out for a period of twenty eight days for five times each at an interval of seven days. This was done to access the overall acceptability of the product with respect to its chemical quality and sensory attributes, and also to know the effect of storage period on acidity, $p^H$ and sensory characteristics of the product.

**4.2 Chemical composition of milk**

Fresh cow milk from a single herd was used to prepare the carrot based milk products. An analysis of the cow milk was carried out for the development of carrot based milk products. This analysis was done to determine the various chemical parameters of milk like total solids, acidity, $p^H$, and fat contents. The composition of milk is mentioned in the table Table 4.1.

**Table 4.1 Chemical composition of milk**

| S. No. | Components (%) | Value (%) |
|---|---|---|
| 1. | Total solids | 16.9 |
| 2. | Fat | 4.1 |
| 3. | Acidity(% lactic acid) | 0.14 |
| 4. | $p^H$ | 6.6 |

**Note:** All the readings are average of three.

### 4.3 Effect of carrot concentration (Juice or Shredded) on the physico-chemical characteristics of fresh flavoured milk

Carrot based flavoured milk was prepared using carrot juice and shredded carrot with different level of concentration in milk. The levels of concentration with respect to milk are 10%, 20%, and 30% of shredded carrot and carrot juice. The products were analyzed for Total Solids content, Total Soluble Solids content, $p^H$, Acidity and Fat percentage. The tests were carried out to analyse the physico-chemical and sensory quality of the different types of carrot based flavoured milks. The physico-chemical properties of freshly prepared flavoured milks are presented in Table 4.2.

The analysis of the above Table reveals that the addition of different concentrations of carrot i.e.10%, 20%, and 30% in forms of carrot juice and shredded carrot affected the fat percentage of the samples. The fat percentage of $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ samples were found to be 4.1, 3.9, 3.6, 4.1, 4.0, and 3.9 percent respectively, which are conclusive of the fact that the fat percentage of samples decreased with corresponding increase in the concentration of carrot as the increase in fat percentage gives significant dilution effect on the original fat percentage of milk. Secondly, the different forms and varying concentrations of carrot did not significantly affect the acidity of the samples tested. The results conclude that acidity of the samples remained a constant 0.14 percent inspite of the

varying concentrations and forms of carrot used in the preparation of carrot based flavoured milk.

**Table 4.2 Physico-chemical characteristics of fresh flavoured milk prepared with different levels of carrot juice or shredded carrot are as follows:**

| S.No. | Carrot form and concentration | Fat (%) | Acidity (%) | $p^H$ Value | TSS ($^0$Brix) | TS (%) |
|---|---|---|---|---|---|---|
| 1 | $T_1$ (Juice 10%) | 4.1 | 0.14 | 6.5 | 21.50 | 25.71 |
| 2 | $T_2$ (Juice 20%) | 3.9 | 0.14 | 6.4 | 21.50 | 25.71 |
| 3 | $T_3$ (Juice 30%) | 3.6 | 0.14 | 6.4 | 21.00 | 25.72 |
| 4 | $T_4$ (Shredded 10%) | 4.1 | 0.14 | 6.4 | 21.00 | 24.91 |
| 5 | $T_5$ (Shredded 20%) | 4.0 | 0.14 | 6.3 | 21.00 | 24.85 |
| 6 | $T_6$ (Shredded 30%) | 3.9 | 0.14 | 6.4 | 21.0 | 24.85 |

**Note:** All the readings are average of three.

The results also conclude that the addition of different forms and concentrations of carrot did bring about significant change in the $p^H$ value of the samples. The $p^H$ of $T_1$,$T_2$,$T_3$,$T_4$,$T_5$ and $T_6$ samples were tested and found to be 6.5, 6.4, 6.4, 6.4, 6.3, and 6.4 respectively, Similarly the addition of carrot in different concentration did not affect the total soluble solids of the samples. The total soluble solids of $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ were found to be 21.50, 21.50, 21.0, 21.0, and 21.0 percent respectively.



The results do not show any effective difference. The total solids of the samples of different concentration and form i.e. $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ were tested and found to be 25.71, 25.71, 25.72, 24.91, 24.85 and 24.85 percent respectively which clearly indicates the absence of any appreciable difference between the samples.

### 4.4 Effect of carrot (shredded and juice) concentration on the sensory characteristics of fresh flavoured milk

The samples of carrot based flavoured milk were subjected to sensory evaluation using 9- point hedonic scale with some modification by the panels of six trained judges. The average scores obtained by testing the different samples with different judges on different sensory characteristics are presented in Table 4.3. The table also gives the average overall acceptability scores allotted by the judges to different flavoured milk samples.

**Table 4.3 Effect of carrot concentration on sensory characteristics of fresh flavoured milk**

| S.No | Carrot Concentration | Sensory Characteristics | | | | | |
|---|---|---|---|---|---|---|---|
| | | Colour & Appearance | Flavour | | | Mouth feel | Overall Acceptability |
| | | | IOC | Sweetness | Overall flavour | | |
| 1 | T1 | 6.66 | 7.17 | 7.17 | 7.17 | 7.33 | 7.17 |
| 2 | T2 | 7.17 | 7.00 | 6.66 | 7.66 | 7.33 | 7.83 |
| 3 | T3 | 7.33 | 7.67 | 7.50 | 7.33 | 7.83 | 7.67 |
| 4 | T4 | 6.33 | 6.67 | 7.33 | 6.83 | 6.83 | 6.83 |
| 5 | T5 | 6.67 | 7.50 | 7.50 | 7.67 | 7.67 | 7.00 |
| 6 | T6 | 7.83 | 7.00 | 6.83 | 7.33 | 7.33 | 6.83 |

### 4.4.1 Colour and Appearance

It can be seen from the Table that the flavoured milk prepared with the addition of 10%, 20%, and 30% carrot juice named $T_1$, $T_2$, and $T_3$, scored 6.66, 7.17, and 7.33 respectively on colour and appearance attributes. The score of colour is higher in $T_3$, implying that the colour of the product increases corresponding to the increase in the content of carrot juice. Samples $T_4$, $T_5$, and $T_6$ samples (shredded carrot with 10%, 20%, and 30%, concentration) scored 6.33, 6.67, and 7.83 respectively for colour and then posses the same type of behavior as that of carrot juice.

### 4.4.2 Flavour

The flavour attributes of the flavoured milk was evaluated as the basis of intensity of carrot, sweetness, and overall flavour.

#### 4.4.2.1 Intensity of Carrot flavour

As observed from the Table 4.3, the scores on intensity of carrot flavour highest for treatment $T_3$ and $T_5$. The corresponding scores are 7.67 and 7.5, respectively. It is also observed from the Table that judges like the presence of carrot flavour in the milk.

#### 4.4.2.2 Sweetness

Sugar at a level of 15 percent was added in the milk with different levels of carrot concentration. Sweetness score for treatment $T_1$, $T_2$, and $T_3$ containing carrot juice is 7.17, 6.66, and 7.5, respectively and for treatment

$T_4$, $T_5$, and $T_6$ containing shredded carrot is 7.33, 7.5, and 6.83, respectively. The treatment $T_3$ and $T_5$ were scored higher marks.

#### 4.4.2.3 Overall Flavour

The overall flavour scores for treatment $T_1$, $T_2$, and $T_3$ using carrot juice are 7.17, 7.66, and 7.33, respectively and for treatment $T_4$, $T_5$, and $T_6$ using shredded carrot are 6.83, 7.67, and 7.33, respectively. The treatment $T_2$ and $T_5$ were scored high marks and it can be conclude that the treatment $T_2$ and $T_5$ were preferred more than the other treatments on its flavour point of view. The treatment $T_1$ and $T_4$ are scoring lesser marks due to the lesser intensity of carrot flavour and $T_3$ and $T_6$ are also scoring lesser marks due to the higher intensity of carrot flavour which do not preferred by the judges.

### 4.4.3 Mouthfeel`

As observed from the Table 4.3, the scores on mouthfeel attributes for treatment $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, and $T_6$ are 7.33, 7.33, 7.83, 6.83, 7.67, and 7.33, which indicates that the treatment $T_3$ samples having better mouthfeel characteristics than other treatments. The treatments of carrot juice of all three concentrations are more acceptable than other treatments of shredded carrot due to its drinking purpose. The shreds of carrot were creating problem in drinking of flavoured milk.

### 4.4.4 Overall acceptability

Flavoured milk prepared using 20% carrot juice and 20% shredded carrot scored highest on overall acceptability attributes. The highest scores obtained prepared flavoured milk with 20% carrot juice and shredded carrot are 7.83, and 7.00 for overall acceptability, respectively. The flavoured milk with 20% carrot juice also scored highest for overall acceptability as compared to flavoured milk with 20% shredded carrot.

It can be conclude that 20% carrot concentration was mostly preferred by the judges due to the optimum level of carrot flavour as compared to the 10% and 30% concentrations which was not liked by the judges because of lesser and higher flavour and colour of flavoured milk respectively.

## 4.5 Effect of storage on Physico-chemical characteristics of flavoured milk

Flavoured milk prepared was filled into glass bottles followed by sealing of bottles using crown cork, and then the product was sterilized at 118 –121 $^{0}$C for 15 minutes. Bottles were then cooled and stored at room temperature for twenty-eight days and analyzed regularly after each seven days interval to evaluate the physico-chemical changes and shelf life of the product. The stored samples of flavoured milk were analyzed for acidity, $p^{H}$, and also evaluated by a panel of trained judges for overall acceptability of the products.

### 4.5.1 Effect of storage period on acidity of flavoured milk

Acidity of each concentration of flavoured milk at different period of storage is presented in Table 4.4. The initial value of acidity of all the samples ($T_1$, $T_2$, $T_3$, $T_4$, $T_5$, and $T_6$) was tested to be 0.15% lactic acid, whereas the corresponding values of acidity of samples $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, and $T_6$ at the end of twenty eight days of storage period were found to be 0.170, 0.170, 0.171, 0.170, 0.172, and 0.170 percent, respectively indicating the slight increase in acidity. Effect of storage period on acidity is also shown in Fig. 4.1. It can be seen from the Fig. that there was a gradual increase in acidity of every treatment with progress of storage time.

### 4.5.2 Effect of storage on $p^H$ of flavoured milk.

The $p^H$ of product samples at different period of storage is presented in Table 4.5. The initial average values of $p^H$ of different samples ($T_1$, $T_2$, $T_3$, $T_4$,$T_5$, and $T_6$ ) were 6.5, 6.4, 6.4, 6.4, 6.3, and 6.4 , respectively whereas the corresponding values of $p^H$ of respective samples i.e. $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ at the end of 28 days storage period were determined to be 5.7, 5.8, 5.7, 5.8 5.7 and 5.7 respectively. The effect of storage period on $p^H$ of flavoured milk with different concentration of carrot juice and shredded carrot is explained in the Fig 4.2 from which it can be observed that there is a gradual decrease on the $p^H$ values of flavoured milk.



T. 1753

**Table 4.4 Effect of carrot concentration and storage period on acidity of flavoured milk**

| S.No | Carrot Concentration | Storage period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 2 | T2 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 3 | T3 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 4 | T4 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 5 | T5 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 6 | T6 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |
| 5 | Average | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.16 |

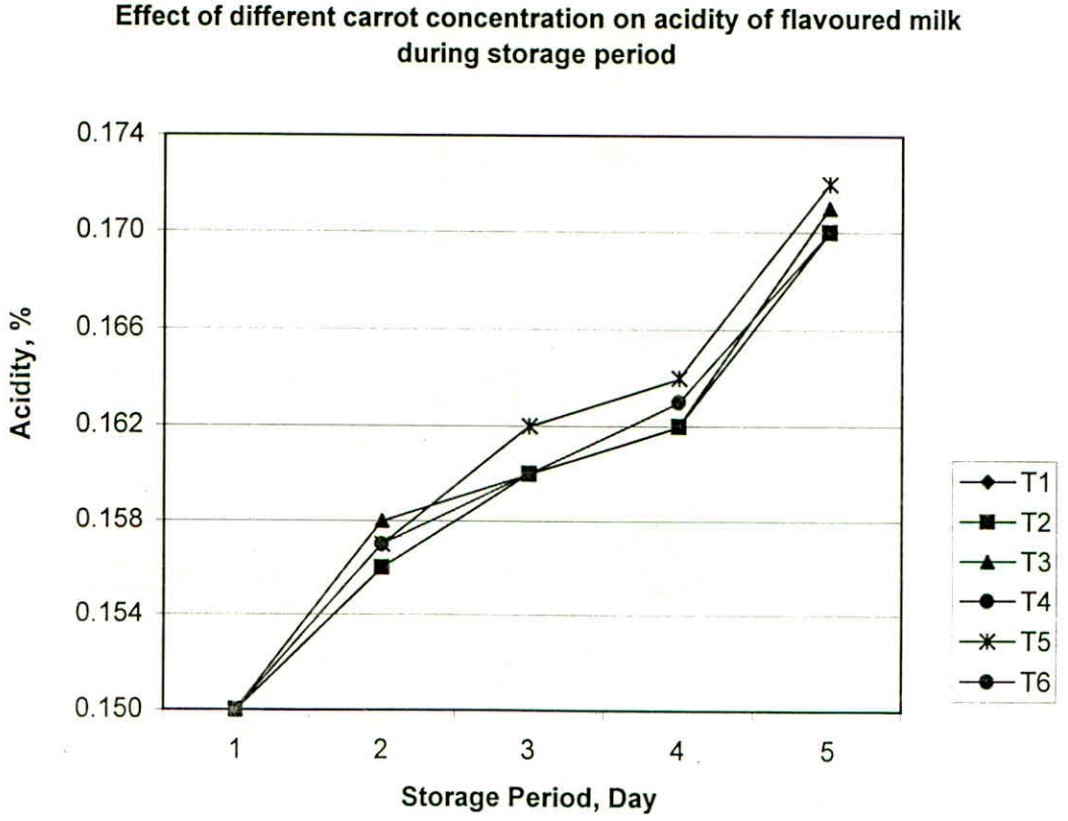



**Fig. 4.1 Effect of different levels of concentration on acidity of flavored milk during storage period**

**Table 4.5 Effect of carrot concentration and storage period on $p^H$ of flavoured milk**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 6.5 | 6.2 | 6.0 | 5.8 | 5.7 | 6.0 |
| 2 | T2 | 6.4 | 6.1 | 6.1 | 5.9 | 5.8 | 6.1 |
| 3 | T3 | 6.4 | 6.1 | 6.0 | 5.8 | 5.7 | 6.0 |
| 4 | T4 | 6.4 | 6.2 | 6.1 | 5.8 | 5.8 | 6.1 |
| 5 | T5 | 6.3 | 6.0 | 6.0 | 5.9 | 5.7 | 6.0 |
| 6 | T6 | 6.4 | 6.1 | 6.0 | 5.8 | 5.7 | 6.0 |
| 7 | Average | 6.4 | 6.1 | 6.0 | 5.8 | 5.7 | 6.0 |

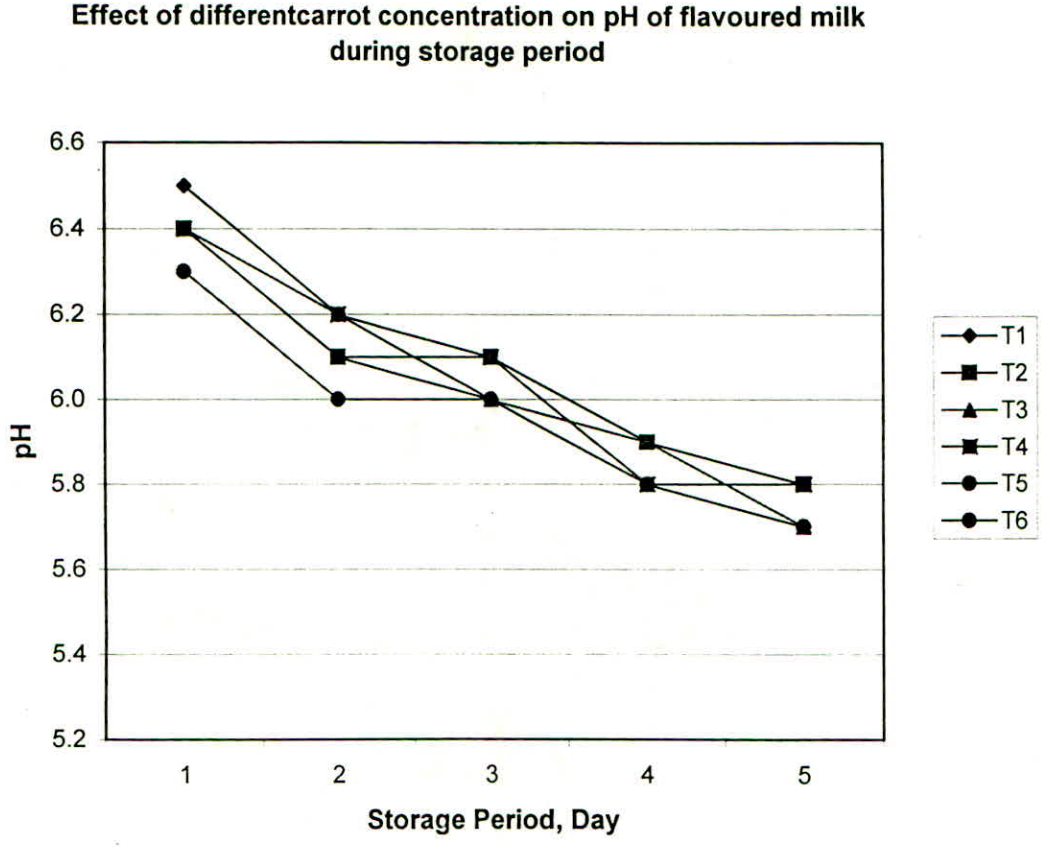



**Fig.4.1 - Effect of different levels of concentration on $p^H$ of flavoured milk during storage period**

## 4.6 Effect of storage on sensory characteristics of flavoured milk

The sensory evaluation of the flavoured milk was performed by panel of trained judges using a 9-point hedonic scale to know the sensory quality and overall acceptability of the product. Sensory scores as presented in the Tables 4.6 through 4.9 reveal that there was significant effect of storage period on the flavour, mouth feel, colour and appearance, and overall acceptability of the flavoured milk which are discussed under the following headings

### 4.6.1 Colour and appearance

Sensory scores on colour and appearance of flavoured milk was presented in Table 4.6. The table shows that the colour and appearance of the flavoured milk was found to be good at the end of the 28 days of storage period.

The score in fresh condition for T1, $T_2$ ,$T_3$, $T_4$, $T_5$, and $T_6$, samples were found to be 6.66, 7.17, 7.33, 6.33, 6.67, and 7.83, respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 5.33, 5.67, 6.00, 5.50, 5.83, and 6.17, respectively for colour and appearance characteristics.. These results are graphically presented in Figure 4.3. The figure shows gradual decrease on colour and appearance of different concentration of flavoured milk during storage period.

**Table 4.6 Effect of carrot concentration on colour and appearance of flavoured milk during storage period**

| S.No | Carrot Concentration | Storage period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 6.67 | 6.33 | 6.50 | 5.50 | 5.33 | 6.07 |
| 2 | T2 | 7.17 | 7.17 | 7.00 | 6.33 | 5.67 | 6.67 |
| 3 | T3 | 7.33 | 7.17 | 6.67 | 6.67 | 6.00 | 6.77 |
| 4 | T4 | 6.33 | 6.17 | 6.33 | 5.33 | 5.50 | 5.93 |
| 5 | T5 | 6.67 | 6.67 | 6.50 | 5.67 | 5.83 | 6.27 |
| 6 | T6 | 7.83 | 7.50 | 7.33 | 6.50 | 6.17 | 7.07 |
| 7 | Average | 7.00 | 6.84 | 6.72 | 6.00 | 5.75 | 6.46 |

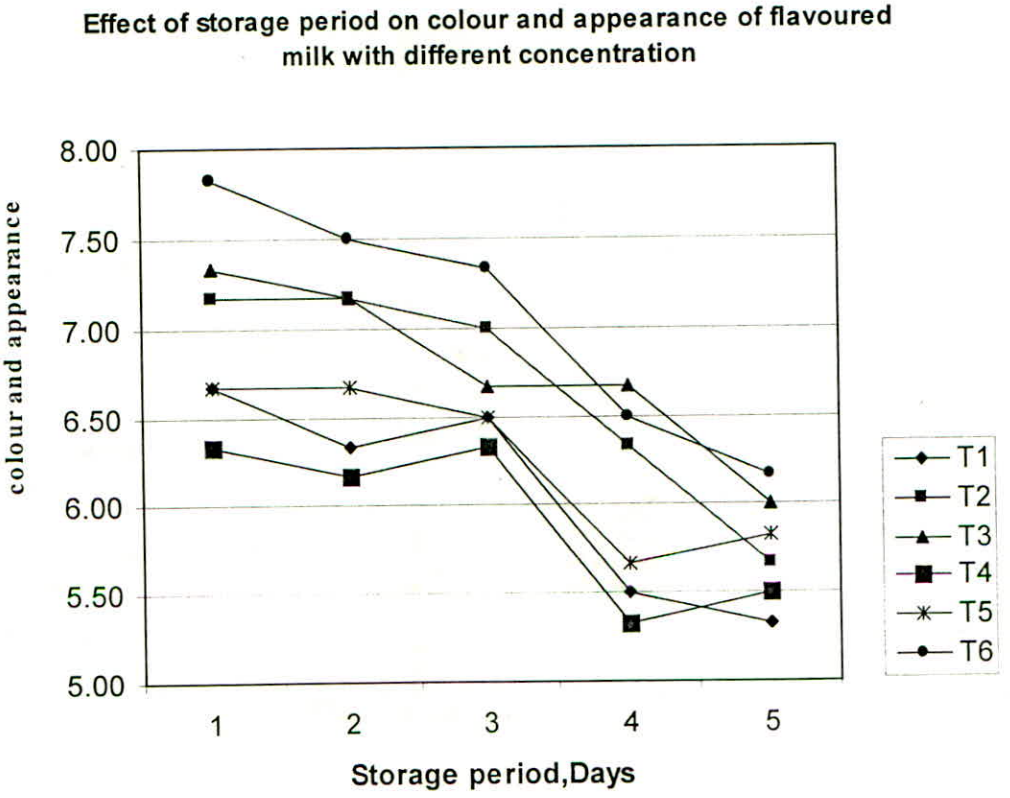



**Fig.4.3 Effect of different levels of concentration on colour and appearance of flavored milk during storage period**

The effect of different concentrations of carrot juice and shredded carrot and the storage days have been found to be significant at 5% level of significance ($P<0.05$). The ANOVA Table is presented under the appendices section. Thus the different concentration of carrot juice and shredded carrot significantly affect the colour and appearance of the fresh flavored milk. Therefore different levels of carrot juice and shredded carrot concentration as well as the storage days were compared with their respective least significant differences. Subsequently it was found that all the concentrations of carrot juice and shredded carrot are having significantly different effects on colour and appearance compare to each other at 5% level of significance. Similarly it was also found that the effect of different levels of storage days have significantly different effects on colour and appearance compared to each other. The interaction of different concentrations of carrot juice and shredded carrot with the storage days was not found to be significant on the colour and appearance of the product.

### 4.6.2 Overall Flavour

Sensory scores on overall flavour of flavoured milk were presented in Table 4.7. The Table shows that the overall flavour of the flavoured milk was found to be good at the end of the 28 days of storage period. The score in fresh condition for $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, and $T_6$, samples were found to be 7.17, 7.33, 7.33, 6.83, 7.67, and 7.33, respectively and at the end of

**Table 4.7 Effect of carrot concentration and storage period on overall flavour of flavoured milk**

| S.No | Carrot Concentration | Storage period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 7.17 | 6.50 | 6.67 | 6.00 | 5.67 | 6.40 |
| 2 | T2 | 7.33 | 7.67 | 7.50 | 6.50 | 6.33 | 7.07 |
| 3 | T3 | 7.33 | 6.83 | 6.67 | 5.50 | 5.83 | 6.43 |
| 4 | T4 | 6.83 | 6.67 | 6.50 | 6.50 | 6.17 | 6.53 |
| 5 | T5 | 7.67 | 7.17 | 7.17 | 6.50 | 6.67 | 7.04 |
| 6 | T6 | 7.33 | 6.83 | 7.00 | 6.50 | 6.00 | 6.73 |
| 7 | Average | 7.00 | 6.95 | 6.92 | 6.25 | 6.11 | 6.70 |

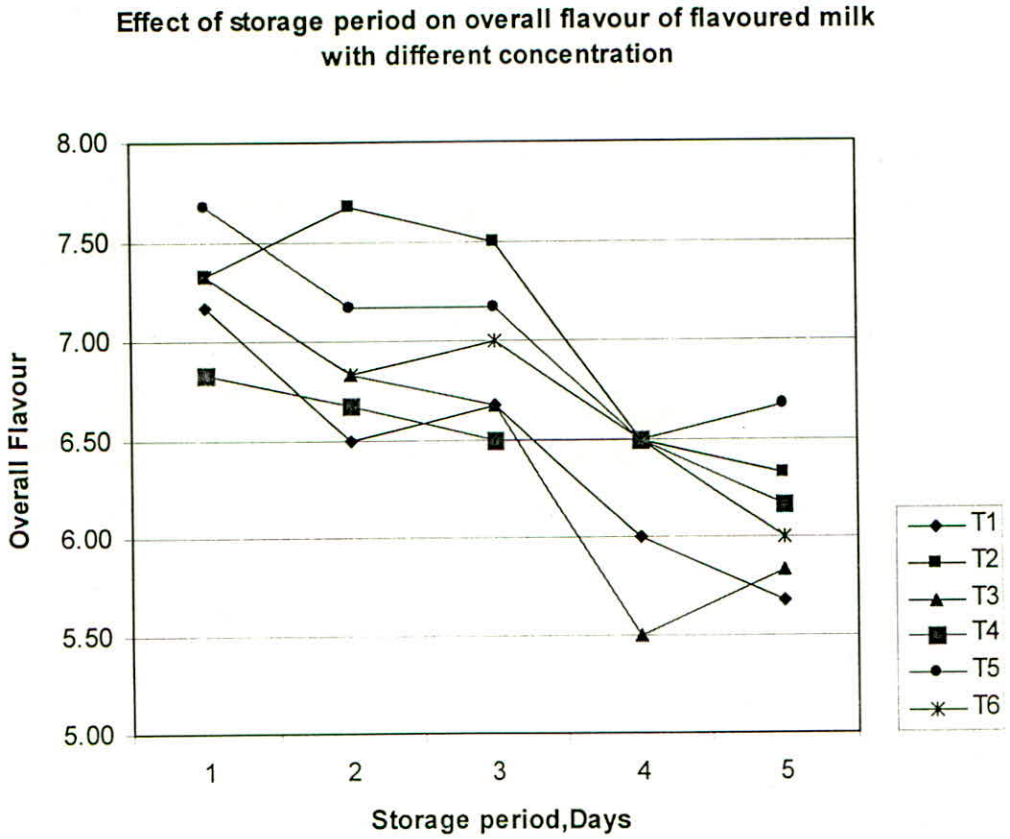



**Fig.4.4 Effect of different levels of concentration on overall flavour of flavored milk during storage period**

28 days of storage period the scores of corresponding samples were found to be 5.67, 6.33, 5.83, 6.17, 6.67, and 6.00, respectively. These results are graphically presented in Figure 4.4. The figure shows gradual decrease on overall flavour of different concentration of flavoured milk during storage period.

In overall flavour characteristics the treatment and the interaction of treatment and days of storage have been found to be non significant at 5%level, and the days of storage is significantly effect the overall flavour of flavoured milk. It means the different concentration of carrot does not affect the overall flavour of the product, but the storage period decreased the overall flavour of the product. Similarly it was also found that the effect of different levels of storage days have significantly different effects on overall flavour compared to each other but the 7 and 14 days of storage are at par. The interaction of different concentrations of carrot juice and shredded carrot with the storage days was not found to be significant on the overall flavour of the product.

**4.6.3 Mouthfeel**

The sensory scores on mouthfeel characteristics of the prepared flavoured milk in fresh as well as storage condition were presented in Table 4.8. These scores are graphically presented on the Figure 4.5. The figure shows gradual decrease on mouthfeel characteristics of different concentration of flavoured milk during storage period.

**Table 4.8 Effect of carrot concentration and storage period on mouthfeel of flavoured milk**

| S.No | Carrot Concentration | Storage period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 7.33 | 6.50 | 6.67 | 6.17 | 5.50 | 6.43 |
| 2 | T2 | 7.50 | 7.33 | 7.17 | 6.33 | 5.83 | 6.83 |
| 3 | T3 | 7.83 | 6.67 | 6.67 | 5.83 | 5.50 | 6.50 |
| 4 | T4 | 6.67 | 6.67 | 6.83 | 6.33 | 6.50 | 6.60 |
| 5 | T5 | 7.00 | 6.33 | 6.50 | 6.17 | 5.67 | 6.33 |
| 6 | T6 | 6.33 | 5.83 | 5.83 | 5.50 | 5.33 | 5.76 |

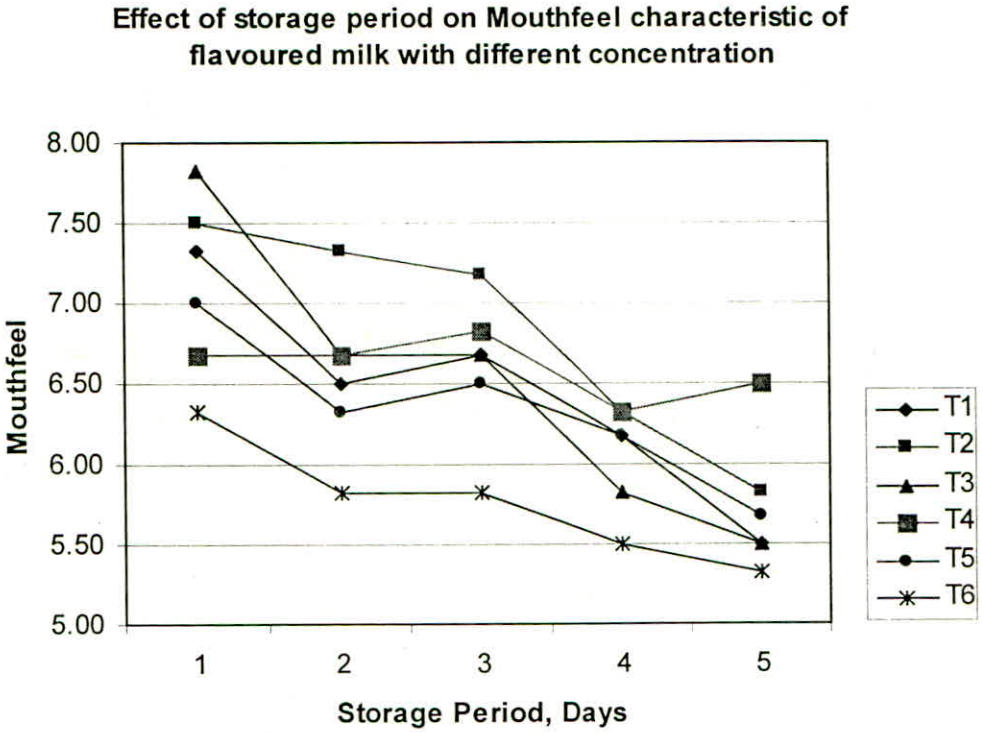



**Fig.4.5 Effect of different levels of concentration on mouthfeel of flavoured milk during storage period**

The effect of different concentrations of carrot juice and shredded carrot and the storage days have been found to be significant at 5% level of significance ($P<0.05$) on mouthfeel characteristics. Therefore different levels of carrot juice and shredded carrot concentrations as well as the storage days were compared with their respective least significant differences. It was found that 10%, 30% carrot juice concentrations are at par but rest of all concentrations having significantly different effect compare to each other. Similarly it was also found that the effect of different levels of storage days have significantly different effects on mouthfeel characteristics compared to each other but the 7 and 14 days of storage are at par.

**4.6.4 Overall acceptability**

The sensory scores of flavored milk on overall acceptability characteristics are presented in Table 4.9. The score in fresh condition for $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, and $T_6$ samples were recorded to be 7.17, 7.83, 7.67, 6.83, 7.00, and 6.83, respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 6.17, 6.50, 6.00, 6.00, 6.17, and 5.33, respectively.

Effect of storage period on overall acceptability of the product is presented in Figure 4.6. The figure shows gradual decrease of overall acceptability scores for all the prepared flavoured milk with different concentration of carrot with the progress of storage period.

**Table 4.9 Effect of carrot concentration and storage period on overall acceptability of flavoured milk**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | T1 | 7.17 | 6.50 | 6.83 | 6.00 | 6.17 | 6.53 |
| 2 | T2 | 7.50 | 7.83 | 7.50 | 7.00 | 6.50 | 7.27 |
| 3 | T3 | 7.67 | 6.83 | 6.50 | 5.67 | 6.00 | 6.53 |
| 4 | T4 | 6.83 | 6.83 | 6.83 | 6.00 | 6.00 | 6.50 |
| 5 | T5 | 8.00 | 7.67 | 7.50 | 6.67 | 6.17 | 7.20 |
| 6 | T6 | 6.83 | 6.33 | 6.67 | 5.83 | 5.33 | 6.20 |
| 7 | Average | 7.33 | 7.00 | 6.97 | 6.20 | 6.03 | 6.71 |

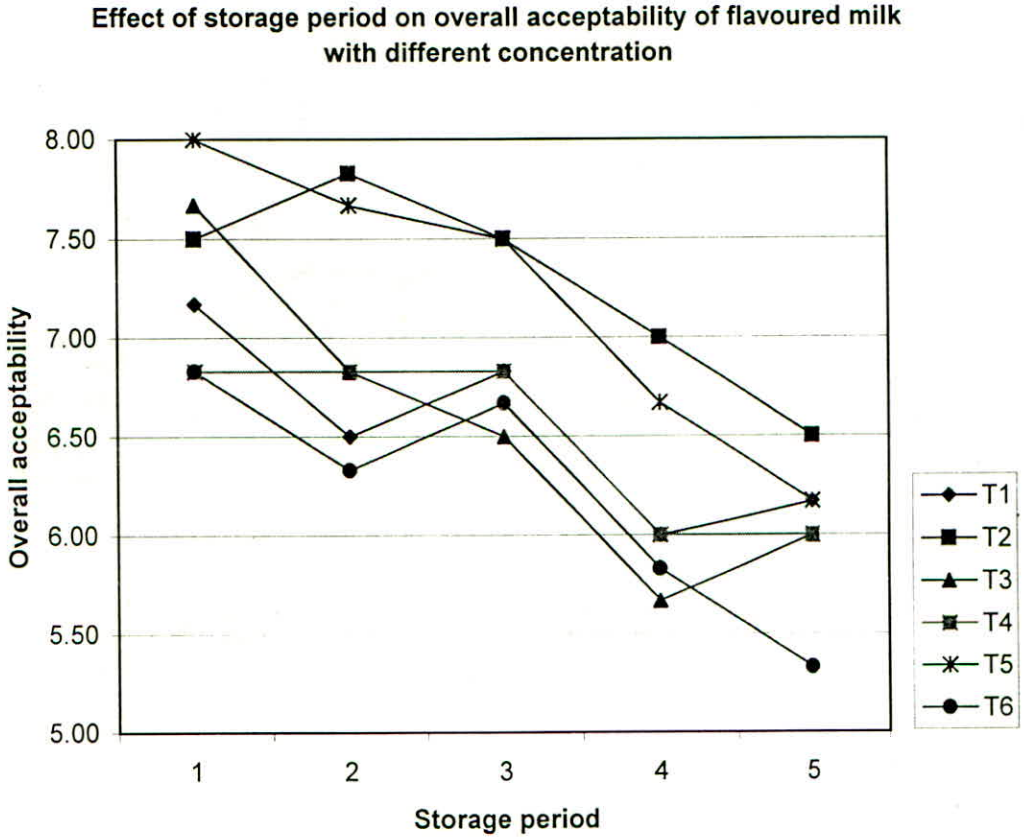



**Fig.4.6 Effect of different levels of concentration on overall acceptability of flavored milk during storage period**

The effect of different concentrations of carrot juice and shredded carrot and the storage days have been found to be significant at 5% level of significance ($P<0.05$) on overall acceptance of the product. Therefore different levels of carrot juice and shredded carrot concentration as well as the storage days were compared with their respective least significant differences. Subsequently it was found that 10% carrot juice and 10 % shredded carrot and 30% carrot juice concentrations are at par to each other, and 20% shredded carrot and 20% carrot juice is also at par but the 30 % shredded carrot having significantly different effect compare to all. It was also found that the effect of different levels of storage days have significantly different effects on overall flavour compared to each other but the 7 and 14 days of storage as well as 0 and 7 days are at par. The interaction of different concentrations of carrot with the storage days was not found to be significant on the overall acceptability of the product.

**4.7 Effect of shredded carrot concentration on physico-chemical characteristics of fresh carrot kheer**

The carrot kheer was prepared using different concentrations of shredded carrot (20%, 30%, and 40%). The product was analyzed for TS, $p^H$, acidity, TSS and fat percent. The physico-chemical characteristics of fresh kheer prepared with different concentration of shredded carrot are detailed in Table 4.10.

**Table 4.10 Physico-chemical characteristics of fresh carrot kheer with different levels of shredded carrot**

| S. No. | Shredded carrot concentration | Fat | Acidity | $p^H$ | TS | TSS |
|---|---|---|---|---|---|---|
| 1 | $K_1$ (20%) | 8.4 | 0.17 | 6.3 | 32.0 | 21.30 |
| 2 | $K_2$ (30%) | 8.2 | 0.17 | 6.3 | 33.3 | 21.10 |
| 3 | $K_3$ (40%) | 8.1 | 0.17 | 6.3 | 33.6 | 20.90 |

From the above Table it is observed that the addition of different concentrations of shredded carrot affects the fat percentage of the samples. The fat percentage of $K_1$, $K_2$, $K_3$, were found to be of the value of 8.4, 8.2, and 8.1 which indicates that fat percentage of samples decrease when concentration increases. Similarly we observe that the acidity and $p^H$ of the samples was not affected by the different concentrations of shredded carrot. The acidity and $p^H$ were found to be 0.17 and 6.3 respectively for each of the samples. It was also observed that the addition of different concentration of shredded carrot increases the Total solids of the samples. The TS percentage of $K_1$, $K_2$, and $K_3$ were found to be the 32.0, 33.3 and 33.6 percent respectively which indicate that the TS of the samples increase when the concentration increases.

The TSS of the $K_1$, $K_2$, and $K_3$ samples are 21.30, 21.10, and 20.90, respectively which do not show any effective difference.

## 4.8 Effect of shredded carrot concentration on the sensory characteristics of fresh carrot kheer

The samples of carrot kheer were subjected to sensory evaluation using 9-point hedonic scale with some modification by the panel of six trained judges. The average scores obtained by the sensory evaluation of different samples by different judges of the various sensory characteristics are presented in Table 4.11. The Table also gives the average overall acceptability scores allotted by the judges to different carrot kheer ($K_1$, $K_2$, and $K_3$) samples.

### 4.8.1 Colour and Appearance

It can be seen from the table that the carrot kheer prepared with the addition of 20%, 30% and 40% shredded carrot i.e. $K_1$, $K_2$, and $K_3$ scored 6.34, 7.50, and 7.84 respectively on colour and appearance attributes. The scores are higher in $K_3$; it means the colour of the product increases with the increase in carrot concentration.

### 4.8.2 Flavour

The flavour attributes of the carrot kheer was evaluated as the basis of intensity of carrot, sweetness, and overall flavour.

**Table 4.11 Effect of carrot concentration on sensory characteristics of fresh Carrot kheer**

| S.No | Carrot Concentration | Sensory Characteristics | | | | | |
|---|---|---|---|---|---|---|---|
| | | Colour & Appearance | Flavour | | | Mouth feel | Overall Acceptability |
| | | | IOC | Sweetness | Overall flavour | | |
| 1 | K1 | 6.34 | 6.34 | 7.84 | 7.67 | 7.50 | 7.67 |
| 2 | K2 | 7.50 | 6.50 | 7.67 | 8.50 | 7.84 | 8.50 |
| 3 | K3 | 7.84 | 7.67 | 7.5 | 7.84 | 7.50 | 7.84 |

### 4.8.2.1 Intensity of Carrot flavour

As observed from the table 4.15, the scores on intensity of carrot flavour highest for treatment $K_3$. The scores of $K_1$, $K_2$, and $K_3$ are 6.34, 6.50, and 7.67, respectively. It is also observed from the table that judges like the presence of carrot flavour.

### 4.8.2.2 Sweetness

In carrot kheer preparation 8% sugar is added in all three different concentrations. Sweetness scores for treatment $K_1$, $K_2$, and $K_3$ is 7.84, 7.67, and 7.50, respectively. The sweetness of $K_1$ sample is more acceptable then others.

### 4.8.2.3 Overall Flavour

The overall flavour scores for treatment $K_1$, $K_2$, and $K_3$ are 7.67, 8.50, and 7.84, respectively. The carrot kheer sample $K_2$ scored high marks and it can be conclude that the treatment $K_2$ preferred more than the other treatments on its flavour point of view.

The treatment $K_1$ and $K_3$ are scoring lesser marks due to the lesser and higher intensity of carrot flavour which do not preferred by the judges.

### 4.8.3 Mouthfeel`

As observed from the table 4.15, the scores on mouthfeel attributes for treatment $K_1$, $K_2$, and $K_3$ scored 7.50, 7.84, and 7.50, respectively which indicates that the treatment $K_2$ sample having better mouthfeel characteristics than other treatments. The $K_1$ and $K_2$ samples are not liked by the judges due to the under and over addition of shredded carrot respectively.

### 4.8.4 Overall acceptability

The overall acceptability scores of the three samples of carrot kheer i.e. $K_1$, $K_2$, and $K_3$ with different concentration i.e. 20%, 30%, and 40% of shredded carrot are 7.67, 8.50, and 7.84, respectively. The $K_2$ treatment of carrot kheer posses the optimum colour, mouthfeel, and overall flavour in kheer which makes it more acceptable then others.

## 4.9 Effect of storage on sensory characteristics of carrot kheer

The sensory evaluation of the carrot kheer was performed by panel of six trained judges using 9-point hedonic scale to know the sensory quality and overall acceptability of the product. Sensory scores as presented in the different tables reveal that there was significant effect of storage period on the flavour, mouth feel, colour, appearance and overall

acceptability of the carrot kheer, which are discussed under the following headings.

### 4.9.1 Colour and appearance

Sensory scores on colour and appearance of carrot kheer were presented in Table 4.12. The Table shows that the colour and appearance of the flavoured milk was found to be good at the end of the 28 days of storage period. The score in fresh condition for $K_1$, $K_2$, and $K_3$ samples were found to be 6.34, 7.50, 7.33, and 7.84, respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 6.34, 6.50, and 6.67, respectively. These results are graphically presented in Figure 4.7. The figure shows gradual decrease on colour and appearance of different concentration of carrot kheer during storage period.

The effect of different concentrations of shredded carrot and the storage days have been found to be significant at 5% level of significance ($P<0.05$). Subsequently it was found that all the concentrations of shredded carrot are having significantly different effects on colour and appearance compare to each other at 5% level of significance. Similarly it was also found that the effect of different levels of storage days have significantly different effects on colour and appearance compared to each other but the 0 and 7 days are at par. The interaction of different concentrations shredded carrot with the storage days was not found to be significant on the colour and appearance of the product.

**Table 4.12 Effect of carrot concentration on colour and appearance of carrot kheer during storage period**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | K1 | 6.34 | 6.50 | 6.57 | 6.50 | 6.34 | 6.45 |
| 2 | K2 | 7.50 | 7.50 | 7.50 | 6.50 | 6.50 | 7.10 |
| 3 | K3 | 7.84 | 7.67 | 7.17 | 7.00 | 6.67 | 7.27 |
| 4 | Average | 7.23 | 7.22 | 7.08 | 6.67 | 6.50 | 6.94 |

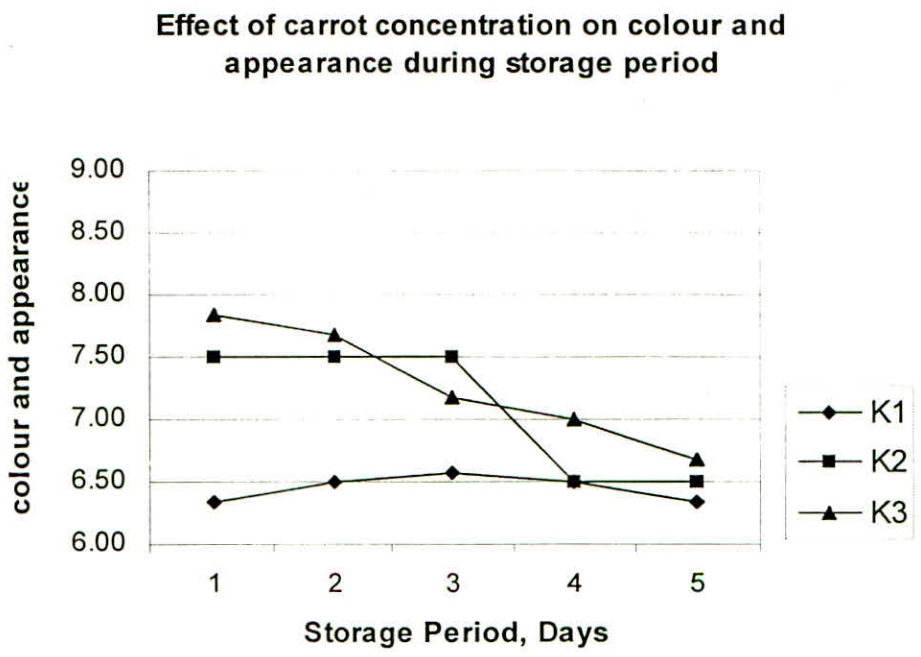



**Fig. 4.7 Effect of different levels of concentration on colour and appearance of carrot kheer during storage period**

### 4.9.2 Overall Flavour

Sensory scores on overall flavour of carrot kheer were presented in Table 4.13. The Table shows that the overall flavour of the flavoured milk was found to be good at the end of the 28 days of storage period. The score in fresh condition for $K_1$, $K_2$, and $K_3$ samples were found to be 7.50, 7.67, and 7.50, respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 6.17, 6.67, and 6.67 respectively. These results are graphically presented in Figure 4.8. The Figure shows gradual decrease on overall flavour of different concentration of flavoured milk during storage period.

The effect of different concentrations shredded carrot was not found to be significant on the overall flavour of the carrot kheer. The storage days has been found to be significant at 5% level of significance ($P<0.05$). Therefore days of storage were compared with their respective least significant differences. Significantly It was found that the effect of 21 and 28 storage days are significantly different effects on overall flavour compare to each other but the 0, 7, and 14 days are at par compare to each other. The interaction of different concentrations shredded carrot with the storage days was not found to be significant on the overall flavour of the products.

**Table 4.13 Effect of carrot concentration on overall flavour of carrot kheer during storage period**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | K1 | 7.50 | 7.50 | 7.34 | 7.34 | 6.17 | 7.17 |
| 2 | K2 | 7.67 | 7.67 | 7.67 | 6.84 | 6.67 | 7.30 |
| 3 | K3 | 7.50 | 7.50 | 7.50 | 6.50 | 6.67 | 7.13 |
| 4 | Average | 7.56 | 7.56 | 7.50 | 6.89 | 6.50 | 7.20 |

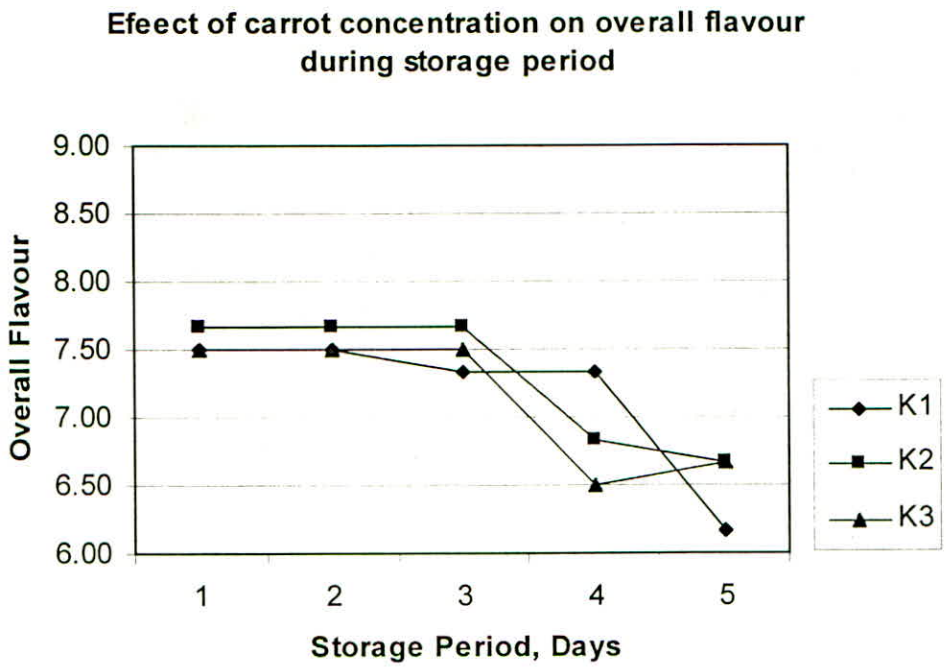



**Fig.4.8 Effect of different levels of concentration on overall flavour of carrot kheer during storage period**



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### 4.9.3 Mouthfeel

The sensory scores on mouthfeel characteristics of the prepared flavoured milk in fresh as well as storage condition were presented in Table 4.14. These scores are graphically presented on the Figure 4.9.

Thus the different concentration of carrot does not affect the mouthfeel characteristics of the products. Storage of the product slightly adversely affects its mouthfeel quality. The effect of different concentrations shredded carrot was not found to be significant on the mouthfeel of the carrot kheer. The storage days has been found to be significant at 5% level of significance ($P<0.05$). Therefore days of storage were compared with their respective least significant differences. It was found that the effect of 21 and 28 storage days are significantly different effects on overall flavour compare to each other but the 0, 7, and 14 days are at par compare to each other. The interaction of different concentrations shredded carrot with the storage days was not found to be significant on the mouthfeel characteristics of the carrot kheer.

**Table 4.14 Effect of carrot concentration on Mouthfeel of carrot kheer during storage period**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | K1 | 7.50 | 7.50 | 7.67 | 6.67 | 5.84 | 7.04 |
| 2 | K2 | 7.84 | 7.84 | 7.67 | 6.84 | 6.00 | 7.24 |
| 3 | K3 | 7.50 | 7.67 | 7.67 | 6.50 | 6.17 | 7.10 |
| 4 | Average | 7.61 | 7.67 | 7.67 | 6.67 | 6.00 | 7.13 |

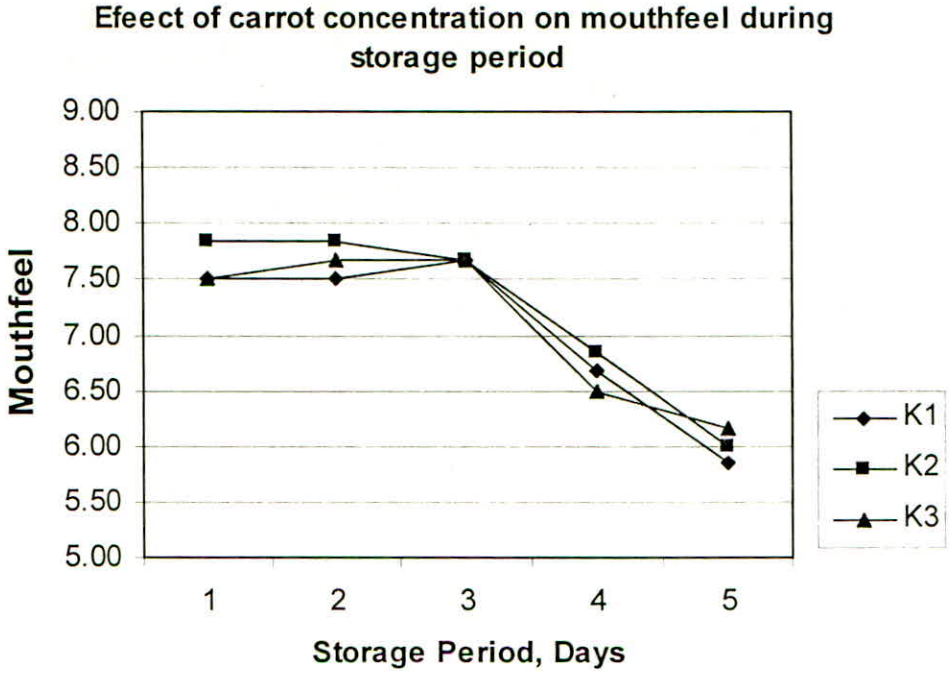



**Fig.4.9 Effect of different levels of concentration on mouthfeel of flavoured milk during storage period**

### 4.9.4 Overall acceptability

The sensory scores of carrot kheer on overall acceptability characteristics are presented in Table 4.15. The score in fresh condition for $K_1$, $K_2$, and $K_3$ samples were recorded to be 7.67, 8.50, and 7.84, respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 6.17, 6.84, and 6.67, respectively. Effect of storage period on overall acceptability of the product is presented in Fig.4.10. The figure shows gradual decrease on overall acceptability scores of carrot kheer with the progress of storage period.

The effect of different concentrations of carrot juice and shredded carrot and the storage days have been found to be significant at 5% level of significance ($P<0.05$) on overall acceptability. It was found that 20% shredded carrot and 30% shredded carrot concentrations are at par to each other on overall acceptability at 5% level of significance but the 30 % shredded carrot having significantly different effect on overall acceptability of the carrot kheer. Similarly it was also found that the effect of different levels of storage days have significantly different effects on overall flavour compared to each other but the 7 and 14 days of storage are at par and 0 and 14 days are also at par. The interaction of different concentrations of carrot juice and shredded carrot with the storage days was not found to be significant on the overall acceptability of the product.

**Table 4.15 Effect of carrot concentration on Overall Acceptability of carrot kheer during storage period**

| S.No | Carrot Concentration | Storage Period | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | Fresh | 7 | 14 | 21 | 28 | |
| 1 | K1 | 7.67 | 7.50 | 7.67 | 6.50 | 6.17 | 7.10 |
| 2 | K2 | 8.50 | 8.50 | 8.34 | 7.50 | 6.84 | 7.94 |
| 3 | K3 | 7.84 | 7.67 | 7.72 | 6.50 | 6.67 | 7.28 |
| 4 | Average | 8.00 | 7.89 | 7.91 | 6.83 | 6.56 | 7.44 |

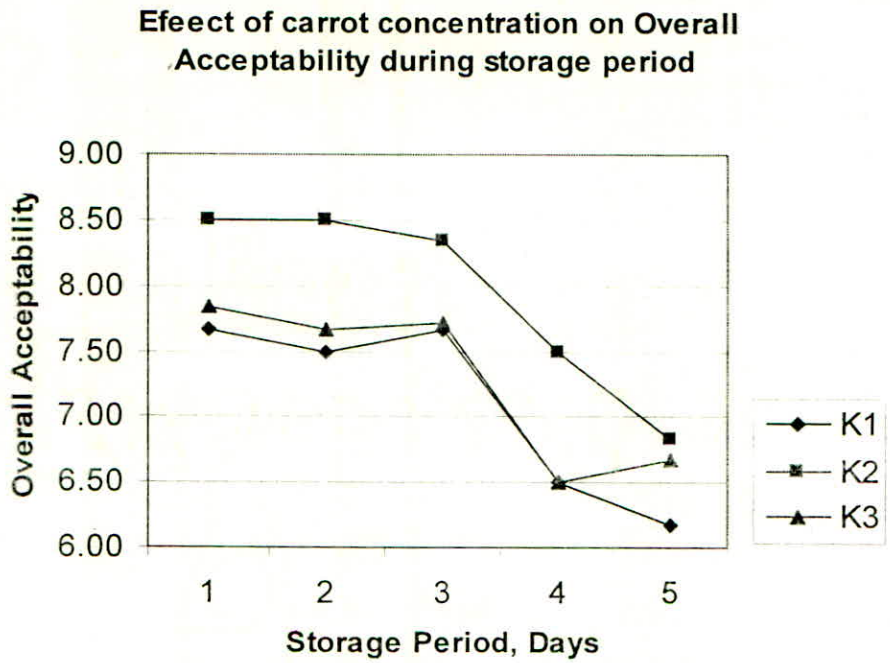



**Fig.4.10 Effect of different levels of concentration on overall acceptability of carrot kheer during storage period**

# *Summary, Conclusion and Suggestions*

# CHAPTER V

# SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

The dairy foods of the future will contain more of healthful, functional foods, Flavoured milk is gaining popularity day by day because it is a cheaper cold drink as compared to non milk based drinks and posses more nutritive value. There is an enormous range of flavouring materials available for flavoured milk which may be natural or chemical origin. Carrot is an important root crop if India. It is also used as vegetable and salad. Carrot is well known for its nutritional and therapeutic properties. It posses natural flavour and colour. Carrot is a relatively new flavour used in the flavoured milk. A traditional Indian dairy product contains a significant proportion of milk nutrient and therefore are highly nutritious. The addition of cereals, fruits, fruit pulps and vegetables in the milk results into value addition in terms of nutrition due to increase demand of the new dairy products, which are tastier, healthier and nutritious. Such types of products are also very useful in infants and growing children due to its nutritional value which provides nourishment in infants. Despite their nutritional significance and popularity, the keeping quality of such products is very less. Keeping above point in view, efforts have been made

to develop a technology for production of sterilized carrot based flavoured milk and sterilized carrot kheer with following objectives.

1. To formulate and standardize the carrot based flavoured milk and carrot kheer.
2. To study the shelf life of the prepared products by sterilization.
3. To study the physico-chemical and sensory properties of fresh and stored carrot based flavoured milk and carrot kheer.

In present investigation carrot based flavoured milk prepared by taking 15% sugar and three different concentration of carrot juice and three different concentration of shredded carrot (i.e. 10, 20, and 30%) with respect to milk were used to make six treatments i.e. $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ (three treatments for carrot juice and three treatments for shredded carrot). The carrot juice was extracted form the freshly peeled and cut carrot through a clean fruit and vegetable juicer. The carrot juice was collected and filtered through clean muslin cloth. For shredded carrot, the carrot was peeled and shredded using a domestic hand grater. The carrot shredded and juice for each concentration was weighed and mixed with sugar. The sugar and carrot mix were mixed and blended thoroughly with milk at the temperature of $60^0$C. This flavoured milk was filled in cleaned glass bottles and crown corked. These bottles were sterilized at 118-$121^0$C for 15 min. and stored at room temperature after labeling it for a period of twenty eight days.

For carrot kheer preparation, the 8% sugar, 3% ghee, 2.5% dry fruits, and shredded carrot of three different concentrations (i.e. 20, 30, and 40%) were used with respect to milk. The three different treatments $K_1$, $K_2$, $K_3$ were made. The shredded carrot was weighed and cooking with ghee till the shreds of carrot were cooked. Then dry fruits and sugar were added and again cooked with milk till the required concentration and consistency of product was obtained. The carrot kheer was then filled in cleaned glass bottles and crown corked. Sterilization was done at 118-121$^0$C for 15 min. the bottles were cooled and stored at room temperature for a period of twenty eight days.

The milk was analyzed for fat, acidity, $p^H$, and total solids. The fresh product (Carrot based flavoured milk and carrot kheer) samples were analyzed for fat, acidity, $p^H$, TS, TSS, and sensory characteristics. The shelf life of the product was evaluated upto twenty eight days of storage period at an interval of seven days. The changes in $p^H$, acidity and sensory characteristics were determined at each stage on storage of flavoured milk. The changes in sensory characteristics i.e. colour and appearance, flavour, mouthfeel and overall acceptability were determined at each stage on storage of carrot kheer.

Desired level of carrot concentration in the flavoured milk and carrot kheer was optimized, on the basis of sensory evaluation and consumer response. It was observed that the carrot concentration of 20%

(carrot juice and shredded carrot) was more suitable than other tow concentration in overall acceptability and overall flavour of the flavoured milk. The 10% and 30% concentration was less acceptable because the flavour and colour of the product was less in 10% and intense sharp flavour and colour in 20% concentration. In the juice and shredded the juice gaining more acceptance than shredded due to the mouthfeel factor. It was observed that acidity increases and $p^H$ decreased during storage period of the all treatment of flavoured milk.

In the carrot kheer, it was conclude that the 30% concentration of shredded carrot was most acceptable than the other two concentration (20% and 40%) in carrot kheer. The overall acceptability and overall flavour of the product was very high in 20% concentration i.e. $K_2$ treatment.

**From the present investigation following conclusions can be drawn:**

1) Flavoured milk prepared form 15% sugar and 20% carrot juice and shredded carrot with respect to milk was found to be quite acceptable.
2) The flavoured milk using carrot juice was more acceptable than the flavoured milk using shredded carrot.
3) Carrot kheer prepared by taking 8% sugar, 3% ghee, 2.5% dry fruits and 30% shredded carrot concentration with respect to milk was preferred mostly by the panel of trained judges.

4) Despite the preference, acceptability and nutritional quality of the carrot based milk product, it also improved the shelf life and palatability of the product.

5) The prepared product having better shelf life due to the sterilization process.

6) Quality of the products was well within acceptable limit upto 1 month of storage at room temperature.

**Suggestions for future work**

The experiences gained from the present study, some suggestions for the future work are given below.

1) Other fruits and vegetables like sapota, strawberry, apple, and custard apple were also used for the preparation of flavoured milk.

2) Some vegetable and fruits like sweet potato, beet root, pumpkin and other cereals may also be tried for preparation of the value added products.

3) Storage study should be extended more than two months in room temperature to evaluate the shelf life of the product.

4) The improved technology was also used for preparation of the product.

5) Some other physico-chemical characteristics were also evaluated for getting better result.

6) Nutritional benefits of these products should also be evaluated for a period of time.

**Development and Standardization of Sterilized Carrot based Flavoured Milk and Carrot Kheer**

**By**

**Mehar Afroz**

## ABSTRACT

The efforts have been made to develop and standardize the carrot based flavoured milk using carrot juice or shredded carrot and carrot kheer at various level of carrot concentration i.e.10-30 percent on both type of products. The product is then sterilized for better shelf life of the products. The prepared products have been evaluated using 9 point hedonic scale for different attributes like colour and appearance, flavour, mouthfeel, and overall acceptability. Storage study has been under taken for a period of 28 days at room temperature. At the regular interval of 7 days, $p^H$, and acidity have been determined upto one months of storage period.

The milk suitable for product preparation contained 16.9 per cent TS, 4.1 per cent fat, 0.14 percent acidity, and 6.6 $p^H$. The flavoured milk using carrot juice and shredded carrot at 20 percent concentration contained 3.9 and 4.0 percent fat, 0.14 percent acidity, 21.50 and 21.00 $^0$Brix TSS, and 25.71 and 24.85 percent TS respectively, the $p^H$ and acidity after 28 days was found to be the 0.17 and 0.17; and 5.8 and 5.7 respectively.

It was observed that the acidity increase while pH decreased during storage period in case of all the treatments. It was observed that the flavoured milk containing 20 percent carrot scored highest and was preferred mostly by the judges. The score in fresh condition for $T_2$ and $T_5$ samples were recorded to be7.83 and 7.00 respectively and at the end of 28 days of storage period the scores of corresponding samples were found to be 6.50, and 6.17 respectively. The carrot kheer using shredded carrot at 30 percent concentration contained 8.2 percent fat, 0.17 percent acidity and 21.10 $^0$Brix TSS, and 33.3 percent TS. It was observed that the carrot kheer 30 percent carrot scored highest marks and was preferred mostly by the judges. The score in fresh condition for $K_2$ sample was found to be 7.50 and at the end of 28 days of storage period the scores of corresponding samples was found to be 6.50. These products are very nutritive and posses effective in the growth of infants. Despite the preference, acceptability and nutritional quality of the carrot based milk product, it also improved the shelf life and palatability of the product. The prepared product having better shelf life due to the sterilization process. Quality of the products was well within acceptable limit upto 1 month of storage at room temperature.

Advisor

(Dr. B.K.Goel)

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## Appendix-I

## DAIRY TECHNOLOGY SECTION

Name of the judge: Date: / /
2004

Time: Batch No:

---

Is/are served to you for organoleptic evaluation. Please judge the product on 9-point hedonic scale. Please write your valuable comments below in the remarks section.

| Particulars | A | | | B | | | C | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 1. Appearance & Color | | | | | | | | | |
| 2. Flavor<br>• Intensity of carrot flavor<br>• Sweetness<br>• Overall | | | | | | | | | |
| 3. Mouth feel | | | | | | | | | |
| 3. Overall Acceptance | | | | | | | | | |

Scale

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

***Special comments on the product:***

Signature

# Appendix-II

## Anova for Carrot Kheer

### COLOUR AND APPEARANCE

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 12.422 | 2 | 6.211 | 10.38629 | 0.003623938 |
| JUDGE | 1.422 | 5 | 0.284 | 0.474916 | 0.787263601 |
| ERROR-I | 5.978 | 10 | 0.598 | | |
| SUBPLOT | | | | | |
| DAY | 6.822 | 4 | 1.706 | 7.719457 | 4.36268E-05 |
| T*D | 3.911 | 8 | 0.489 | 2.21267 | 0.038802191 |
| ERROR-II | 13.267 | 60 | 0.221 | | |
| TOTAL | 43.822 | 89 | 9.509 | | |

### INTENSITY OF CARROT

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 19.356 | 2 | 9.678 | 29.23867 | 6.64149E-05 |
| JUDGE | 2.489 | 5 | 0.498 | 1.504532 | 0.271991719 |
| ERROR-I | 3.311 | 10 | 0.331 | | |
| SUBPLOT | | | | | |
| DAY | 5.711 | 4 | 1.426 | 5.074733 | 0.001370636 |
| T*D | 3.422 | 8 | 0.428 | 1.523132 | 0.1683894 |
| ERROR-II | 16.867 | 60 | 0.281 | | |
| TOTAL | 51.156 | 89 | 12.642 | | |

### SWEETNESS

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 0.267 | 2 | 0.133 | 0.554167 | 0.591228666 |
| JUDGE | 2.933 | 5 | 0.587 | 2.445833 | 0.107221649 |
| ERROR-I | 2.4 | 10 | 0.24 | | |
| SUBPLOT | | | | | |
| DAY | 16.889 | 4 | 4.222 | 19.01802 | 3.81239E-10 |
| T*D | 2.176 | 8 | 0.272 | 1.225225 | 0.300256033 |
| ERROR-II | 13.333 | 60 | 0.222 | | |
| TOTAL | 37.998 | 89 | 5.676 | | |

**OVERALLFLAVOUR**

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 0.867 | 2 | 0.433 | 2.592814 | 0.123832919 |
| JUDGE | 4.267 | 5 | 0.853 | 5.107784 | 0.013872576 |
| ERROR-I | 1.667 | 10 | 0.167 | | |
| SUBPLOT | | | | | |
| DAY | 18.176 | 4 | 4.544 | 15.35135 | 1.0622E-08 |
| T*D | 1.689 | 8 | 0.211 | 0.712838 | 0.679182358 |
| ERROR-II | 17.733 | 60 | 0.296 | | |
| TOTAL | 44.399 | 89 | 6.504 | | |

**MOUTHFEEL**

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 0.6 | 2 | 0.3 | 0.737101 | 0.502791171 |
| JUDGE | 2.133 | 5 | 0.427 | 1.04914 | 0.441366096 |
| ERROR-I | 4.067 | 10 | 0.407 | | |
| SUBPLOT | | | | | |
| DAY | 42.4 | 4 | 10.6 | 38.68613 | 5.51223E-16 |
| T*D | 0.733 | 8 | 0.092 | 0.335766 | 0.948674653 |
| ERROR-II | 16.467 | 60 | 0.274 | | |
| TOTAL | 66.4 | 89 | 12.1 | | |

**OVERALL ACCEPTANCE**

| SOURCE | SS | DF | MS | F-CAL | P-VALUE |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 8.289 | 2 | 4.144 | 9.773585 | 0.004440384 |
| JUDGE | 1.689 | 5 | 0.338 | 0.79717 | 0.575886342 |
| ERROR-I | 4.244 | 10 | 0.424 | | |
| SUBPLOT | | | | | |
| DAY | 30.444 | 4 | 7.611 | 33.23581 | 1.31077E-14 |
| T*D | 1.622 | 8 | 0.228 | 0.995633 | 0.448848277 |
| ERROR-II | 13.733 | 60 | 0.229 | | |
| TOTAL | 60.021 | 89 | 12.974 | | |

# Appendix-III

## Anova for flavoured milk

### COLOUR AND APPEARENCE

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 28.85 | 5 | 5.77 | 15.38667 | 6.1123E-07 |
| JUDGE | 10.717 | 5 | 2.143 | 5.714667 | 0.001196656 |
| ERROR-I | 9.363 | 25 | 0.375 | | |
| SUBPLOT | | | | | |
| DAY | 40.356 | 4 | 10.089 | 38.95367 | 7.1879E-21 |
| T*D | 6.176 | 20 | 0.309 | 1.19305 | 0.272078354 |
| ERROR-II | 31.067 | 120 | 0.259 | | |
| TOTAL | 126.529 | 179 | 18.945 | | |

### INTENSITY OF CARROT

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 3.978 | 5 | 0.796 | 1.007595 | 0.433860555 |
| JUDGE | 3.711 | 5 | 0.742 | 0.939241 | 0.472901833 |
| ERROR-I | 19.756 | 25 | 0.79 | | |
| SUBPLOT | | | | | |
| DAY | 32.7 | 4 | 8.175 | 27.90102 | 2.19763E-16 |
| T*D | 15.3 | 20 | 0.765 | 2.610922 | 0.000696703 |
| ERROR-II | 35.2 | 120 | 0.293 | | |
| TOTAL | 110.645 | 179 | 11.561 | | |

### SWEETNESS

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 2.644 | 5 | 0.529 | 1.555882 | 0.20891135 |
| JUDGE | 1.444 | 5 | 0.289 | 0.85 | 0.527699074 |
| ERROR-I | 8.489 | 25 | 0.34 | | |
| SUBPLOT | | | | | |
| DAY | 25.922 | 4 | 6.481 | 28.42544 | 1.29134E-16 |
| T*D | 3.078 | 20 | 0.154 | 0.675439 | 0.843481968 |
| ERROR-II | 27.4 | 120 | 0.228 | | |
| TOTAL | 68.977 | 179 | 8.021 | | |

**OVERALL FLAVOUR**

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 11.244 | 5 | 2.249 | 4.149446 | 0.00699587 |
| JUDGE | 8.178 | 5 | 1.636 | 3.01845 | 0.0288539 |
| ERROR-I | 13.556 | 25 | 0.542 | | |
| SUBPLOT | | | | | |
| DAY | 35.522 | 4 | 8.881 | 27.84013 | 2.33829E-16 |
| T*D | 5.811 | 20 | 0.291 | 0.912226 | 0.572621553 |
| ERROR-II | 38.267 | 120 | 0.319 | | |
| TOTAL | 112.578 | 179 | 13.918 | | |

**MOUTHFEEL**

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 19.494 | 5 | 3.899 | 9.195755 | 4.59047E-05 |
| JUDGE | 2.761 | 5 | 0.552 | 1.301887 | 0.294899854 |
| ERROR-I | 10.606 | 25 | 0.424 | | |
| SUBPLOT | | | | | |
| DAY | 42.589 | 4 | 10.647 | 34.68078 | 3.17335E-19 |
| T*D | 11.811 | 20 | 0.591 | 1.925081 | 0.016219131 |
| ERROR-II | 36.8 | 120 | 0.307 | | |
| TOTAL | 124.061 | 179 | 16.42 | | |

**OVERALL ACCEPTANCE**

| SOURCE | SS | DF | MS | F-CAL | P- Value |
|---|---|---|---|---|---|
| MAINPLOT | | | | | |
| TREAT | 29.894 | 5 | 5.979 | 12.25205 | 4.53762E-06 |
| JUDGE | 8.094 | 5 | 1.619 | 3.317623 | 0.019603885 |
| ERROR-I | 12.206 | 25 | 0.488 | | |
| SUBPLOT | | | | | |
| DAY | 40.389 | 4 | 10.097 | 31.45483 | 6.53301E-18 |
| T*D | 7.076 | 20 | 0.354 | 1.102804 | 0.355715796 |
| ERROR-II | 36.533 | 120 | 0.321 | | |
| TOTAL | 134.192 | 179 | 18.858 | | |