

# **DEVELOPMENT AND EVALUATION OF VALUE ADDED SHRIKHAND**

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**B. Tech (Dairy Technology)**

**MASTER OF SCIENCE  
(FOOD TECHNOLOGY)**



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# **DEVELOPMENT AND EVALUATION OF VALUE ADDED SHRIKHAND**

**BY**

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**B. Tech (Dairy Technology)**

**THESIS SUBMITTED TO THE PROFESSOR JAYASHANKAR  
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**(FOOD TECHNOLOGY)**

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**2016**

## **DECLARATION**

I, **J. SRINIVAS**, hereby declare that the thesis entitled **“DEVELOPMENT AND EVALUATION OF VALUE ADDED SHRIKHAND.”** submitted to **Professor Jayashankar Telangana State Agricultural University** for the degree of **Master of Science in Food Technology** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

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## **CERTIFICATE**

**Mr. J. SRINIVAS** has satisfactorily executed the course of research and that thesis entitled “**DEVELOPMENT AND EVALUATION OF VALUE ADDED SHRIKAHND**” submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by him for a degree of any university.

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# CERTIFICATE

This is to certify that the thesis entitled “**DEVELOPMENT AND EVALUATION OF VALUE ADDED SHRIKHAND**” submitted in partial fulfillment of the requirements for the degree of “**MASTER OF SCIENCE IN FOOD TECHNOLOGY**” to **Professor Jayashankar Telangana State Agricultural University, Hyderabad** is a record of the bonafide original research work carried out by **Mr. J. SRINIVAS** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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## LIST OF SYMBOLS AND ABBREVIATIONS

%	: Percentage
@	: At the rate of
<	: Less than
>	: More than
±	: Plus or minus
µg	: microgram
a*	: Hue
°C	: Degree Celsius
mg	: milligram
ml	: milliliter
ANOVA	: Analysis of variance
AOAC	: Association of Official Analytical Chemists
AR	: Analytical reagent
b*	: Brightness
BP <sub>1</sub>	: Control with 3% WPC + 0.1% beet root powder
BP <sub>2</sub>	: Control with 3% WPC + 0.3% beet root powder
BP <sub>3</sub>	: Control with 3% WPC + 0.5% beet root powder
C	: Control sample
CD	: Critical Difference
CaCl <sub>2</sub>	: Calcium chloride
CFU/g	: Colony Forming Units per gram
CO <sub>2</sub>	: Carbon dioxide
CuSO <sub>4</sub>	: Copper sulphate
CVD	: Cardio vascular diseases
DF	: Dilution factor
e.g.	: for example, for instance
<i>et al.</i>	: and other people
etc.	: and so on; and other people/things

<i>E. coli</i>	:	<i>Escherichia coli</i>
FAO	:	Food and Agriculture Organization
FFA	:	Free fatty acid
Fig	:	Figure
FSSAI	:	Food Safety and Standards Authority of India
g	:	gram
g/l	:	gram per liter
hrs	:	Hour(s)
HCl	:	Hydrochloric acid
H <sub>2</sub> O	:	Water
H <sub>2</sub> SO <sub>4</sub>	:	Sulphuric acid
HTST	:	High temperature short time
i.e	:	Means
KCl	:	Potassium chloride
Kcal	:	Kilo calories
Kg	:	Kilogram
KOH	:	Potassium hydroxide
l	:	Liter
L*	:	Lightness
LA	:	Lactic acid
M	:	Molarity
MF	:	Microfiltration
mg	:	mg
min	:	Minute(s)
ml	:	Milliliter(s)
N	:	Normality
NaOH	:	Sodium hydroxide
Na <sub>2</sub> CO <sub>3</sub>	:	Sodium carbonate
NDDB	:	National Dairy Development Board
no.	:	number
PGRC	:	Post Graduate Research Center

pH	:	Log of H <sup>+</sup> ion concentration
SCC	:	Somatic cell count
SD	:	Standard deviation
sec	:	Second(s)
SE	:	Standard error deviation
sp. gr	:	Specific gravity
TBC	:	Total Bacterial Count
TMC	:	Total Mould Count
viz.	:	Namely
w/v	:	Weight per volume
w/w	:	Weight per weight
wt	:	Weight
WHO	:	World Health Organization
WPC	:	Whey protein concentrate
WP <sub>1</sub>	:	Control with 1% WPC
WP <sub>2</sub>	:	Control with 3% WPC
WP <sub>3</sub>	:	Control with 5% WPC

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## **ABSTRACT**

Of the total milk produced in India, 50 to 55% is converted into a variety of traditional milk products using various processes like coagulation, concentration, desiccation and fermentation. Fermented milk products not only are consumed directly but often form starting materials from which other dairy products are prepared. Fermentation of milk helps in extending the shelf life of this perishable food with the potential health benefits that are desirable by the consumers. India is the largest milk producer in the world and home to most popular fermented milk products like dahi, lassi and shrikhand.

Shrikhand is a traditional fermented semi soft and sweetened milk product prepared by lactic fermentation of milk with sweetish-sour taste. It is very refreshing particularly during summer months. Shrikhand is known for its high nutritive, characteristic flavour, taste, palatable nature and possible therapeutic value. Currently, due to change in economic status, food habits and awareness of the consumers toward health functional foods, demand for shrikhand as a probiotic is increasing. This led to the development of variants with functional ingredients like ashwagandha powder, walnut powder, cocoa powder, fruits etc.

Whey, the by-product obtained majorly from the cheese and other allied dairy industries is discarded as a waste product during processing in India. It comprises 80-90% of the total volume of milk entering the cheese production and contains about 50% of the nutrients in the original milk. Demineralised whey powder is made by removing dissolved salts and water. Whey protein concentrate (WPC) is made by ultra filtration of whey to concentrate the proteins into a small volume which are then dried to a soluble powder.

Whey is widely accepted as food ingredients in confectionery, bakery, health and sport supplement formulations. It possess relevant nutritional (high content of essential

amino acids), functional (gelation, foaming and emulsifying agent) and biological (antimicrobial, anticarcinogenic and immunomodulatory) properties for health.

Therefore, the present study was undertaken with the objective to develop value added shrikhand by incorporating whey protein concentrate (WPC) and beet root powder. The response towards its acceptance by the consumers was also evaluated.

Established brand raw milk, whey protein concentrate and good quality beetroot were procured from local market in Hyderabad. Beetroot was grated, spread on the trays and dried at 55°-60°C temperature for about 8-10 hours in a tray dryer. The dried beetroots were ground and the fine powder was obtained.

Pasteurized milk inoculated @ 1.5 % with the LAB culture was mixed well and incubated at 30°C till the curd sets firmly with acidity of 0.7-0.8% lactic acid. The curd so formed is broken, placed in a muslin cloth bag and hanged on a peg to remove whey for 8-10 hours. The whey drained curd obtained was called chakka, which was the shrikhand base. The sugar @ 40 % was powdered and kneaded uniformly to chakka and shrikhand was prepared. In order to enrich shrikhand, whey protein concentrate (WPC) at levels of 1%, 3% and 5% by weight of chakka was incorporated and subjected to sensory evaluation with 15 semi trained panelists using a 9 point hedonic scale. The preferred WPC added shrikhand sample was taken and added with beet root powder at 0.1, 0.3 and 0.5 % respectively to improve the appearance of the final product. Again this was evaluated for its sensory properties such as color, texture, taste, flavor and overall acceptability. The mean scores of sensory evaluation showed that treatment with 3% WPC with 0.5 % beet root powder had maximum sensory scores and was selected as the best product. This product was taken for consumer evaluation studies using a structured questionnaire.

The maximum  $\Delta L$  value was observed for value added shrikhand and least was for control sample. The control was light in colour than value added shrikhand as beetroot contained anthocyanins and other colored components. Control shrikhand had higher moisture than the value added shrikhand and showed significant difference ( $p < 0.05$ ) as the addition of WPC and beet root powder bound the free water in it.

The result of chemical and nutritional quality characteristics of control and value added shrikhand revealed that the protein, fat, ash, carbohydrate, energy, acidity, total solids and reducing sugars were high in value added shrikhand compared to control. Statistically significant difference ( $p < 0.05$ ) was observed between the samples.

There was a decreasing trend of sensory scores for colour, texture, taste, flavour and overall acceptability for control and value added shrikhand, during shelf life study and significant difference was found between the treatments. The total bacteria and mould counts were increased after storage for a period of 7 days. Both the TBC and TMC were higher in value added shrikhand compared to control. The microbial counts gradually increased with the increase in storage period *i.e.* day 0 to day 24 in both control and value added shrikhand.

The consumer study showed that 97% of the consumers heard of fermented products and 53% were aware of shrikhand. The value added shrikhand was well received by consumers and was “somewhat liked” by 60% of consumers for its color, taste and

texture whereas 90% of them found it to be acceptable. About 25 to 30% of consumers “extremely liked” the product for its color, taste and texture but only 10% of the consumers found to be overall acceptable. The reason may be due to the fact that this sweet dish is not frequently consumed in south India. A few of them neither liked nor disliked the product.

The other attributes like quality of the product and preferred packaging was evaluated. In this 87% consumers stressed on the quality product but a meagre 6-7% preferred packing style and brand image.

Price was a major deciding factor in buying the non traditional foods. About 43% consumers preferred the price of Rs.20-30/-, 40% of them preferred it to be less than Rs 20 /- with 17% preferring cost above Rs 30/-

The present study conducted is a preliminary step towards assessing the feasibility of effective utilization of whey protein concentrates and the incorporation of beet root powder in the development of value added shrikhand which also enhanced the nutrient contents. Consumption of these nutrient dense products will improve the nutritional status of the population and health benefits. Hence, a bright future is envisaged for the use of whey based products in food industry.

# *INTRODUCTION*

# CHAPTER I

## INTRODUCTION

The nature's wonder beverage "Milk" is as ancient as mankind itself that provided sustenance to mammalian infants. All species of mammals, from man to whales, produce milk for this purpose. As early as 6000-8000 BC, ancient man learned to domesticate animals for milk consumption. The role of milk in the traditional diet has varied greatly from region to region in the world (Bina and Raaz, 2012). The tropical countries were not traditional milk consumers, whereas Europe and North America, have traditionally consumed far more milk and milk products in their diet. In tropical countries the high temperatures and lack of refrigeration has led to the inability to store fresh milk. Milk has traditionally been preserved through means other than refrigeration, by conversion into more stable fermented milk products (De, 2014).

Technological advances have come about very recently in the history of milk consumption and the present generation will be the ones credited for having turned milk processing from an "Art" to a "Science". The availability and distribution of milk and its products today in the modern world is a blend of the centuries old knowledge of traditional milk products with the application of modern science and technology (Goff and Griffiths, 2006). Milk helps to build strong bones and lower blood pressure. It provides satisfaction and is a powerful package of goodness (National Institute of Health, 2014).

Milk composition varies depending on the species of dairy animal, its breed, age and diet, along with the stage of lactation, parity, farming system, physical environment and season influences the colour, flavour and composition of milk. Although there are minor variations in milk composition among various species, on an average it consists of 85.5-89.5% water, 2.5-6.5% fat, 2.9-5.0% protein 3.6-5.5% lactose, 0.6-0.9% minerals and total solids 10.5-14.5% (Forsbäck and Andréé, 2010).

Milk constituents are treated as important source of nutrients such as protein (phosphor proteins, lipoproteins, chromo proteins), carbohydrates (lactose), vitamins, minerals like calcium, potassium, magnesium, phosphorus and trace elements like copper, iron, nickel and zinc (Bina and Raaz, 2012). The technological advancements have helped to develop different types of milk to suit every taste like whole milk (6.0 % fat),

standardize milk (4.5 % fat), toned milk (3.0 % fat), double toned milk (1.5 % fat) and skim milk (fat-free 0.01%). All types of milk provide the same nutrients and health benefits (Rudrello, 2004).

Food provides a favorable environment for the growth of micro organisms. Yeasts, moulds and a broad spectrum of bacteria grow in milk at temperatures above 16°C (Durham, 2006). These microbes can enter milk via the cow, air, feed, milk handling equipment and the milker. Once micro organisms get into the milk their numbers increases rapidly due to conducive environment. It is more effective to exclude micro organisms than to try to control microbial growth once they have entered the milk (Walstra *et al.*, 2006).

In dairying, some micro organisms were harmful causing spoilage and pathogenic products while others were beneficial like cheese and yoghurt starters, yeasts and moulds used in controlled fermentations of milk processing. The microbial growth in milk and milk products is mostly dependent on the temperature, nutrient availability, water supply, oxygen supply and acidity of the medium (Büchl and Seiler, 2011).

Moulds under aerobic conditions can grow on a wide variety of substrates and were generally regarded as spoilage organisms. However, moulds were used in the production of antibiotics and certain cheese varieties. They can be killed by relatively mild heat treatments and by excluding air with careful packaging. Viruses attack acid producing bacterial cells and inhibit acid production in milk (Lingathurai and Vellathurai, 2010).

Microbial growth can be controlled by cooling the milk. Most micro organisms reproduce slowly in colder environments and it slows chemical deterioration (Chambers, 2002). The total bacterial count was a good indicator for monitoring the sanitary conditions practiced during production and processing of milk. The initial bacterial count of milk may range from less than 1000 cells/ml to 10<sup>6</sup>/ml but poor production results in counts of more than 10<sup>5</sup>/ml and is an important attribute for safety of milk (Oliver *et al.*, 2005).

Fermented milk products are produced as milk is a highly perishable commodity (Law *et al.*, 2011). Natural souring of milk gives products like butter, yoghurt, sour cream, ripened buttermilk and cheese. It provides ways to preserve milk that were pleasant to consume and more readily digested than fresh milk. Dairy products were consumed not

only for meeting the nutritional requirements, but also to prevent certain disorders (Nagpal *et al.*, 2012).

Over 3500 traditional fermented foods of great significance with diverse flavors, aromas and textures enrich the human diet worldwide (Anon, 2003). Fermented milks manufactured throughout the world have approximately 400 generic names and the Indian fermented milk products mainly include dahi, lassi, shrikhand, buttermilk and misti doi (Khurana and Kanawji, 2007). Dahi is one of the most important products in the family of fermented milks (Verma *et al.*, 2012). Cultured lassi is a product made by blending yoghurt with water, salt or sugar and spices until frothy (Singh *et al.*, 2012).

The staple desert and a fermented milk product, “Shrikhand” was obtained from chakka to which fruits, nuts, sugar, saffron and other spices can be added (FSSAI 2011).

Therefore, efforts were made to standardize shrikhand by incorporating whey proteins and beet root powder that nutritionally enriched the product with proteins and antioxidants. Therefore the study was carried out with the following objectives

Objectives:

1. To standardize shrikhand by incorporating whey proteins.
2. To add value to shrikhand by addition of beet root powder for colour.
3. To assess physico–chemical, nutritional and sensory quality characteristics of the developed product.
4. To conduct shelf life studies.
5. To conduct consumer evaluation studies.

*REVIEW*  
*OF*  
*LITERATURE*

## CHAPTER II

# REVIEW OF LITERATURE

In the recent years, there is a global trend towards the use of natural substances as a source of antioxidant and functional ingredients (Kim, 2005). The efficient utilization of foods, their by products and other unconventional food sources for human consumption enhanced the nutritional value of food products developed from them. An attempt has been made to review the literature for earlier work carried out relevant to present study on “Development and evaluation of value added shrikhand”. A lot of work was carried out in India and abroad on shrikhand. But the incorporation of beet root powder in shrikhand which is a rich source of antioxidants and minerals was not done. The following aspects were covered in this chapter.

2.1 Description of milk

2.2 Importance of milk

2.3 Processing of milk

2.4 Milk products

2.5 Fermented milk products

2.6 Value added milk products

2.7 Whey powder

2.8 Vegetable powders

### **2.1 Description of milk**

Milk is a fluid secreted by and unique to female mammals for the nurturing of their young ones. Its composition and properties vary widely between species depending on the specific nutritional and physiological requirements of the young ones of that species (Fox, 2011).

Milk which is the characteristic secretion of mammals provides complete nutritional and other physiological requirements to neonates. Humans have used the milk of other species in their diets for about 8000 years and a major industry has developed around the processing of milk of a few species especially cattle, buffalo, sheep and goats. Milk is a very flexible raw material from which a wide range of products, including thousands of cheese were produced (O'Mahony, 2014).

The total milk production of India was 127.9 million tons, out of which 46% was consumed as liquid milk and 54% was converted into products (Anonymous, 2012). The milk production in 2015 was 146.3 million tons and demand for milk is likely to reach 180 million tons by 2022, as estimated by the National Dairy Development Board in 2015.

At present, there are 678 registered dairy processing units processing 12–15 % or 26.63 tons of the total milk produced in the country each year. Of the total dairy units registered in the different states of India under the Milk and Milk Product Order, 403 private dairies process around 11.83 tons per annum, 212 cooperative dairies process 10.36 tons per annum and 63 government plants process 4.44 tons per annum (Kumar, 2014).

Milk is an ideal food containing carbohydrates, proteins, fats and vital minerals that is consumed by all sections of the population. An increased demand in the rate of production of milk is seen as it is perishable in nature due to high moisture content for which it needs to be processed to extend the shelf life from hours to days/months without compromising on its quality and safety. In general, the use of heat is a well-established method practiced in dairy industries along with suitable packaging to maintain the quality of milk and milk products that prevents post process contamination (Chavan *et al.*, 2016).

Poor metabolic health conditions such as overweight, obesity, aging and cardiovascular diseases represent an ever increasing global epidemic. Epidemiological evidence showed that consumption of dairy products was associated with decreased prevalence of metabolic related disorders and the dairy protein aids in prevention of Type II diabetes (Robin and Sally, 2013).

## 2.2 Importance of milk

The buffalo milk constitutes 12% of the global milk production and in India more than 58% of milk is produced by buffaloes. Buffalo milk provides more energy per unit volume than cow's milk as it has higher fat and protein content. The buffalo milk has high content of total solids, fat, proteins, colloidal calcium with casein micelles and fat globules. It is therefore highly suited for fluid milk supply, fermented products like dahi, yogurt, shrikhand, lassi, leben, fat-rich dairy products like cream, butter, ghee, butter oil, heat desiccated and acid-coagulated products like khoa, paneer, casein, caseinate, ice cream and dairy whitener (Sindhu and Arora, 2011).

Milk, the first food for mammals provides all the necessary energy and nutrients for growth, development as well as is crucial for bone mass formation. Milk and its products are frequently included as important elements in a healthy and balanced diet. Epidemiologic studies confirmed the nutritional importance of milk in the human diet and reinforced its role in preventing several chronic conditions like cardiovascular diseases, certain cancers, obesity and diabetes (Paula, 2014).

Milk is widely consumed as it provides important macro and micronutrients required for the human health. It is an essential diet for several millions of people worldwide. Studies indicated that the dairy consumption does not increase cardiovascular risk or the incidence of some cancers and is actually beneficial in human health for a balanced diet (Francesco and Andrea, 2014).

Milk and milk products are good sources of calcium which is important for growing bones and the prevention of osteoporosis. Children and elderly require high calcium in diets and the bioavailability of the calcium in dairy products was considered as the best dietary source (Farré, 2015).

Low calcium intake hampers bone mineral acquisition in adolescent girls. Aside from being a major source of calcium, milk provides phosphates, magnesium, proteins and other unidentified nutrients which favor bone health (Esterle *et al.*, 2009). Protein and alkalizing minerals play a major role in influencing bone status, not only in the elderly but also in children and adolescents (Alexy *et al.*, 2005).

Evidences reported that the intake of calcium in the form of milk and dairy products reduced the risk of hypertension. Also Asian populations showed lower consumption of dairy products than their Western counterparts (Mohammad *et al.*, 2016).

Daily milk intake improves vitamin B<sub>12</sub> among vegetarians as they make up more than half of the Indian population. The recommended dietary allowance of vitamin B<sub>12</sub> for adults in India is 1.0 µg/day. The consumption of dairy products viz. milk, yogurt and cheese/butter, tea/coffee with milk provide required vitamin B<sub>12</sub> in diet (Naik *et al.*, 2013).

Milk consumption can be used as an alternative beverage for the hydration process. The use of milk as an alternative to sports drinks optimizes hydration levels in physically active individuals. The nutritional composition of cow's milk promotes post-exercise rehydration process due to the presence of water and electrolytes such as sodium and potassium naturally (Pegoretti *et al.*, 2015).

The consumption of raw milk increased the risk of contracting disease due to exposure to contagious foods. Although milk and milk products are important components of a healthy diet, unpasteurized milk increases the risk of health hazards due to possible contamination with pathogenic bacteria at any stage in the production-to-consumption. The bacteria can originate from healthy animals where milk was derived or from environment during collection and storage of milk. The risk of milk borne diseases can be eliminated by pasteurization which enhances the microbiological safety of milk without altering its nutritional value (Jeffrey *et al.*, 2009).

Michael (2008) studied the effect of consumption of unpasteurized milk with *Mycobacterium bovis* that caused tuberculosis in cattle and humans acting as a primary vehicle for transmission of disease. The heat treatments like pasteurization, sterilization and Ultra High Treatments (UHT) makes milk a safe product for human consumption.

### **2.3 Processing of milk**

Pasteurization of milk was introduced more than 100 years ago to reduce the incidence of illnesses associated with raw milk consumption and the prevalence of pathogens in raw milk, due to concern on the risk of milk borne illness. In today's world, it is a regulatory requirement to market milk (Lucey, 2015).

Pasteurized Milk Ordinance specifies that minimum processing conditions are 72°C for at least 15 sec for High Temperature, Short Time (HTST) to pasteurize milk products. Milk processed at 73°C or higher temperatures indicated that HTST inversely affected the bacterial numbers during refrigerated storage of pasteurized fluid milk (Ranieri *et al.*, 2009).

Pasteurized fluid milk shelf life is influenced by raw milk quality. The microbial count and somatic cell count (SCC) determined the load of heat-resistant enzymes in milk. High levels of psychrotrophic bacteria in raw milk were required to contribute sufficient quantities of heat-stable proteases and lipases to cause breakdown of protein and fat after pasteurization. Sanitation, refrigeration and the addition of CO<sub>2</sub> to milk are used to control both total and psychrotrophic bacteria count. As the ability to kill, remove or control microbial growth in pasteurized refrigerated milk continued to improve, the original milk SCC influenced the time of refrigerated storage before development of off-flavors (Barbano *et al.*, 2006).

The quality and shelf life of fluid milk products are dependent on the amount and type of micro organisms present after pasteurization. Studies evaluated the effects of different pasteurization processes on the microbial populations in fluid milk. There was no detection of *Bacillus* in initial samples pasteurized at 82°C for 30 min, but *Bacillus* was present in samples after storage for 14 days, indicating that injury and recovery time preceded growth (Hanson *et al.*, 2005).

Sensory attributes and volatile compound composition were monitored at 77, 79, 82, and 85°C to determine the effect of these treatments. Consumers preferred 79°C milk over other treatments. Altering pasteurization temperature did not affect shelf-life or sensory attributes or volatile compound composition at the end of storage period (Gandy *et al.*, 2008).

Homogenized milk containing 2% fat was subjected to minimum HTST pasteurization and non-thermal process, microfiltration (MF). The combination of MF with HTST pasteurization (73.8°C for 15s), along with filling and packaging protected the milk from microbial contamination. It achieved a refrigerated shelf life of 60 to 90 days at 1.7 and 5.7°C refrigeration temperature for 2% fat milks (Caplan and Barbano, 2013).

## 2.4 Milk products

One of the primary objectives of making milk products is to preserve the nutritive values of milk from spoilage due to growth of harmful micro organisms some of which are even pathogens and to increase shelf life as milk is the most perishable product (Harper and Richard, 2008).

Indigenous dairy products have played an important role in socio-economic life of Indians since times immemorial as they accounted for over 90% of all dairy products consumed (Singh, 2007). About 45 to 50% of milk produced in the country was converted into indigenous products and the consumption is likely to grow at an annual rate of more than 20% (Kumar *et al.*, 2005).

Dairy desserts comprise a diverse range of consumer products containing significant amounts of milk solids. Some of the varied products include creamy and gelled desserts, custards and puddings, sachet dessert mixes and cheesecakes (Saunders, 2011).

Flavored milks are unfermented products mixed with sugar and flavor/aroma giving ingredient along with thickeners that stabilize the casein, pH and other milk constituents. In flavored milks,  $\kappa$ -carrageenan is used as a thickening agent at relatively low concentrations of 0.01–0.05% (Bisig, 2011).

Milk is used in preparation of cheese varieties like cottage, quarg and cream cheeses by coagulating with acid. The low pH due to high lactic acid content ensures product safety but shelf life may be limited due to the growth of yeasts and molds (Lucey, 2011).

Khoa is a traditional unfermented dairy product produced in India by thermal concentration over an open fire with continuous vigorous stirring to about 20% moisture with a smooth texture and pasty body. The popular khoa-based sweets are peda, burfi, gulabjamun, kalakand and milk cake (Bansal, 2011).

Rabri is partially concentrated and sweetened milk product containing several layers of cream. It is a milk based dessert, quite popular in northern and eastern parts of the country (Aneja *et al.*, 2002). Traditionally, it is prepared by simmering of whole milk for a

prolonged period to achieve 1/5th concentration and then added with sugar. The shelf life is 2-4 days at room temperatures due to the reduced moisture content and increased solids (Chauhan *et al.*, 2014).

Kheer, a sweet milk-rice indigenous confection prepared during festivals, is quite popular because of its good taste, higher nutritional value and relatively lower cost (Aneja *et al.*, 2002). Kheer is known by different names in different parts of the country like 'kheer' in North Western region, 'payasam' in Southern region, 'payas' in Eastern region, 'phirni' in Northern region, 'kheech' in Mewar region and 'payesh' in Bengal (Pariskar *et al.*, 2015).

Basundi has been prepared over several centuries in the western and southern parts of India. It is a heat-desiccated, thickened milk dessert with white to light caramel colour and creamy consistency with soft textured flakes that are uniformly suspended throughout the product matrix (Pal, 1997).

Paneer is a South Asian variety of soft cheese obtained by acid and heat coagulation of milk. It is a non-fermentative, non-renneted, non-melting and unripened type of cheese. Paneer is used in raw form or in preparation of several varieties of culinary dishes and snacks. The ability of paneer to be deep fried is one feature that has led to its wider acceptance and a favorite for making snacks (Aneja, 2007). Paneer is a rich source of animal protein available at a comparatively lower cost and forms an important source of protein for vegetarians apart from fat, minerals and vitamins. Over and above its high protein content and digestibility, the biological value of protein in paneer ranges from 80 to 86 (Goyal *et al.*, 2007). It has a reasonably good shelf life under refrigeration (Rai, 2014).

Sandesh is a sweet produced in unorganized small-scale sectors wherein variations in quality between batches, days of production and shops were noticed as they do not maintain specific standards (Patil, 2005).

Channa is an acid coagulated product obtained from milk using organic acids such as citric acid, lactic acid at higher temperature with subsequent draining of whey and the mass of curd obtained was called channa. It appears off-white, tastes mildly acidic and has characteristic spongy texture. Channa is mainly prepared from cow milk and used for

preparation of varieties of Bengali sweets like sandesh, rasogolla, chamcham, rasmalai, pantoa and chhana murki. About 6% of the total milk produced in India is used for channa making (Das and Sahu, 2009).

Rosogolla is a famous indigenous dairy based sweet of India popular in West Bengal and Odissa. Traditionally rosogolla is prepared using channa, which is kneaded into smooth paste. It is rolled into small balls of about 6 to 7g each, cooked in boiling sugar syrup with 50 to 55° brix followed by its soaking in sugar syrup at 35 to 40° brix overnight (Karunanithy *et al.*, 2007).

Cream is the fluid milk product rich in fat or emulsified fat in skimmed milk, obtained by physical separation from milk. The various types of creams available in the market are liquid cream, cream packed under pressure, whipped cream, fermented cream and acidified cream (FAO and WHO, 2010h).

Butter is an ancient product produced by preserving milk fat. It has pseudoplastic properties and is manufactured in four varieties with different flavor and taste as sweet cream-unsalted butter; sweet cream-salted butter; cultured-unsalted butter and cultured-salted butter. Butter is a water-in-oil emulsion in which fat globules, fat crystals, water droplets and air bubbles were dispersed. The main factors limiting the keeping quality of butter are microbial deterioration, lipolysis and oxidation. The most commonly used method for production of butter is the churning/agitation method in which cream is converted into butter either in a continuous or batch process. Modified butter products are produced by adding spices, confectionery and nutritionally modified butter is prepared with reduced cholesterol along with increased content of conjugated linoleic acid and omega-3 fatty acids content (Mortensen, 2011).

Sweet cream butter milk (SCBM) is a by-product of butter industry with similar composition and appearance to skimmed milk, but contains most of the milk fat globule membrane that is rich in phospholipids (Kennan and Dylewski, 1995).

Ghee (ghrita) is produced in ancient India as far back as 1500 BC (Achaya, 1997) mainly by indigenous methods with fat-soluble vitamins and essential fatty acids. It is commonly used for culinary purposes but also for particular social functions and

therapeutic purposes (Chand *et al.*, 1986). The characteristic flavour of ghee is due to carbonyls, lactones, free fatty acids and is greatly influenced by the fermentation of the cream or butter and the heating processes. Ghee is fairly shelf-stable for 6-8 months due to low moisture content and possible antioxidative properties (Bekele and Kassaye, 1987). Ghee may contain high amounts of conjugated linoleic acid which has anti-carcinogenic properties. It may contain certain amounts of cholesterol oxidation compounds which may cause adverse health effects (Sserunjogia *et al.*, 1998).

Dulce *de* Leche is a concentrated dairy product with origins in Latin America. It is widely consumed as a dessert and as an ingredient in confectionery mainly in South American countries as a part of the cultural and gastronomic traditions (Zalazar *et al.*, 2011).

Evaporated milk is a traditional product manufactured from fresh milk and recombined with milk powder to milk or fat and consumed by preheating, concentration, homogenization, testing for heat stability, packaging and sterilization. Sweetened condensed milk uses evaporated milk and sugar. Crystallization of lactose, color, flavor and age of gelation determines the overall quality of this product (Nieuwenhuijse, 2016).

Milk in which water is partially removed is called condensed milk. Condensed dairy products are value-added milk products to extended shelf life with the economic advantages of reduced space required for storage and low transportation costs. Condensed milk has been used for various preparations in different parts of the world. These products are used under adverse conditions, such as wars and natural calamities, when fresh milk is not available. They are also suitable for specialty foods designed for people such as sportsmen, convalescents and older individuals (Kalyankar *et al.*, 2016).

Ice creams are combination of milk fat, milk solids-not-fat, sugars, stabilizers, emulsifiers and water. The processing steps include pasteurization, homogenization, ageing of the mix to allow fat crystallization and flavoring with ingredients. The dynamic freezing of the mix under shear with concomitant whipping to  $-5$  to  $-7^{\circ}\text{C}$  that creates microscopically small ice crystals and includes air bubbles to obtain a smooth fat structure network. The freeze concentrated sugars and other solutes were suspended uniformly (Goff, 2015).

## 2.5 Fermented milk products

Fermented milk and milk products occupy an important place in satisfying nutritional requirements of human beings since antiquity. Fermented milk products have been well recognized to have therapeutic, anticholesterolemic and anticarcinogenic properties (Boghra and Mathur, 2000).

Preservation of milk using fermentation with lactic acid bacteria (LAB) is one of the oldest and efficient methods to preserve milk with its valuable nutrients. Increased understanding of human diet and processing technologies has led to the development of products such as acidophilus milk using *Lactobacillus acidophilus* bacteria. This acidophilus milk is generally known as 'probiotic' or nutraceutical food product and its consumption is increasing worldwide (Kongo and Malcata, 2016).

Dahi is considered as the oldest Indian fermented milk product and is equivalent to Western yogurt from which derivatives such as shrikhand (sweetened concentrated curd) and lassi (stirred curd) are derived. The significance of fermented milk products has been established due to its various nutritional and therapeutic properties. Quality dahi is made by acid and flavor producing organisms with two-stage fermentation (Ghatak and Dutta 1998). Application of bio-preservatives and thermization (mild heat-treatment) are recommended to extend shelf-life and improve the market reach (Sarkar, 2008).

Dahi is an indispensable fermented dairy product of diets in Indian subcontinent and about 8% of the total milk produced in India is converted into dahi. Globally it is known as yogurt with local names like leben in Iran, villi in Finland, shosim in Nepal, jugurt in Turkey, roba in Iraq and mazun in Armenia. Dahi is eaten with rice and is used to prepare several culinary dishes. The most popular Indian sweet dishes like shrikhand and lassi are prepared from dahi. Dahi has potential medicinal value and may display several therapeutic benefits, including an alleviation of lactose intolerance, the stabilization of gastrointestinal microbiota, antiallergic and hypocholesterolemic properties (Khedkar *et al.*, 2016).

Buttermilk, a natural fermented product is obtained by churning soured cream and separating butter from it. Standard buttermilk has acidity not less than 0.60% (w/w),

expressed as lactic acid that was fermented by *Lactococcus lactis* or its subspecies and biovariants and/or *Leuconostoc mesenteroides* and its subspecies. Minimum counts of specific culture micro organisms should be  $10^7$  cfu/g at the time of sale (Libudzisz and Stepaniak, 2002).

Lassi, one of the fermented milk products is ideal for serving with hot dishes as it helps the body to digest the spicy food. Lassi is a digestive aid for the afternoon meal and settles the upset stomach as a perfect cooling agent. ‘Chaach’ or ‘Mattha’ is desi buttermilk, which is the byproduct obtained by churning curdled whole milk for the production of desi butter (De, 1997).

Along with all essential nutrients required for growth, development and tissue differentiation, fermented milks contain growth hormones like gastrin and insulin (Arora, 2006). In India, a great variation was reported in technology of lassi preparation as well as the basic ingredients used. Presently, the kinds of lassi available in different markets of India are plain, salted, bhang, amritsari, soya, vanilla, saffron and makhaniya lassis. Lassi also can be prepared using pulp or juice of fruits like mango, passion fruit, pineapple, strawberry and banana or a combination of them (Anonymous, 2006).

Yoghurt and yoghurt-based products are developed and consumed all over the world with different chemical composition, texture formation, incorporation of additives and special cultures. Different varieties of yoghurt have been designed to improve the shelf-life, nutritive and health properties. Attempts have been made to produce yoghurt from plant ‘milks’ like soy, coconut, almond and sesame milk to alter functionality and help people with lactose intolerance (Behare *et al.*, 2016).

Kefir is a traditional fermented milk beverage originated in the Caucasus and has been called the champagne of the dairy world due to its complex flavor and effervescences. The flavor is due to compounds like lactate, acetate, diacetyl and acetaldehyde produced during fermentation. CO<sub>2</sub> is also produced by yeast fermentation which gives kefir its slightly effervescent quality. Kefir is used to treat gastrointestinal problems, hypertension, allergy and ischemic heart disease along with improving lactose digestion (Ratray and O’Connell, 2011).

Shrikhand is a semi-soft, sweetish-sour, whole milk product prepared from lactic fermented curd (Singh *et al.*, 2014). Shrikhand is one of the important fermented milk products which derive its name from the Sanskrit word “Shikharani” meaning a curd prepared with added sugar, flavouring agents like saffron, fruits and nuts. It is popular in western India, especially in Maharashtra, Gujarat and Karnataka. Shrikhand is known for its high nutritive, characteristic flavour, taste, palatable nature and possible therapeutic value. It is very refreshing particularly during summer months and is recommended for people with obesity and cardiovascular diseases as it have low fat content (Swapna and Chavannavar, 2013).

Shrikhand is a popular Indian dessert perceived for its texture, consistency and taste. The shrikhand exhibits a combination of several rheological properties that include weak gel-like viscoelasticity, yield stress, thixotropy and long structural recovery time scales. There were two different microstructures, one composed of crystallites of milk fats with length scale of 50–100  $\mu$  m, and the other composed of aggregates of colloidal casein micelles of 0.5–10  $\mu$  m size. The temperature affected the viscoelastic parameters particularly the semi crystalline milk fat microstructure whereas the shear sensitivity is largely dictated by the protein network (Chandrashekhar *et al.*, 2006).

Shrikhand is served as special delicacy during festivals and ceremonial occasions in northern India. The consumption of shrikhand was reported to be effective in treatment of many diseases like diarrhea, acidity and gastro enteritis (Patel and Schauen, 1997).

Singh *et al.*, (2015) experimented with buffalo milk based shrikhand containing fat levels of 4, 5 and 6% with sugar of 30, 40 and 50% added to it. The sensory evaluation of this developed shrikhand showed that the sample with 6% fat and 40% sugar had the best sensory scores for flavor, texture, sweetness and overall acceptability.

Karche *et al.*, (2015) assessed microbiological quality during storage of shrikhand prepared with 90% cow milk chakka and 10% sapota pulp. Shrikhand was stored at room and refrigeration temperatures for 10 days and the microbial counts were taken on 0, 2, 4, 6, 8 and 10<sup>th</sup> day. On 10<sup>th</sup> day of storage, bacterial count of shrikhand increased from  $14.26 \times 10^3$ /g to  $82.61 \times 10^3$ /g and  $62.03 \times 10^3$ /g at room and refrigeration temperatures respectively. The yeast and mould count increased from  $0.00 \times 10^1$ /g to  $27.25 \times 10^1$ /g and

$4.25 \times 10^1$ /g at room and refrigeration temperature respectively. The blended shrikhand spoiled within 4 days at room temperature whereas it was acceptable up to 8 days when stored at  $4 \pm 1^\circ\text{C}$ .

## 2.6 Value added milk products

Nutritive butter milk was produced by blending with dry drumstick leaves to prevent micro nutrient malnutrition. The dry leaves were incorporated to butter milk at three different concentrations of 1, 2 and 3% with no effect on pH and acidity of the fortified butter milk. Protein and ash content increased from 3.41 to 4.09% and 0.75 to 1.13% which was 20 and 50% higher respectively at 3% level. The overall acceptability score of 3% incorporation was found to be most acceptable (Nadeem *et al.*, 2012).

Zare *et al.*, (2011) experimented on yoghurt supplemented with lentil flour and studied its microbial, physical and sensory properties. Skim milk with 9.5% w/v solid content and 1–3% lentil flour was fermented and stored at  $4^\circ\text{C}$ . Acid production during the fermentation, microbial growth, physical properties like pH, syneresis and color along with sensory properties like flavor, mouth feel and overall acceptability after production were studied for 28 days under refrigerated storage. Milk supplementation with 1–3% lentil flour enhanced acid production during fermentation, but the microbial population (CFU) were in the same range in all lentil flour supplemented yogurts. 1–2% lentil flour supplemented yogurt showed comparable sensory properties with control yoghurt.

Low fat yogurts fortified with 0, 1, 2.5, and 5% of soy protein concentrate were observed through one month storage at  $5^\circ\text{C}$ . Yogurts were adjusted to equivalent total solids with nonfat dried milk. Microbiological count, fermentation time and final developed acidity were not affected by soy protein. Viscosity, thickness, aroma and flavor increased with soy protein concentrate addition significantly ( $p \leq 0.05$ ). Yogurt with 5% soy protein was darker, more chalky and less sweet compared to control yogurt ( $p \leq 0.05$ ). Yogurts with 1 or 2.5% soy protein were most similar to control yogurt (Drake *et al.*, 2000).

Dough, an Iranian fermented and diluted yoghurt drink was carbonated to produce a fizzy variant of the traditional product that improved the mouth-feel of the product.

Similarly sweetened low-fat and flavoured probiotic yoghurt was carbonated and stored upto 45 days at 4°C. This treatment did not affect the sensory properties and consumer acceptability (Wszolek *et al.*, 2006).

Softy ice cream was blended with ginger juice at 1, 2, 3 and 4% levels. Sensory evaluation revealed that the ginger juice can be used to prepare acceptable ice cream. Ice cream prepared with 4% ginger juice had all desired characters of flavour, colour and appearance, body texture and taste with overall acceptability of 8.51 on a 9 point scale. There was significant increase in the melting period of ice cream with the addition of ginger juice and thus improved storage stability (Pawar *et al.*, 2012). Ice-cream fortified with 50% guava pulp showed higher nutrient and acceptable sensory scores than the control ice cream especially of ascorbic content (Hemali and Bijal, 2015).

Soymilk blend was used in the preparation of frozen desserts especially ice cream. Soymilk ice cream was a smooth and soft frozen mixture with components of milk, cream, sweeteners, stabilizers, emulsifiers, flavouring and possibly other ingredients like egg products and coloring agents. The need to reduce the cost of ice cream production lead to soymilk as an alternative choice for making ice cream as it has bioactive molecules also. It contains good amounts of protein, polysaccharides with indigestible fiber, unsaturated fat with lecithin, vitamins, minerals and bioactive organic molecules like polyphenols (Nande, 2013).

Dairy products such as fermented milks are most popular probiotics with live micro organisms that confer health benefits. The most common strains of probiotics bacteria are *Lactobacillus* and *Bifidobacterium* which are tailored into dietary formulations (Ram and Bhavadasan, 2002). The emphasis for prolonged survival of probiotics in the food matrix is the priority and these probiotic bacteria have to remain viable in the food matrix by surviving the harsh conditions with a minimum count of  $10^6$  CFU/g (Kumar and Mishra, 2003). The traditional dairy foods like yoghurt, curd, milk beverages and many more are innovated and manufactured as new probiotic dairy products (Singh, 2001).

## 2.7 Whey powder

Whey was discovered about 3000 years ago. In the late 20<sup>th</sup> century, regulations prevented disposal of untreated whey facilitating the nutritional and functional value of whey components. Modern science has unraveled the secrets of whey proteins (Smithers, 2008). It comprises 80-90% of the total volume of milk with about 50% of the nutrients in the original milk like soluble protein, lactose, vitamins and minerals. It is a by-product obtained from the manufacture of cheese and rennet casein (Fox, 2003).

Whey contains many valuable constituents like  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin, immunoglobulin, bovine serum albumin, lactoferrin and lactoperoxidase. They are widely used as food ingredients in several confectionery, bakery, health and sport supplements as they possess relevant nutritional, functional and biological properties (Brownlow *et al.*, 1997).

Tunick *et al.*, (2016) studied the physical and chemical changes in whey protein concentrate stored at elevated temperature and humidity to provide information on shelf life in hot and humid areas. Whey protein concentrates with 34.9g and 76.8g protein/100g respectively were stored for up to 18 months under ambient conditions, at elevated temperature and relative humidity. The samples became yellower when stored at 35°C and were removed after 12 months due to their unsatisfactory appearance. Decreased lysine content, increased water activity, volatile compound formation and powder caking values were observed. Levels of aerobic mesophilic bacteria, coliforms, yeast and mold were <3.85 log<sub>10</sub> cfu/g in all samples. Relative humidity did not effect the shelf life of most samples.

The off-flavors in whey protein negatively influenced consumer acceptance and use as ingredient in food industry. The clear acidic beverages use whey protein but the acidification in beverage processing enhanced off-flavor production. To overcome this problem, the preacidification of whey proteins to pH 3.5 before spray drying decreased off-flavors as there was a decreased protein interaction with volatile compounds at lower pH (Park *et al.*, 2014).

Chatterjee *et al.*, (2014) studied the incorporation of whey protein hydrolysates due to their bland neutral flavor to a wide variety of food beverages as it helped in increasing the protein content without affecting taste. Jooyandeh and Minhas, (2009) incorporated fermented whey protein concentrate to 15% to milk in the preparation of cheese and this resulted in higher yield and good quality cheese with increased fat and protein content.

Khillari *et al.*, (2007) evaluated the quality of low fat ice cream made by incorporation of whey protein concentrate and showed that the protein content of low fat ice cream increased with increased whey protein concentrate substitution.

## **2.8 Vegetable powder**

Colour plays an important role in visual recognition and assessment of the surface and the subsurface properties of the object. It has a great influence on the appearance, processing and acceptance of food materials (Woolfe, 1979). Consumer interest in natural coloring has also been growing in parallel with their consciousness of food-health relationship (Bayram *et al.*, 2015).

Beet root powder or its pigments are used industrially to improve the red color of foods like tomato pastes, sauces, soups, desserts, jams, jellies, ice creams, sweets and breakfast cereals (Roy *et al.*, 2004 ; Koul *et al.*, 2002). The red beetroot (*Beta vulgaris L.*) is a good source of red and yellow pigments known as betalains. Betalains consist of betacyanins (red) and betaxanthins (yellow). The major betacyanin in beetroot is betanin and accounts for 75–95 % of the red pigment (Chandran *et al.*, 2014).

Beetroots are rich in valuable, active compounds such as carotenoids (Dias *et al.*, 2009), glycine betaine, (de Zwart *et al.*, 2003), saponins (Atamanova *et al.*, 2005), betacyanines, betanin, polyphenols and flavonoids (Vali *et al.*, 2007). They have antimicrobial and antiviral properties and also inhibit the cell proliferation of human tumor cells (Strack *et al.*, 2003).

*MATERIAL*

*&*

*METHODS*

## **CHAPTER III**

# **MATERIAL AND METHODS**

The chapter deals with the details of material used and methods followed for the research topic entitled “Development and evaluation of value added shrikhand”.

The present study was carried out for the preparation of shrikhand, sensory evaluation of the product by incorporating whey protein concentrate and beet root powder, shelf life stability as well as its acceptability by consumers. The work was carried out at the Post Graduate & Research Centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad.

3.1 Procurement of raw material

3.2 Preparation of beet root powder

3.3 Preparation of standard shrikhand

3.4 Process description of shrikhand prepared

3.5 Preparation of whey protein concentrate (WPC) shrikhand

3.6 Value addition to WPC added shrikhand with beet root powder

3.7 Sensory evaluation of value added shrikhand

3.8 Physical properties of value added shrikhand

3.9 Proximate analysis of value added shrikhand

3.10 Microbial analysis of value added shrikhand

3.11 Consumer evaluation studies of the value added shrikhand

3.12 Statistical analysis

### **3.1 Procurement of raw material**

Established brand raw milk and whey protein concentrate were procured from the local markets. All other chemicals used in the investigation were of food and analytical reagent (AR) grade. The glassware and equipment were from PGRC, PJTSAU, Rajendranagar, Hyderabad.

### **3.2 Preparation of beetroot powder**

**3.2.1 Procurement of beet root:** Good quality beetroot was procured from local market in Hyderabad.

**3.2.2 Preparation of beetroot (*Beta vulgaris L.*) powder:** Beetroot (*Beta vulgaris*) was washed in running water twice to remove extraneous material and trimmed with a knife. Beetroot was grated, spread on the trays and dried at temperature of 55°-60°C for about 8-10 hours in a tray dryer. The dried beetroot was powdered in a grinder. The ground material was passed through 60 mesh sieve and the fine powder was packed in dark air tight coloured bottles till further use (Gokhale and Lele, 2011).

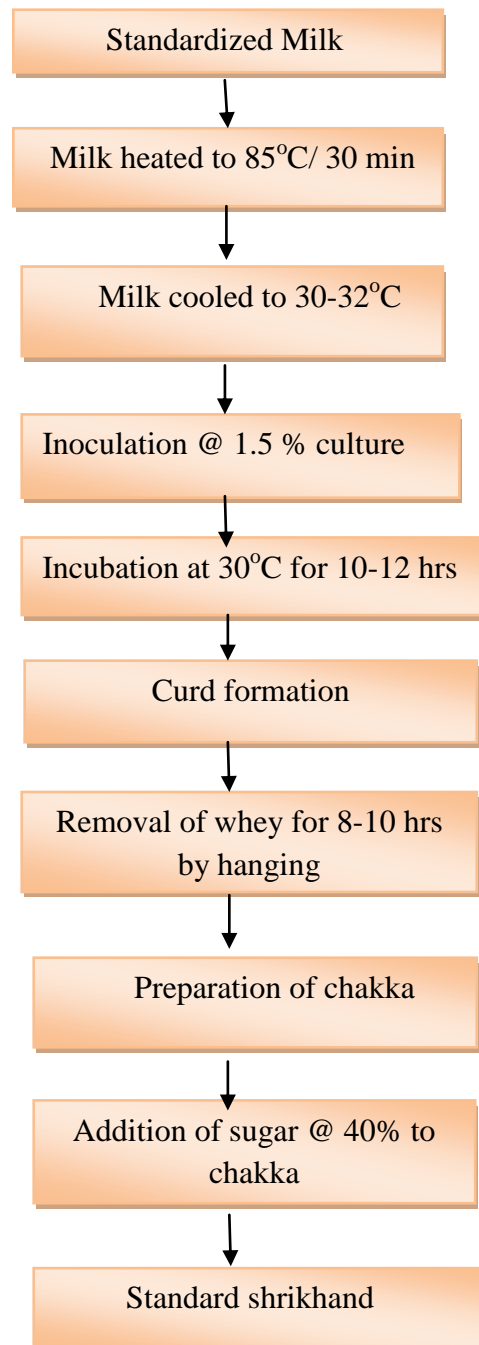
### **3.3 Preparation of standard shrikhand**

**3.3.1 Preparation of curd:** Milk with 4.5% fat and 8.5% SNF was heated to 85°C, cooled to 30-32 °C, inoculated with 1.5 % LAB culture and incubated at 30°C for 4-5 hours so that the curd sets firmly with acidity of 0.7-0.8% lactic acid (Singh *et al.*, 2014).

**3.3.2 Preparation of chakka:** The curd so prepared was broken, placed in a muslin cloth bag and was hung on a peg to remove the whey for 8-10 hours. During this period, the whey was drained from the curd and the chakka obtained was used as the shrikhand base.

**3.3.3 Preparation of shrikhand:** The shrikhand base chakka was taken to which powdered sugar @ 40% was added and shrikhand was prepared (Singh *et al.*, 2015).

### 3.4 Process description of shrikhand prepared



**Figure 3.1 Flow chart for preparation process of standard shrikhand**

### 3.5 Preparation of whey protein concentrate (WPC) incorporated shrikhand

To the prepared shrikhand WPC at 1, 3 and 5% levels by weight was incorporated as shown in Table 3.1. The WPC added shrikhand was subjected to sensory evaluation by 15 semi trained panelists using 9 point hedonic scale. The best accepted formulation was added with beet root powder.

**Table 3.1 Formulations used for incorporation of WPC in shrikhand**

Combinations	Shrikhand (g)	WPC (g)
Control	100.0	–
CW <sub>1</sub>	99.0	1.0
CW <sub>2</sub>	97.0	3.0
CW <sub>3</sub>	95.0	5.0

**Note:** All formulae were repeated three times.

Control: Chakka with 40% powdered sugar

CW<sub>1</sub>: Control with 1% WPC

CW<sub>2</sub>: Control with 3% WPC

CW<sub>3</sub>: Control with 5% WPC

### 3.6 Value addition to WPC added shrikhand with beet root powder

The best accepted WPC added shrikhand was incorporated with beetroot powder at 0.1, 0.3 and 0.5% levels by weight as given in table 3.2. The sensory evaluation was conducted using 9 point hedonic scale by 15 semi trained panelists. The best accepted formulation was selected for further analysis.

**Table 3.2 Beet root powder incorporated WPC shrikhand**

<b>Ingredients</b>	<b>Shrikhand(g)</b>	<b>WPC (g)</b>	<b>Beetroot powder (g)</b>
Control	100.0	–	–
S	97.0	3.0	–
<b>Standard with beet root powder</b>			
SB <sub>1</sub>	96.9	3.0	0.1
SB <sub>2</sub>	96.7	3.0	0.3
SB <sub>3</sub>	96.5	3.0	0.5

**Note:** All formulae were repeated three times.

Control: Chakka with 40% sugar

S: Shrikhand with 3% WPC

SB<sub>1</sub>: S with 0.1% beet root powder

SB<sub>2</sub>: S with 0.3% beet root powder

SB<sub>3</sub>: S with 0.5% beet root powder

### **3.7 Sensory evaluation of shrikhand**

Sensory evaluation of WPC added shrikhand and beetroot powder incorporated WPC shrikhand was evaluated by fifteen semi trained panelists at Post Graduate & Research Centre, PJTSAU, Rajendranagar, Hyderabad. It was done using 9 point hedonic scale and was scored for colour, texture, flavor, taste and overall acceptability. Scores were based on a hedonic rating of 1 to 9 where: ‘1’ is I dislike extremely (very bad) and 9 is I like extremely (excellent) as given by Meilgaard *et al.* (1999). The score card for evaluation of sensory properties of shrikhand was given in Appendix-I.



Plate 3.1 Boiling of milk



Plate 3.2 Curd formation



Plate 3.3 Curd tied in muslin cloth bag



Plate 3.4 Hung curd for draining of whey



Plate 3.5 Chakka



Plate 3.6 Sugar powder



Plate 3.7 Shrikhand



Plate 3.8 Whey protein concentrate



Plate 3.9 Grated beet root



Plate 3.10 Beet root powder



Plate 3.11 Display of value added shrikhand



Plate 3.12 Sensory evaluation by panelist



Plate 3.13 Protein estimation



Plate 3.14 Titration for determination of acidity



Plate 3.15 Microbial analysis

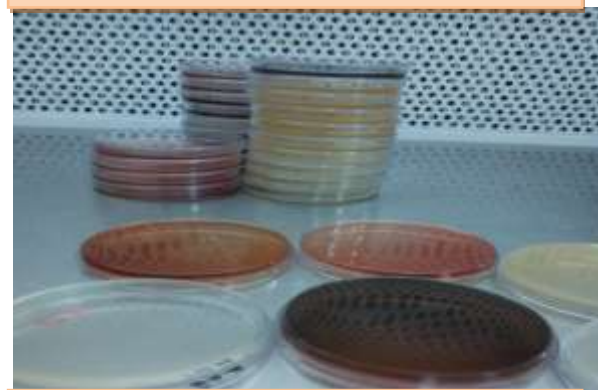


Plate 3.16 Petriplates with agar

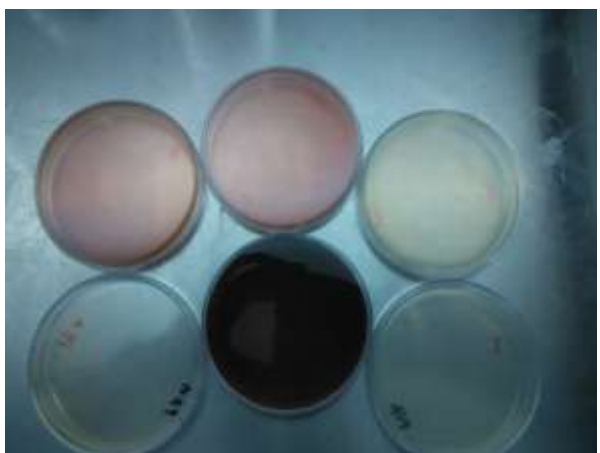


Plate 3.17 Day 0



Plate 3.18 Day 21

### 3.8 Physical properties of shrikhand

**3.8.1 Colour:** Colour quality of the samples was estimated by using Hunter lab calorimeter (Colour Quest XE Hunter Lab, USA). Colour lab scale values (CIE LAB scale) were determined by using hunter calorimeter. L\* indicates lightness and extends from 0.0 (black) to 100.0 (white). The other two coordinates a\* and b\* represent redness (+a\*value) to greenness (-a\*value) and yellowness (+b\*value) to blueness (-b\*value) respectively (Hunter Lab, 2013).

### 3.9 Proximate analysis of shrikhand

**3.9.1 Estimation of moisture:** Moisture and water content are among the most important parameters measured in food as moisture content is inversely related to the dry matter of a food item that has direct economic effect on consumers and processors. More importantly, the moisture content in food also influences its storage stability and quality. Moisture content of the shrikhand was estimated as per (AOAC, 2005) method.

#### Procedure

- The empty petridish with lid was weighed.
- 2.0 g of sample was weighed into the petridish and spread evenly for uniform drying.
- Oven was set at 102 °C and the petridish with sample was placed inside the oven with lid open for 2 hrs.
- After that the petridish was transferred to a dessicator for cooling.
- Then the weight of the petridish with sample was noted.
- This was repeated for all the samples till constant weight was achieved.

#### Calculations

$$\text{Moisture (\%)} = \frac{(W_2 - W_1) - (W_2 - W_3)}{(W_2 - W_1)} \times 100$$

W<sub>1</sub> = Initial weight of petridish (g)

W<sub>2</sub> = Weight of the petridish with sample before drying (g)

W<sub>3</sub> = Weight of the petridish with sample after drying (g)

### 3.9.2 Estimation of ash

**Principle:** Foods and food products were heated to temperatures of 550 – 600 °C where the water and other volatile constituents evolve as vapours. The organic constituents were burned in the presence of oxygen to carbon dioxide and oxides of nitrogen eliminated together with hydrogen as water. The mineral constituents remained in the residue as oxides, sulphates, phosphates and chlorides. This inorganic residue constitutes the ash in food products (AOAC, 2005).

#### Procedure

- The temperature of the muffle furnace was set to 600 °C in which empty crucibles were heated for 1 hr, then cooled in a dessicator and weighed ( $W_1$ ).
- 2.0 g of sample was weighed into the crucible and weight was noted ( $W_2$ ).
- The sample was kept on flame for charring and then incinerated at 600 °C for 3 hrs in muffle furnace.
- After complete ashing of the sample, crucible was transferred into the dessicator, cooled and weighed ( $W_3$ ).
- Incineration was repeated until the difference between two successive weighing is less than 1.0 mg.
- Record the lowest weight.

#### Calculations

$$\text{Ash (\%)} = \frac{\text{Weight of the ash } (W_3 - W_1)}{\text{Weight of the sample taken } (W_2 - W_1)} \times 100$$

where

$W_3 - W_1$  = Weight of the ash

$W_2 - W_1$  = Weight of the sample taken

### 3.9.3 Estimation of protein

The crude protein content of the sample was estimated according to the micro kjeldhal method. The percent nitrogen of product was calculated and multiplied with 6.38 to obtain the protein content (AOAC, 2005).

## Procedure

- Shrikhand sample of 0.5 g was weighed into the digestion tubes and 5.0 g of digestion mixture (98 g of potassium sulphate + 2 g copper sulphate) plus 10.0 ml of concentrated H<sub>2</sub>SO<sub>4</sub> were carefully added. The samples were placed in the digestion unit for 1½ hr at 375 °C.
- In a 100 ml conical flask, 40.0 ml of 4% boric acid was added along with few drops of mixed indicator containing (1.0 ml of 0.2% bromocresol green + 3.0 ml of 0.2% methyl red).
- Distillation was done for 10 minutes in the kjeldhal distillation apparatus adding 10.0 ml of distilled water, 15.0 ml of 40% NaOH and steaming for 10 seconds.
- The contents collected in conical flask were blue in color after distillation was completed.
- Titration was done with standard 0.1 N HCl till the contents of the flask turned to pink colour. A blank was run simultaneously.

## Calculations

$$\text{Protein (\%)} = \frac{(\text{Sample TV} - \text{blank TV}) * 0.014 * 0.1 \text{N of HCl} * 100 * 6.38}{\text{Weight of the sample (g)}} \times 100$$

where

TV= Titration value in ml

\* indicates multiplication

### 3.9.4 Estimation of fat

Fat was extracted with diethyl ether and petroleum benzene using Rose-Gottlieb Method (AOAC, 2000).

## Procedure

- Shrikhand of 10.0 g was weighed into an extraction tube.
- To this 1.25 ml of ammonia (sp. gr. 0.91) was added, mixed and shaken thoroughly.
- Next 25 ml of diethyl ether was added, stoppered and shaken vigorously for about a minute. Later 25 ml petroleum ether was added and shaken again vigorously.
- It was allowed to stand until the upper ethereal layer separated completely and was clear.

- The clear ethereal layer was decanted into a weighed flat bottom container.
- The delivery end of the extraction tube was washed with a little ether and the washings were added to the container.
- The container extractions were repeated twice using 15 ml of each solvent every time. The ethereal extracts were added to the same container and later evaporated off completely.
- The flask was dried in an air oven at  $102 \pm 2^{\circ}\text{C}$  for two hours, cooled in a desiccator and weighed.
- The flask was heated again in the oven for 30 min, cooled in a desiccator and weighed.
- The process of heating, cooling and weighing was repeated until the difference between two successive weights do not exceed 1.0 mg.
- The flask with fat was washed with petroleum ether carefully leaving any insoluble residue in the flask was dried in the oven and reweigh.
- The difference in weights represented the weight of fat extracted from the standardized shrikhand.

### Calculations

$$\text{Fat (\%)} = \frac{\text{Weight of extracted fat (g)}}{\text{Weight of sample taken (g)}} \times 100$$

**3.9.5 Calculation of carbohydrate content:** Carbohydrate content was calculated by subtracting the total of moisture, ash, protein and fat from 100 (AOAC, 2000).

$$\text{Carbohydrate (g)} = 100 - (\text{moisture} + \text{ash} + \text{protein} + \text{fat})$$

**3.9.6 Calculation of energy content:** Energy content was calculated by multiplying protein, fat and carbohydrate values obtained from analysis by 4, 9 and 4 respectively and expressed as Kcal / 100 g (AOAC, 2000).

$$\text{Energy (Kcal)} = (\text{Protein} \times 4) + (\text{Fat} \times 9) + (\text{Carbohydrates} \times 4)$$

### 3.9.7 Determination of titratable acidity

The acidity of the shrikhand was determined by titrating with 0.1N NaOH and adding phenolphthalein indicator to determine the end point (AOAC, 2000).

#### Procedure

- 10.0 g of shrikhand was taken to which 30.0 ml of warm water and 1.0 ml of phenolphthalein indicator were added.
- They were shaken well and titrated with 0.1 N NaOH solution.
- The titration was completed in 20 seconds.
- Keep a blank by taking 10.0g of material diluted with 30 ml of water in another dish for comparison of colour.

#### Calculations

$$\text{Titratable acidity (\% of LA)} = \frac{9 \times A \times N}{W}$$

where

A = Volume of standard NaOH required for titration in ml

N = Normality of standard NaOH solution

W = Weight of the sample taken in g

**3.9.8 Determination of total milk solids:** In cultured dairy products such as dahi, yoghurt or shrikhand, total solids were determined after neutralization the developed acidity with alkali (AOAC, 2005).

#### Procedure

- The empty dish with lid was dried in oven maintained at  $100 \pm 2^\circ\text{C}$  for one hour, cooled in a desiccator and weighed.
- Shrikhand of 5.0 g was weighed, replaced with lid and weighed again.
- 1-2 drops of phenolphthalein indicator was added to the sample in the dish and neutralised with 0.1 N NaOH solution to a faint pink colour.
- The volume of 0.1 N NaOH required to neutralize the sample was noted down.
- The dish without lid was placed on boiling water until the water is removed from the sample.

- The dish was placed in the oven maintained at  $100 \pm 2^\circ\text{C}$ , for 3 hrs for drying.
- The dish was removed along with the lid and cooled in a desiccator and weighed.
- The heating and re-weighing at hourly intervals was carried out until successive weights do not vary by more than 0.5 mg.
- The half weight of the 0.1N sodium hydroxide was deducted from the residue added to neutralize the sample after drying and total solids were calculated.

### Calculations

$$a = \frac{N \times T \cdot V \times 40}{1000 \times 2}$$

$$\text{Total solids (\% w/w)} = \frac{100 \times (W_2 - a)}{W_1}$$

where

N = Normality of NaOH

T. V = Titrate value in ml

$W_2$  = Weight in g of residue left after drying

$W_1$  = Weight in g of the prepared sample taken

a = Half of the volume of 0.1 N Sodium hydroxide added

### 3.9.9 Determination of reducing sugars

The reducing sugars present in the shrikhand were estimated by Fehling's method (AOAC, 2000).

#### Procedure

- 25.0 g of shrikhand sample was weighed and transferred into 250 ml volumetric flask.
- 10.0 ml of neutral lead acetate solution was added to sample, diluted to volume with water and filtered.
- 25.0 ml of the clarified filtrate was taken in a 500 ml volumetric flask containing 100 ml of distilled water.

- Potassium oxalate in small amounts was added until there was no further precipitation and made up to volume.
- This solution was mixed well and filtered through whatman no. 1 filter paper.
- The filtrate was taken into a 50 ml burette.
- For preliminary titration, 5 ml each of Fehling A and B were taken into 250 ml conical flask. 10 ml water was added, mixed well and heated to boiling.
- 3 drops of methylene blue indicator was added and titration was done until the end point of brick-red appeared. The titre volume was noted down.
- For final titration, 5 ml each of Fehling A and B were taken again into 250 ml conical flask. 10 ml sample was added mixed well and heated to boiling.
- 3 drops of methylene blue indicator was added and titration was done until the end point brick-red appeared.
- The volume of glucose run down was noted in ml.

#### **Determination of Fehling factor**

- 4.75 gm of analar grade sucrose was transferred into 500 ml volume flask with 50 ml distilled water.
- 5.0 ml conc. HCl was added and allowed to stand for 24 hours.
- Later it was neutralized with NaOH solution and made upto 500 ml.
- 50 ml of well mixed solution was taken to a 100 ml volumetric flask, made up to volume with water and transferred to a burette.
- The titration of Fehling solution was carried out and the volume rundown was noted.

#### **Calculations**

$$\text{Fehling factor} = \frac{\text{Titrate Value (ml)} \times \text{Weight of sucrose (g)}}{500}$$

$$\text{Reducing sugars (\%)} = \frac{\text{Dilution} \times \text{Fehling factor} \times 100}{\text{Weight of the sample (g)} \times \text{Titrate value (ml)}}$$

### **3.10 Microbial analysis**

Milk and milk products contain about 85-90 % of water and hence the growth of microbes was commonly observed. The standardized shrikhand was estimated for standard plate count (SPC), colliform count, *E.coli*, total bacterial count, total molds count and *Salmonella* species.

**3.10.1 Preparation of plate count agar (PCA) media:** It was prepared by taking 25.5 g of PCA in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and was aseptically poured into sterile petri plates.

**3.10.2 Preparation of MacConkey agar:** MacConkey agar was used for the enumeration of colliform counts in the sample. The media was prepared by taking 51.51 g and dissolved in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and aseptically poured into sterile petri plates.

**3.10.3 Preparation of Sabouraud dextrose agar (SDA):** It was used for the yeast population count from sample. The media of 65.0 g SDA was taken, dissolved in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and aseptically poured into sterile petri plates.

**3.10.4 Preparation of potato dextrose agar (PDA):** Potato dextrose agar medium was used for the enumeration of total fungi/mold population from sample. The media was prepared by taking 39.0 g of PDA and dissolved in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and aseptically poured into sterile petri plates.

**3.10.5 Preparation of *Salmonella* agar media:** Selective *Salmonella* agar base was used for enumeration of *Salmonella spp.* by taking 54.0 g and was dissolved in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and aseptically poured into sterile petri plates.

**3.10.6 Preparation of Eosine methylene blue (EMB) agar:** EMB agar was used for enumeration of *Escherichia coli*. The media was prepared by taking 35.96 g EMB and dissolved in 1.0 l of distilled water and sterilized in an autoclave at 15 psi and 121°C for 15 min. It was cooled to 45-50°C and aseptically poured into sterile petri plates.

### **3.10.7 Sample preparation for microbial analysis**

10.0 g of sample was suspended in 90 ml sterile water in 250 ml flask. It was thoroughly agitated over a shaker for 10 min, 1.0 ml of each of the appropriate dilution ( $10^{-1}$ ) of the sample was plated aseptically and transferred to 9 ml sterile water in a test tube. Dilution process was continued till  $10^{-3}$  dilution was reached. From this dilution, 1.0 ml aliquots were withdrawn and transferred to sterile petriplates. Appropriate medium for different groups of microbes were poured in petriplates and allowed for solidification. The plates were incubated in inverted position at  $31 \pm 2^{\circ}\text{C}$  temperature. The developed bacterial colonies on the plates were counted with the help of Quebec Colony Counter and the population determined was expressed as  $\log_{10} \text{cfu g}^{-1}$ .

### **3.11 Consumer evaluation studies**

The WPC @ 3 % and beet root powder @ 0.5 % added shrikhand was used for consumer evaluation studies. A structured questionnaire was prepared as shown in Appendix II and was given along with the sample to 50 consumers for feedback. The information obtained was summarized to evaluate the acceptance of the value added shrikhand.

### **3.12 Statistical analysis**

All the results will be statistically analyzed to the test significance of the results using percentages, means, standard deviations and co-relation coefficient (Snedecor and Cochran, 1997).

*RESULTS*

*&*

*DISCUSSION*

## Chapter IV

# RESULTS AND DISCUSSION

The present investigation entitled “Development and evaluation of value added shrikhand” was carried at Post Graduate & Research Center, Rajendranagar, Hyderabad. The whey protein concentrate was added for the effective utilization of by product and beetroot powder was incorporated to improve the nutritional quality, appearance and color. This product was evaluated for sensory, nutritional and microbial analysis followed by shelf life studies and consumer evaluation. The results are discussed as follows:

- 4.1 Sensory quality characteristics of shrikhand
- 4.2 Selection of best experimental shrikhand
- 4.3 Physical quality characteristics of value added shrikhand
- 4.4 Nutritional quality characteristics of value added shrikhand
- 4.5 Minor attributes quality characteristics of value added shrikhand
- 4.6 Microbial quality characteristics of value added shrikhand
- 4.7 Storage stability of value added shrikhand
  - 4.7.1 Sensory quality characteristics of value added shrikhand
  - 4.7.2 Nutritional quality characteristics of value added shrikhand
- 4.8 Consumer acceptance of value added shrikhand

### **4.1 Sensory quality characteristics of shrikhand**

Shrikhand is a traditional Indian sweet dish prepared from curd/yogurt. Flavoured shrikhand can be prepared by blending with aromatic fruits which have better aesthetic appeal than the normal product (Parveez, 2015). Shrikhand blended with papaya pulp was studied for quality characteristics (Nigam *et al.*, 2009). Now-a-days shrikhand added with mango commercially called as “amrakhand” was successfully marketed on commercial scale. Because of the change in the economic status and food habit of consumers the fruit shrikhand were in great demand (Mali *et al.*, 2010).

Awareness of the consumers toward health foods, demand for shrikhand with enhanced functional attributes is increasing and the same has encouraged researchers to

develop its variants using several ingredients like ashwagandha (*Withania somnifera*) powder, apple pulp with *celosia* powder, papaya pulp, cocoa powder and papaya pulp, strawberry pulp, mango pulp, walnut powder and probiotics as given in various researches.

Shrikhand prepared by blending orange and sapota pulp was compared with ordinary shrikhand for storage under refrigeration. The shelf life of shrikhand is relatively short at room temperature due to the presence of microflora in the product at the initial stage but improved under refrigeration storage (Chandan and Kilara, 2013; Narayanan and Lingam, 2013).

#### 4.1.1 Sensory evaluation of whey protein concentrate (WPC) incorporated shrikhand:

To improve the sensory and nutritive characteristics of the shrikhand, WPC and beetroot powder were added. The shrikhand prepared using WPC at 1, 3 and 5 % levels was evaluated for sensory qualities like colour, texture, taste, flavor and overall acceptability by 15 semi trained panelists. Each member independently evaluated the shrikhand and assigned score on a 9 point hedonic scale for its sensory attributes. The sensory evaluation results are given in the Table 4.1.

**Table 4.1 Mean sensory scores of control and WPC shrikhand**

Shrikhand	Colour	Texture	Taste	Flavor	Overall acceptability
Control	7.72 <sup>a</sup> ±0.66	7.27 <sup>a</sup> ±0.89	7.05 <sup>a</sup> ±0.99	7.11 <sup>a</sup> ±0.86	7.22 <sup>a</sup> ±0.63
WP <sub>1</sub>	7.61 <sup>a</sup> ±0.46	7.22 <sup>a</sup> ±0.61	7.22 <sup>a</sup> ±0.46	7.22 <sup>a</sup> ±0.70	7.33 <sup>a</sup> ±0.63
WP <sub>2</sub>	7.66 <sup>a</sup> ±0.64	7.44 <sup>a</sup> ±0.76	7.83 <sup>b</sup> ±0.80	7.50 <sup>a</sup> ±0.75	7.88 <sup>b</sup> ±0.61
WP <sub>3</sub>	7.55 <sup>a</sup> ±0.74	7.33 <sup>a</sup> ±0.74	7.55 <sup>ab</sup> ±0.63	7.27 <sup>a</sup> ±0.80	7.39 <sup>a</sup> ±0.65
<b>Mean</b>	7.88	7.56	7.69	7.64	7.71
<b>CD</b>	0.441	0.45	0.518	0.472	0.411
<b>S.E</b>	0.223	0.23	0.261	0.238	0.207
<b>C.V (%)</b>	8.490	9.100	10.197	9.363	8.078

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: Chakka with sugar @ 40%

WP<sub>1</sub>: Control with 1% WPC

WP<sub>2</sub>: Control with 3% WPC

WP<sub>3</sub>: Control with 5% WPC

The mean sensory scores for colour ranged from 7.55 to 7.72, texture 7.22 to 7.44, taste 7.05 to 7.83, flavor 7.11 to 7.50 and overall acceptability from 7.22 to 7.88 for the control and the three experimental samples i.e WP<sub>1</sub>, WP<sub>2</sub> and WP<sub>3</sub> which were incorporated with WPC at 1, 2 and 3% levels respectively.

The colour was one of the important attributes of the sensory quality and the scores of the samples were presented in Table 4.1. The mean sensory score for colour and appearance for the treatments at 1%, 3 % and 5 % WPC showed no significant difference ( $p < 0.05$ ). The 3% WPC sample had highest score of 7.66 and was attractive with uniform smooth surface.

The mean texture scores were 7.22, 7.44 and 7.33 for 1, 3 and 5% WPC incorporated shrikhand. The highest score was found for 3% WPC incorporated sample 7.44 and had most acceptable texture mean score compared to other samples. The flavour was considered as another most important component of sensory quality. The mean scores were 7.22, 7.50 and 7.27 for the three treatment samples which has no significant difference ( $p < 0.05$ ).

The results showed significant difference ( $p < 0.05$ ) for taste when incorporated with WPC at 1, 3 and 5% levels. The mean score of taste for sample with 3% WPC incorporation was rated highest (7.83) when compared to 5 % (7.55) and 1% WPC (7.22) addition. The least mean score for taste was observed for control (7.05) made with chakka and 40% sugar. The increased incorporation of WPC from 3 to 5% resulted in a decrease in the mean sensory scores from 7.83 to 7.55 indicating that the further increased incorporation of WPC showed a gradual decrease in the sensory attributes like taste and texture mean sensory scores from 7.44 to 7.33.

The results of the overall acceptability mean scores of shrikhand prepared by incorporating 3% WPC had the highest score (7.88) than the remaining two samples i.e 5% (7.39) and 1% (7.33) in the hedonic scoring and it differed significantly ( $p < 0.05$ ). Considering the results of the highest scored attributes for color (7.66), texture (7.44), taste (7.83), flavor (7.50) and overall acceptability (7.88) in shrikhand samples, from the Table

4.1 it was concluded that the variation with 3% WPC incorporated shrikhand was rated the best. This sample was further investigated for sensory quality characteristics.

**Table 4.2 Mean sensory evaluation scores of WPC shrikhand incorporated with beet root powder**

<b>Shrikhand</b>	<b>Colour</b>	<b>Texture</b>	<b>Taste</b>	<b>Flavor</b>	<b>Overall acceptability</b>
WP	7.66 <sup>a</sup> ±0.64	7.44 <sup>a</sup> ±0.76	7.83 <sup>a</sup> ±0.80	7.50 <sup>a</sup> ±0.75	7.88 <sup>ab</sup> ±0.61
BP <sub>1</sub>	7.83 <sup>a</sup> ±0.66	7.83 <sup>b</sup> ±0.74	8.11 <sup>b</sup> ±0.77	8.05 <sup>b</sup> ±0.61	7.83 <sup>a</sup> ±0.66
BP <sub>2</sub>	8.33 <sup>b</sup> ±0.61	8.00 <sup>b</sup> ±0.86	8.16 <sup>b</sup> ±0.82	8.16 <sup>b</sup> ±0.69	8.05 <sup>b</sup> ±0.73
BP <sub>3</sub>	8.44 <sup>b</sup> ±0.64	7.94 <sup>b</sup> ±0.55	8.00 <sup>ab</sup> ±0.82	8.16 <sup>b</sup> ±0.58	8.27 <sup>c</sup> ±0.42
<b>Mean</b>	7.88	7.57	7.69	7.64	7.71
<b>SE</b>	0.441	0.45	0.518	0.472	0.411
<b>CD</b>	0.223	0.23	0.261	0.238	0.207
<b>CV (%)</b>	8.49	9.1	10.197	9.363	8.078

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at ( $p \leq 0.05$ ).

WP: Shrikhand with 3% WPC

BP<sub>1</sub>: Shrikhand with 3% WPC + 0.1% beet root powder

BP<sub>2</sub>: Shrikhand with 3% WPC + 0.3% beet root powder

BP<sub>3</sub>: Shrikhand with 3% WPC + 0.5% beet root powder

The 3% WPC shrikhand was incorporated with 0.1, 0.3 and 0.5 % beet root powder. This sample was subjected to sensory evaluation using 9 point hedonic scale by 15 semi trained panelists as given in table 4.2. The mean scores for colour of WPC shrikhand incorporated with beet root powder ranged from 7.66-8.44, for texture from 7.44-8.00, for taste 7.83-8.16, for flavor 7.50-8.16 and for overall acceptability from 7.83-8.27.

Texture is one of the most important properties of food stuff that includes roughness, graininess, stickiness and smoothness. There was a significant difference

between the texture of 3% WPC incorporated shrikhand. The WPC shrikhand incorporated with 0.5% beet root powder had a shiny and smooth texture.

The mean sensory scores for flavor indicated that there was no much difference in 0.3 and 0.5% addition of beet root and the mean score was 8.16. Significant difference in flavor was observed between WP and the three beet root powder added variations 0.1, 0.3 and 0.5%.

Among the tested sample formulations prepared by incorporating beet root powder, the highest scored attributes for color (8.44), flavor (8.16) and overall acceptability (8.27) were for the 0.5% beet root powder incorporated WPC shrikhand.

The taste and texture mean scores were high for 0.3% beet root incorporated shrikhand with sensory scores of 8.16 and 8.00. Considering the overall acceptability among the samples, shrikhand with 0.5% beet root powder had the highest mean sensory score 8.27 followed by 0.3% (8.05), WP (7.88) and the least was for 0.1% beet root powder incorporated shrikhand (7.83) There was a significant difference between the experimental samples ( $p < 0.05$ ) and the control sample.

#### 4.2 Selection of best experimental shrikhand

The sensory scores of control shrikhand with WPC and beet root powder incorporated shrikhand were evaluated for the sensory parameters *viz.* colour, texture, taste, flavor and overall acceptability. The shrikhand with high sensory scores was selected as it was most accepted and was further analyzed for physical, nutritional and microbial parameters.

The shrikhand with 3 % WPC was selected to which 0.5 % beet root powder incorporated was found to be the most accepted product as shown in Table 4.3. The sensory attributes are shown in Figure 4.1.

**Table 4.3 Control and selected value added shrikhand (in 100g)**

S. No.	Product	Shrikhand (g)	WPC (g)	Beet root powder (g)
1.	Control	100.00	-	-
2.	WP <sub>2</sub>	97.0	3.0	-
3.	BP <sub>3</sub>	96.5	3.0	0.5

**Note:** Values are expressed as mean of three determinations.

Control: Chakka with sugar @ 40%

WP<sub>2</sub>: Control with 3% WPC

BP<sub>3</sub>: Control with 3% WPC and 0.5% beet root powder

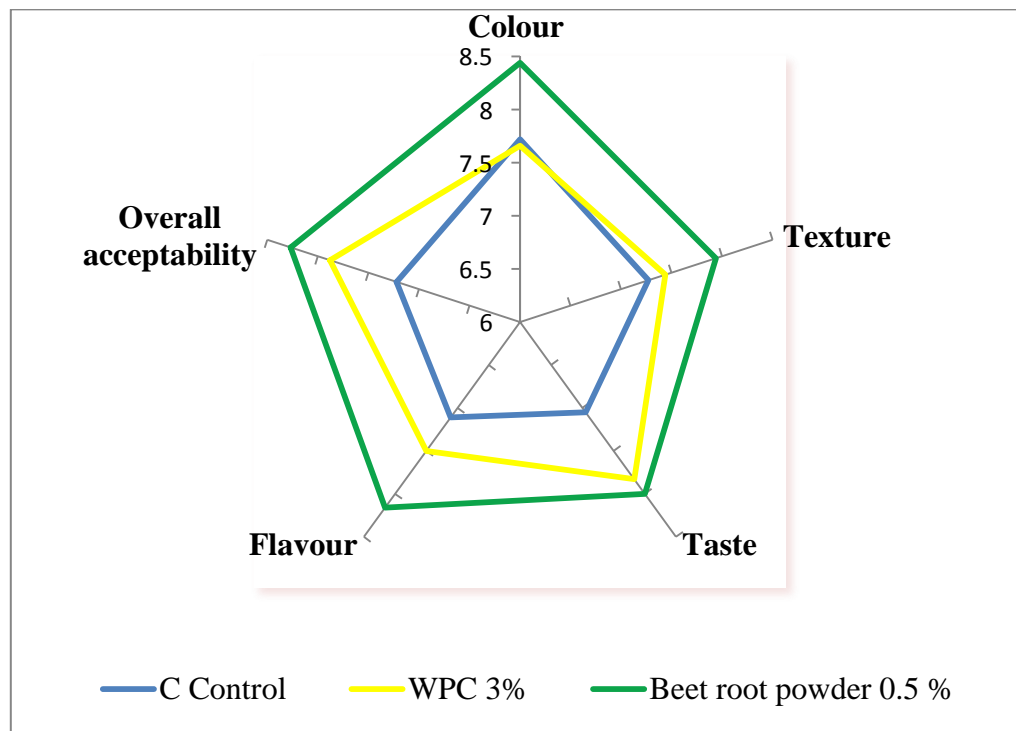


Figure 4.1 Mean sensory scores of control and best selected shrikhand

### 4.3 Physical quality characteristics of value added shrikhand

**4.3.1 Colour scores of shrikhand:** Color scores of the standardized shrikhand were presented as L\*, a\* and b\* values in the Table 4.4. Generally the L\* value ranges from 0 to 100 indicating luminance or lightness component along with two chromatic components, a\* component from green to red and the b\* component from blue to yellow. The L\*a\*b\* units are often used in food research studies to determine the uniform distribution of colors as L\*a\*b\* units are very close to human perception of colour.

The colour of food ingredients is important as it has a bearing on the visual appeal of the product to which they are added (Meena, 2013). The colour of the WPC and beet root powder added to shrikhand was analysed using light yellow in colour. The value added shrikhand was red in color as beetroot contained anthocyanins and other colored

components. The colour values  $\Delta L$ ,  $\Delta a$  and  $\Delta b$  were 46.45 and 62.96; 10.75 and 13.17, 6.16 and 6.99 respectively for control and SWB samples as shown in Table 4.4.

**Table 4.4 Colour analysis of control and value added shrikhand**

<b>Sample</b>	<b><math>\Delta L</math></b>	<b><math>\Delta a</math></b>	<b><math>\Delta b</math></b>
Control	46.45 <sup>a</sup> ±0.92	10.75 <sup>a</sup> ±1.15	6.16 <sup>a</sup> ±0.50
SWB	62.96 <sup>b</sup> ±3.30	13.17 <sup>b</sup> ±1.43	6.99 <sup>b</sup> ±0.38
<b>Mean</b>	54.71	11.96	6.58
<b>S.E</b>	1.71	0.92	0.34
<b>C.D</b>	4.19	2.26	0.82
<b>C.V (%)</b>	4.43	10.90	7.24

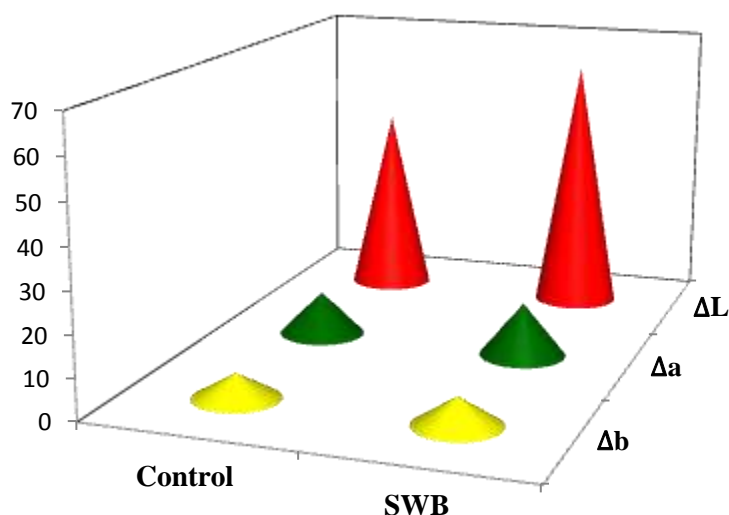
**Note:** Values are expressed as mean  $\pm$  standard deviation of three determinations.

Means within the same column followed by a common letter do not significant differ at  $p \leq 0.05$

Control: Chakka with 40% sugar

SWB: Control with 3 % WPC and 0.5 % beet root powder

The maximum colour change for shrikhand was observed in  $L^*$  value followed by  $a^*$  and  $b^*$  with respect to control sample as shown in Figure 4.2 and was significant at  $p < 0.05$ .



**Figure 4.2 Mean colour scores of incorporated shrikhand**

#### **4.4 Nutritional quality characteristics of value added shrikhand**

The shrikhand samples were analyzed for the proximate properties which included moisture, ash, protein, fat, carbohydrate and energy content presented in Table 4.5.

**4.4.1 Moisture:** The moisture content of control shrikhand was 50.32% and the least was moisture content was observed for value added shrikhand at 48.52%. The value added shrikhand showed 3.57% decrease in moisture content in comparison with control sample and showed significant difference ( $p < 0.05$ ) as the bound water may have been taken by added ingredients.

**4.4.2 Ash:** The ash content was 0.81% and 0.98% for the control and value added products respectively. The results indicated that ash content showed a significant difference ( $p < 0.05$ ) between the products. The ash content of value added shrikhand increased by 21.3% due to incorporation of WPC and beet root powder.

**4.4.3 Fat:** The results obtained showed that the fat content was 7.95% and 8.58% in control and value added product. Significant difference at  $p < 0.05$  was observed in the fat content between the control and the value added shrikhand. An increase of 8% was observed in the value added shrikhand.

**4.4.4 Protein:** The protein content was 8.39% and 8.78% for the control and value added product respectively. Statistically significant difference ( $p < 0.05$ ) was observed in the protein content between the two samples.

**4.4.5 Carbohydrates:** The carbohydrate content was 30.86% for control and 32.22% for sample. There was a significant difference at ( $p < 0.05$ ) between the samples. An increase of 4.4% was observed in the value added shrikhand.

**4.4.6 Energy:** The energy content was 228.60 Kcal/100g for control and 241.27 Kcal/100g for the value added sample. There was a significant difference ( $p < 0.05$ ) between the samples. Addition of WPC and beet root powder showed an increase of 5.5% in the energy content of the value added shrikhand.

**Table 4.5 Proximate composition of major attributes of value added shrikhand**

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrates (%)	Energy (Kcal/100g)
Control	50.32 <sup>b</sup> ±0.01	0.81 <sup>a</sup> ±0.01	7.95 <sup>a</sup> ±0.06	8.39 <sup>a</sup> ±0.01	30.86 <sup>a</sup> ±0.39	228.60 <sup>a</sup> ±1.00
SWB	48.52 <sup>a</sup> ±0.02	0.98 <sup>b</sup> ±0.01	8.58 <sup>b</sup> ±0.07	8.78 <sup>b</sup> ±0.09	32.22 <sup>b</sup> ±0.20	241.28 <sup>a</sup> ±1.20
<b>Mean</b>	49.425	0.896	8.266	8.593	31.542	234.94
<b>CD</b>	0.041	0.024	0.148	0.032	0.712	2.514
<b>S.E</b>	0.011	0.006	0.037	0.008	0.181	0.640
<b>C.V (%)</b>	0.037	1.204	0.790	0.166	0.995	0.472

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: chakka with 40% sugar

SWB: Control + 3% WPC+ 0.5 % beet root powder

#### **4.5 Minor attributes quality characteristics of value added shrikhand**

The minor attributes which may also affect the nutritional properties were titratable acidity, total solids and reducing sugars as shown in Table 4.6.

**4.5.1 Titratable acidity:** The acidity content was 0.82% and 0.88% for the control and value added product respectively. Statistically significant difference ( $p < 0.05$ ) was observed in the acidity content between the control and the experimental shrikhand. There was an increase of 7.3% in the titratable acidity.

**4.5.2 Total solids:** The total solids content was 60.20% and 62.69% for the control and value added product respectively. Statistically significant difference at ( $p < 0.05$ ) was observed in the total solids content between the control and the experimental shrikhand and an increase of 4.1% in the value added shrikhand.

**4.5.3 Reducing sugars:** The reducing sugars content was 2.21% and 2.53% in the control and the sample. Statistically significant difference at ( $p < 0.05$ ) was observed in the reducing sugars content between the control and the experimental shrikhand and an increase of 14.5% in the value added shrikhand.

**Table 4.6 Minor attributes of value added shrikhand**

Sample	Acidity (% L.A)	Total Solids (%)	Reducing sugars (%)
Control	0.82 <sup>a</sup> ±0.01	60.20 <sup>a</sup> ±0.05	2.21 <sup>a</sup> ±0.02
SWB	0.88 <sup>b</sup> ±0.01	62.69 <sup>b</sup> ±0.17	2.53 <sup>b</sup> ±0.04
<b>Mean</b>	0.850	61.451	2.373
<b>CD</b>	0.023	0.287	0.082
<b>S.E</b>	0.006	0.073	0.021
<b>C.V (%)</b>	1.237	0.206	1.539

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: chakka with 40% sugar

SWB: Control + 3% WPC+ 0.5 % beet root powder

#### **4.6 Microbial quality characteristics of value added shrikhand**

This study delineates the production of microbial characteristics, viz., total plate count (TPC), total mold count (TMC), colliform count (CC) and for the presence of *Escherichia coli*. The control and value added shrikhand sample were analyzed on the

basis of their micro organism content viz. TPC, TMC, colliforms and *E.coli* in the products on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage as shown in Table 4.7.

**Table 4.7 Microbial quality characteristics of value added shrikhand**

Treatment	Duration (Days)	TPC (Log cfu/g)	TMC (Log cfu/g)	Colliform (cfu/g)	<i>E.coli</i>
Control	0	1.45 <sup>a</sup> ±0.03	0	ND	ND
	7	1.71 <sup>a</sup> ±0.05	1.25	ND	ND
	15	1.81 <sup>a</sup> ±0.05	3.25	ND	ND
	21	2.16 <sup>a</sup> ±0.03	5.50	3.0	ND
SWB	0	1.55 <sup>b</sup> ±0.64	0	ND	ND
	7	1.80 <sup>b</sup> ±0.64	2.50	ND	ND
	15	3.12 <sup>b</sup> ±0.64	6.25	ND	ND
	21	5.12 <sup>c</sup> ±0.83	9.25	5.0	ND

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

SWB: Control + 3% WPC+ 0.5 % beet root powder

ND: Not detected

**4.6.1 Total Plate Count (TPC):** The initial day TPC was low in both control and value added shrikhand samples but gradually increased over the period of storage. The mean values of TPC were expressed as  $\log \text{cfu g}^{-1}$  showed that number of micro organisms increased during storage days but this increase was not significant ( $p > 0.05$ ).

The mean TPC values for control was  $1.45 \pm 0.03$  and value added shrikhand was  $1.55 \pm 0.64$  on the initial refrigeration period. The mean TPC ranged from 1.45 to 2.16  $\log \text{cfu g}^{-1}$  for control samples and from 1.55 to 5.12  $\log \text{cfu g}^{-1}$  for value added shrikhand with beet root powder. However microbial growth increased by 18%, 25% and 49% for control sample on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> day of storage. Similarly the value added shrikhand had an increase of 16% on 7<sup>th</sup> day, doubled by 15<sup>th</sup> day and increased by 3 times on 21<sup>st</sup> day. Hence the value added shrikhand cannot be stored for that long. One week of storage was most ideal. Apart from this coliforms were not detected in control as well as in the value added shrikhand throughout the refrigeration on 7<sup>th</sup> and 14<sup>th</sup> days of storage period. There was detection of coliforms after 3 weeks in both samples. The results of microbial characteristics revealed that the product can be stored up to three week under refrigeration.

The mean values of TPC with increased during storage under refrigeration in milk nuggets also (Jain, 2003). The dietetic Kashmiri saffron phirne prepared from reconstituted skim milk (Bhat *et al.*, 2010) and shrikhand prepared by incorporating apple pulp (Kumar *et al.*, 2011) also showed an increase in TPC.

TPC in fresh samples that is on day zero and its consistent increase with increase in days of storage is in conformation with the reports of Nadaf *et al.* (2012) in the dairy products described for TPC. The above reports have also stated absence of coliforms in fresh and stored samples, which agreed with our results also.

**4.6.2 Total Mould Count (TMC):** The presence of yeast and molds at storage interval was expressed as  $10^1/\text{gram}$  for both control and value added shrikhand on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days as tabulated in the table 4.7. The yeast and moulds were absent in both samples

on 0<sup>th</sup> day. The yeast and moulds appeared on 7<sup>th</sup> day and gradually increased by 21<sup>st</sup> day of storage for both samples even under refrigeration. On 21<sup>st</sup> day of storage, yeast and moulds count in value added shrikhand increased from 0.00 to  $9.25 \times 10^1$  /gram where as it was  $5.50 \times 10^1$  /gram for control sample at refrigeration temperature. Borate (2011) also observed that the yeast and moulds count increased during storage and the rate of increase was faster at room temperature than under refrigeration. Shubhangi *et al.*, (2010) reported that the yeast and moulds of shrikhand was more as these micro organisms grow at lower pH and water activity created by high sugar concentrations.

According to Prevention of Food Adulteration Act (2009) the TMC should not be more than 50,000/gram for shrikhand. Results of control and value added shrikhand at refrigeration temperature were within the prescribed limits. Presence of congenial condition such as developed acidity and sufficient moisture in shrikhand supported the growth of yeast and mould during storage (Prajapati *et al.*, 1993).

The important factor that affects the presence, survival and growth of unwanted micro organisms in the fermented products was the pH of the product. It was known that low pH favors the growth of yeast and molds (Todar, 2000).

Apart from the TPC and TMC the presence of harmful food pathogen *E. coli* was tested. The absence of this bacteria in both control and value added shrikhand indicated that there was no possible source of contamination during the preparation process and throughout the refrigeration period.

Contamination by disease causing micro organisms can occur at any point in the food-handling sequence. Infections like septic sore throat, scarlet fever and food poisoning has been traced to the consumption of milk products (Yadav *et al.*, 1993). The detection and control of pathogens and food spoilage micro organisms are important aspects to be determined during storage (Fahey *et al.*, 2006).

## **4.7 Storage stability of value added shrikhand**

### **4.7.1 Sensory quality characteristics of value added shrikhand**

Shrikhand possess antibacterial properties against pathogenic as well as spoilage organisms due to high acidity and sugar concentration. The use of sterile packaging material and good storage conditions were required to ensure improved shelf life of shrikhand (Meena, 2013).

The results of the shelf life studies of control and value added shrikhand conducted revealed that with the samples being observed periodically were evaluated for sensory properties on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days. The samples were observed daily for visual differences for the 21 days of storage. The results of the mean sensory evaluation of control and value added shrikhand from initial day were tabulated in the Table 4.8.

**4.7.1.1 Colour:** The colour was one of the important attributes of the sensory quality and the mean sensory scores for color in control was 7.37 on day zero, decreased to 7.25 on day 7, 6.25 on day 15 and 4.37 on day 21 during storage. Similarly mean scores of color for value added shrikhand was maximum on initial days and decreased from 8.12 on initial day to 7.87, 6.87 and 5.12 on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> day respectively. The mean values of color did not differ significantly ( $p \leq 0.05$ ) for control, but differed significantly ( $p \leq 0.05$ ) for value added shrikhand during the storage.

**4.7.1.2 Texture:** The mean scores of texture for control was 7.25 on day zero, gradually decreased to 6.75 on day 7, 5.12 on day 15 and 3.75 on day 21. Similarly mean scores for value added shrikhand too consistently declined during storage. On day zero it was 8.00 and decreased to 7.50, 6.00 and 4.87 on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days respectively.

This may be due to loss of water and hard texture developed which did not give melting feeling in the mouth during sensory evaluation. There was no significant difference ( $p \leq 0.05$ ) among the mean scores of control and value added shrikhand.

**4.7.1.3 Taste:** The mean scores of taste in control was 6.62 on day zero, gradually decreased to 6.12 on 7<sup>th</sup> day, 5.00 on 15<sup>th</sup> day and 3.37 on 21<sup>st</sup> day of storage. Similarly mean scores of taste for value added shrikhand was maximum on the day zero was 7.87 decreased to 7.00, 5.87 and 4.25 on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> day respectively.

During storage acidity of the products increased giving the products sour taste. There was no significant difference ( $p \leq 0.05$ ) among the mean scores for both the samples stored for 21 days.

**4.7.1.4 Flavour:** The flavour mean scores in control was 7.37 on day 0, gradually decreased to 6.12 on day 7 to 4.75 on day 15 and 3.50 on day 21 during storage. Similarly

mean scores of flavor for value added shrikhand was maximum on zero day with 8.25 and decreased to 6.75, 5.50 and 4.25 on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> day respectively. There was no significant difference ( $p \leq 0.05$ ) among the mean scores for control and value added shrikhand during the days of storage.

**4.7.1.5 Overall acceptability** Mean sensory scores of overall acceptability for control was 7.50 on day zero and gradually decreased to 6.62 on day 7, 5.50 on day 15 and 3.62 on day 21 during storage. Similarly mean scores of overall acceptability for value added shrikhand was maximum on the day of storage was 8.25 and decreased to 7.37, 6.25 and 4.62 on 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> day respectively.

The fresh value added shrikhand during storage showed significant decrease in overall acceptability due to the reduction of moisture content which affected the texture and taste. Patel *et al.* (1993) reported that the overall acceptability score decreased with increase in storage period due to the increased acidity, deterioration of flavor and the rancidity of fat.

There was a significant effect ( $p \leq 0.05$ ) due to storage on all the sensory parameters viz. colour, flavor and texture. The same was reported by Kumar *et al.* (2011) who studied the effect of apple pulp on the quality characteristics of shrikhand at various levels of 0, 10, 20 and 30% in the preparation of shrikhand by replacing chakka in the formulation. The mean scores observed for all the sensory parameters decreased significantly ( $p < 0.05$ ) during storage. The product was acceptable for a period of three weeks under refrigerated conditions at  $4 \pm 1^\circ\text{C}$ .

Statistical analysis revealed a significant difference for all the sensory characteristics of control and value added shrikhand during the storage. The declining trend in quality scores for texture was due to the loss of moisture that had inverse correlation with texture (Sonawane *et al.*, 2007).

Some deterioration of the product during storage due to bacterial action was inevitable as the spore-forming bacteria may survive the heat treatment. Shelf life was a major consideration in developing, producing and marketing of food product and refers to the time during which a product remains 'acceptable' to a consumer in terms of sensory characters. Many factors influence the shelf life of the product like moisture loss, spoilage

due to micro organisms, enzymatic changes and the varying conditions from which the product is prepared and stored (Craven *et al.*, 2001).

The product after 24 days of storage became unfit for consumption due to the surface mold growth as observed visually. Mould growth in samples added further discoloration to the samples. Similar results were reported by Sharma and Zariwala, (1980) who evaluated the chemical and bacteriological deteriorations of shrikhand samples during storage at  $10\pm 3^{\circ}\text{C}$  and  $37^{\circ}\text{C}$ .

**Table 4.8 Mean sensory scores of shrikhand during storage**

<b>Treatment</b>	<b>Duration (Days)</b>	<b>Colour</b>	<b>Texture</b>	<b>Taste</b>	<b>Flavor</b>	<b>Overall acceptability</b>
Control	0	7.37 <sup>a</sup> ±0.51	7.25 <sup>a</sup> ±0.70	6.62 <sup>a</sup> ±0.74	7.37 <sup>a</sup> ±0.51	7.50 <sup>a</sup> ±0.53
	7	7.25 <sup>a</sup> ±0.47	6.75 <sup>a</sup> ±0.70	6.12 <sup>a</sup> ±0.83	6.12 <sup>a</sup> ±0.64	6.62 <sup>a</sup> ±0.51
	15	6.25 <sup>a</sup> ±0.46	5.12 <sup>a</sup> ±0.83	5.00 <sup>a</sup> ±0.76	4.75 <sup>a</sup> ±0.46	5.50 <sup>a</sup> ±0.53

	21	4.37 <sup>a</sup> ±0.51	3.75 <sup>a</sup> ±1.03	3.37 <sup>a</sup> ±0.52	3.50 <sup>a</sup> ±0.53	3.62 <sup>a</sup> ±0.91
SWB	0	8.12 <sup>b</sup> ±0.6 4	8.00 <sup>b</sup> ±0.5 3	7.87 <sup>b</sup> ±0.8 3	8.25 <sup>b</sup> ±0.4 6	8.25 <sup>b</sup> ±0.46
	7	7.87 <sup>b</sup> ±0.6 4	7.50 <sup>b</sup> ±0.5 3	7.00 <sup>b</sup> ±0.5 3	6.75 <sup>b</sup> ±0.4 6	7.37 <sup>b</sup> ±0.74
	15	6.87 <sup>b</sup> ±0.6 4	6.00 <sup>b</sup> ±0.7 6	5.87 <sup>b</sup> ±0.6 4	5.50 <sup>b</sup> ±0.5 3	6.25 <sup>b</sup> ±0.70
	21	5.12 <sup>a</sup> ±0.83	4.87 <sup>b</sup> ±0.8 3	4.25 <sup>b</sup> ±0.7 0	4.25 <sup>b</sup> ±0.7 0	4.62 <sup>b</sup> ±0.91
CD value	0	0.625	0.672	0.847	0.526	0.536
	7	0.599	0.672	0.751	0.599	0.687
	15	0.599	0.853	0.751	0.536	0.672
	21	0.750	1.008	0.664	0.672	0.982

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: Chakka + 40% sugar

SWB: Control + 3 % WPC + 0.5 % beet root powder

The investigation focuses on such microbial changes, which are a consequence of unhygienic practices during production, incomplete fermentation and poor storage conditions. Microbial growth involves successive changes with enteric or food related factors causing food poisoning and deterioration of product (Shubhangi *et al.*, 2011).

#### **4.7.2 Nutritional quality characteristics of value added shrikhand during storage**

The shrikhand samples were analyzed during storage for the proximate properties which includes moisture, ash, protein, fat, carbohydrate and energy content presented in Table 4.9 and the percentage change during storage was showed below in figure 4.3.

**4.7.2.1 Moisture:** The mean scores of moisture content in control shrikhand was 50.32, 50.28, 50.22 and 50.13% and for the value added shrikhand was 48.52, 48.45, 48.37 and 47.91% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The moisture content for both control and value added shrikhand was highest on the day 0 and decreased by 21<sup>st</sup> day of storage. The results revealed that there was 0.38% and 1.27% decrease in mean moisture content of control and value added shrikhand respectively during storage. There was a significant difference ( $p < 0.05$ ) in the moisture content as the bound water may have been taken by added ingredients.

**4.7.2.2 Ash:** The mean scores of ash content in control shrikhand was 0.81, 0.77, 0.74 and 0.71% and for the value added shrikhand was 0.98, 0.95, 0.91 and 0.81% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The ash content for both control and value added shrikhand was highest on the day 0 and decreased by 21<sup>st</sup> day of storage. The results revealed that there was 12.3% and 17.6% decrease in mean ash content of control and value added shrikhand respectively during storage. There was a significant difference ( $p < 0.05$ ) in the ash content due to incorporation of WPC and beet root powder.

**4.7.2.3 Fat:** The fat content of control shrikhand was 7.95, 7.81, 7.72 and 7.56% and for the value added shrikhand was 8.58, 8.45, 8.35 and 8.21% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The fat content for both control and value added shrikhand was highest on the day 0 and decreased by 21<sup>st</sup> day of storage. The results revealed that there was 4.9% and 4.3% decrease in mean fat content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the fat content between the samples.

The decline in fat content was faster after 15 days of storage. The product if stored at room temperatures will spoil within 24 hrs and it will become unacceptable. The decrease in fat content was mainly due to metabolic activity of micro organisms during storage and conversion of fat into free fatty acids.

**4.7.2.4 Protein:** The protein content of control shrikhand was 8.39, 8.56, 8.71 and 8.89% and for the value added shrikhand was 8.78, 8.92, 9.15 and 9.30% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The protein content for both control and value added shrikhand was least on the day 0 and increased by 21<sup>st</sup> day of storage. The results revealed

that there was an equal 5.85% increase in mean protein content for control and value added shrikhand during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the protein content between the samples.

**4.7.2.5 Carbohydrates:** The carbohydrate content of control shrikhand was 30.86, 30.25, 30.05 and 29.80% and for the value added shrikhand was 32.22, 31.88, 31.64 and 30.56% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The carbohydrate content for both control and value added shrikhand was highest on the day 0 and decreased by 21<sup>st</sup> day of storage. The results revealed that there was 3.45% and 5.15% decrease in mean carbohydrate content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the carbohydrate content between the samples.

**4.7.2.6 Energy:** The energy content of control shrikhand was 228.60, 226.60, 224.14 and 223.12 Kcal/100 gm and for the value added shrikhand was 241.27, 240.52, 238.49 and 236.63 Kcal/100 gm on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The energy content for both control and value added shrikhand was highest on the day 0 and decreased by 21<sup>st</sup> day of storage. Addition of WPC and beet root powder showed an increase of 5.5% in the energy content of the value added shrikhand when compared to control on day zero. Further the results revealed that there was 2.4% and 1.92% decrease in mean energy content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the energy content between the samples.

**Table 4.9 Proximate composition of major attributes of value added shrikhand during storage**

<b>Treatment</b>	<b>Duration (Days)</b>	<b>Control</b>	<b>SWB</b>	<b>Mean</b>	<b>CD</b>
Moisture (%)	0	50.32 <sup>a</sup> ±0.01	48.52 <sup>b</sup> ±0.02	49.425	0.041
	7	50.28 <sup>a</sup> ±0.01	48.45 <sup>b</sup> ±0.01	49.366	0.030
	15	50.22 <sup>a</sup> ±0.02	48.37 <sup>b</sup> ±0.01	49.300	0.034
	21	50.13 <sup>a</sup> ±0.02	47.91 <sup>b</sup> ±0.02	49.025	0.052
Ash (%)	0	0.81 <sup>a</sup> ±0.01	0.98 <sup>b</sup> ±0.01	0.896	0.024
	7	0.77 <sup>a</sup> ±0.01	0.95 <sup>b</sup> ±0.01	0.865	0.009
	15	0.74 <sup>a</sup> ±0.01	0.91 <sup>b</sup> ±0.01	0.831	0.011
	21	0.71 <sup>a</sup> ±0.01	0.81 <sup>b</sup> ±0.01	0.761	0.022
Fat (%)	0	7.95 <sup>a</sup> ±0.06	8.58 <sup>b</sup> ±0.07	8.266	0.148
	7	7.81 <sup>a</sup> ±0.01	8.45 <sup>b</sup> ±0.03	8.131	0.058
	15	7.72 <sup>a</sup> ±0.02	8.35 <sup>b</sup> ±0.01	8.035	0.045
	21	7.56 <sup>a</sup> ±0.02	8.21 <sup>b</sup> ±0.02	7.888	0.046
Protein (%)	0	8.39 <sup>a</sup> ±0.17	8.78 <sup>b</sup> ±0.01	8.593	0.323
	7	8.56 <sup>a</sup> ±0.01	8.92 <sup>b</sup> ±0.01	8.741	0.292
	15	8.71 <sup>a</sup> ±0.01	9.15 <sup>b</sup> ±0.01	8.935	0.030
	21	8.89 <sup>a</sup> ±0.01	9.30 <sup>b</sup> ±0.01	9.121	0.034
	0	30.86 <sup>a</sup> ±0.39	32.22 <sup>b</sup> ±0.20	31.542	0.712

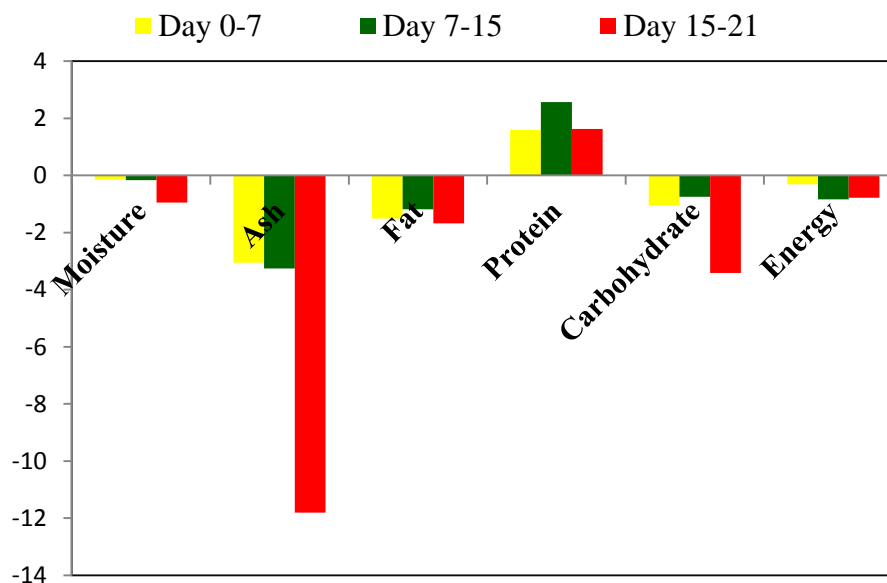
Carbohydrates (%)	7	30.25 <sup>a</sup> ±0.01	31.88 <sup>b</sup> ±0.01	31.069	0.022
	15	30.05 <sup>a</sup> ±0.04	31.64 <sup>b</sup> ±0.01	30.853	0.069
	21	29.80 <sup>a</sup> ±0.02	30.56 <sup>b</sup> ±0.01	30.180	0.047
Energy (Kcal/100g)	0	228.60 <sup>a</sup> ±1.00	241.27 <sup>b</sup> ±1.20	234.942	2.514
	7	226.60 <sup>a</sup> ±0.06	240.52 <sup>b</sup> ±0.03	233.513	0.107
	15	224.14 <sup>a</sup> ±0.01	238.49 <sup>b</sup> ±0.01	231.323	0.035
	21	223.12 <sup>a</sup> ±0.02	236.63 <sup>b</sup> ±0.08	229.871	0.137

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: Chakka with 40% sugar

SWB: Control + 3% WPC+ 0.5 % beet root powder



**Figure 4.3 Percentage change in chemical quality characteristics of value added shrikhand**

#### 4.7.3 Minor attributes in value added shrikhand during storage

The attributes which may also affect the nutritional properties were titratable acidity, total solids and reducing sugars as shown in Table 4.10 and the percentage change during storage was showed below in figure 4.4.

**4.7.3.1 Titratable acidity:** The acidity content of control shrikhand was 0.82, 0.84, 0.88 and 0.92% and for the value added shrikhand was 0.88, 0.92, 0.97 and 1.11% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The acidity content for both control and value added shrikhand was low on the day zero and increased by 21<sup>st</sup> day of storage. The results revealed that there was 12.2% and 26.1% increase in mean acidity content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the acidity content between the samples.

**4.7.3.2 Total solids:** The total solids content of control shrikhand was 60.20, 61.07, 62.11 and 62.60% and for the value added shrikhand was 62.69, 63.11, 63.52 and 64.15% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The total solids content for both control and value added shrikhand was low on the day zero and increased by 21<sup>st</sup> day of storage. Further the results revealed that there was 4.1% and 2.5% increase in mean total solids content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the total solids content between the samples.

**4.7.3.3 Reducing sugars:** The reducing sugars content of control shrikhand was 2.21, 2.33, 2.52 and 2.89% and for the value added shrikhand was 2.53, 2.97, 3.34 and 3.5% on 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage respectively. The reducing sugars content for both control and value added shrikhand was low on the day zero and increased by 21<sup>st</sup> day of storage. The results revealed that there was 30.77% and 38.33% increase in mean reducing sugars content of control and value added shrikhand respectively during storage. Statistically significant difference ( $p < 0.05$ ) was observed in the reducing sugars content between the samples.

**4.7.3.4 Effect of pH:** The pH for control was 5.6, 5.1, 4.7 and 3.9 and value added shrikand was 5.7, 5.3, 4.8 and 4.1 at day 0, 7, 15 and 21 respectively. There was a gradual decrease in pH for sample and control during the storage period indicated that the product had become acidic during storage and the conversion of lactose into lactic acid.

Statistically significant difference ( $p < 0.05$ ) was observed in the pH content between the samples. Similar results were reported by Reddy *et al.* (1984) for shrikhand during storage at  $5 \pm 1^\circ\text{C}$ .

**Table 4.10 Minor attributes of value added shrikhand during storage**

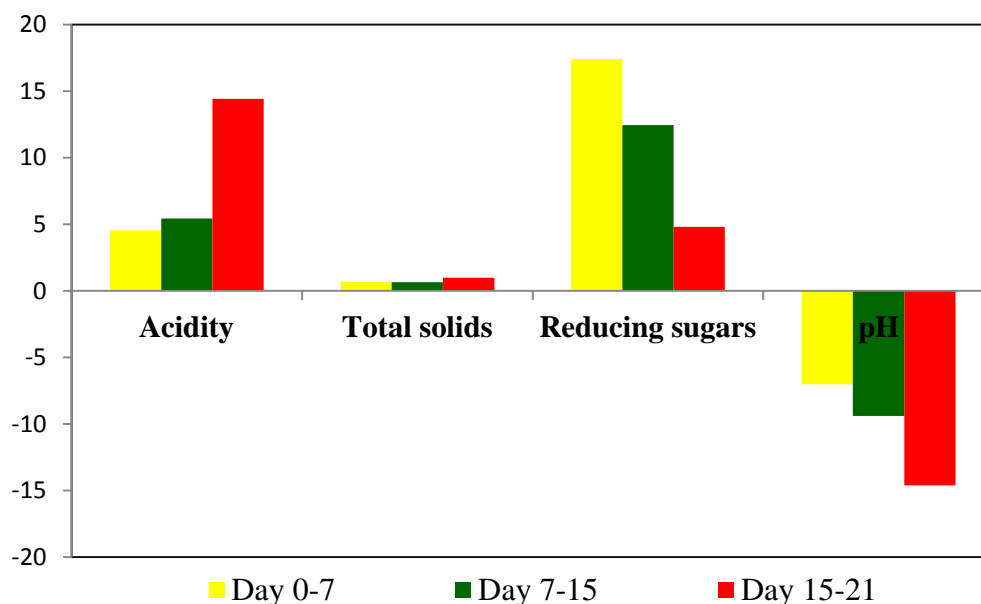
Treatment	Duration (Days)	Control	SWB	Mean	CD
Acidity (%)	0	0.82 <sup>a</sup> ±0.01	0.88 <sup>b</sup> ±0.01	0.850	0.023
	7	0.84 <sup>a</sup> ±0.01	0.92 <sup>b</sup> ±0.01	0.885	0.014
	15	0.88 <sup>a</sup> ±0.01	0.97 <sup>b</sup> ±0.01	0.928	0.018
	21	0.92 <sup>a</sup> ±0.01	1.11 <sup>b</sup> ±0.01	1.016	0.030
Total solids (%)	0	60.20 <sup>a</sup> ±0.05	62.69 <sup>b</sup> ±0.17	61.452	0.287
	7	61.07 <sup>a</sup> ±0.02	63.11 <sup>b</sup> ±0.03	62.093	0.058
	15	62.11 <sup>a</sup> ±0.01	63.52 <sup>b</sup> ±0.01	62.814	0.034
	21	62.60 <sup>a</sup> ±0.01	64.15 <sup>b</sup> ±0.03	63.372	0.050
Reducing sugars (%)	0	2.21 <sup>a</sup> ±0.02	2.53 <sup>b</sup> ±0.04	2.373	0.082
	7	2.33 <sup>a</sup> ±0.01	2.97 <sup>b</sup> ±0.01	2.653	0.034
	15	2.52 <sup>a</sup> ±0.01	3.34 <sup>b</sup> ±0.01	2.934	0.030
	21	2.89 <sup>a</sup> ±0.01	3.50 <sup>b</sup> ±0.01	3.120	0.030
pH	0	5.6 <sup>a</sup> ±0.01	5.7 <sup>b</sup> ±0.01	5.650	0.011
	7	5.1 <sup>a</sup> ±0.01	5.3 <sup>b</sup> ±0.01	5.200	0.013
	15	4.7 <sup>a</sup> ±0.01	4.8 <sup>b</sup> ±0.01	4.750	0.010
	21	3.9 <sup>a</sup> ±0.01	4.1 <sup>b</sup> ±0.01	4.000	0.012

**Note:** Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at  $p \leq 0.05$

Control: Chakka with 40% sugar

SWB: Control + 3% WPC+ 0.5 % beet root powder



**Figure 4.4 Percentage change in acidity, total solids, reducing sugars and pH in value added shrikhand**

The reducing sugar contents in all cases were found to increase with decrease in sucrose levels showing breakdown of sucrose during storage and finally samples became unacceptable for consumption (Sharma *et al.*, 1980).

Similar proportionate increase in reducing sugar during storage for longer period was found by Raghuwanshi *et al.*, (2011) who studied on the effect of source and storage interval on reducing, non-reducing sugar content in shrikhand. The highest residual sugars in P1 x P2 (22.66 %) followed by P2 (22.50 %), P3 (22.50 %), P1 (22.40 %) and the lowest total sugars (%) was found in C (22.27 %). This may be due to sugar utilization by lactic acid bacteria (Osman and Razig, 2010).

Moreover the continued storage of shrikhand at  $5 \pm 1^{\circ} \text{C}$  further revealed that fresh shrikhand was having 2.96% reducing sugar which increased to 3.39% during 5 day storage and finally reached to 4.70% in 35 days storage. This trend did indicate that there was comparatively less reduction in sucrose during short period of storage and substantial decrease was noticed at longer duration storage (Khurana and Kanawjia, 2007).

This gradual increase in titratable acidity with the storage period as reported by (Ghatak and Dutta, 1998) was due to the conversion of lactose into lactic acid and other organic acids by the starter cultures reduced the pH of shrikhand. The lactose content of shrikhand was dependent on the extent of lactose degradation and moisture content of shrikhand (Boghra and Mathur, 2000).

Similar observation were recorded by Rameshwar (2006) that the shrikhand has a typical semi solid consistency showing a characteristic firmness and pliability contributing to its suitability for consumption with puri and bread. Salunke *et al.*, (2006) and Patel and Chakraborty (1985) reported that varying levels of fat, moisture and sugar had the least effect on colour but had a profound effect on flavour, body and textural properties of shrikhand.

Kuttabadkar *et al.*, (2014) studied chemical changes during storage in shrikhand prepared from buffalo milk blended with 50 % safflower milk. The shrikhand contained 8.56 % fat, 5.81 % protein, 0.72 % ash and 58.83 % total solids and 41.17 % moisture. The pH of shrikhand stored at 10 °C was 4.2, 4.1, 3.9 and 3.7 while the acidity was 1.42, 1.58, 1.71 and 1.85 % on day 14<sup>th</sup>, 28<sup>th</sup>, 42<sup>th</sup> and 56<sup>th</sup>, days respectively. The fat content of shrikhand decreased during storage. The decrease in fat content was more at higher temperature of storage. The increase in FFA of shrikhand was faster at higher temperature of storage. The protolytic activity (release of tyrosine) was slower at low temperature and faster at higher temperature.

Stevia powder and extract were used to replace sugar in shrikhand preparation at various concentrations along with control. It was found that shrikhand with 30% substitution with stevia extract and 20% substitution with stevia powder were comparable to control. The storage study revealed that there was an increased microbial load and decrease in fat, protein, ash and moisture content in both the control and experimental sample after 21 days of storage period (Rolly, 2014).

Landge *et al.*, (2011) prepared shrikhand using ashwagandha powder as an additive @ 0.3%, 0.5% and 0.7% level with 40% cane sugar. The samples were stored at 7°C and evaluated for sensory and microbial properties at regular interval. Shrikhand samples under different treatments preserved at 7°C showed decreased microbiological quality during

storage. The treated product was acceptable up to 52 days of storage under refrigerated temperature.

The addition of sugar to shrikhand at levels 30 and 40% and strawberry pulp at 10, 15 and 20% on weight basis of chakka showed a decrease in moisture content during storage period. The acidity of shrikhand increased as pulp level increased when samples were stored at room temperature (Sonawane, 2007).

Narayanan and Lingam, (2013) studied the sensory properties of shrikhand blended with banana pulp at 10, 20 and 30%. Sample with the 20% incorporation of banana pulp showed no significant difference in sensory attributes up to 14 days in comparison with other two samples.

David (2015) prepared herbal shrikhand with basil (*Ocimum basilicum*) by incorporating aqueous basil extract @ 1%, 2%, 3% and 4% and evaluated the various physico-chemical, organoleptic and microbiological parameters. The physico-chemical analysis results showed that treatment of basil @ 4% was best accepted and had maximum moisture, protein, ash content, antioxidant activity and acidity while the control sample had maximum total solids, fat content and pH. Microbial examination of samples at all the stages showed no microbes which indicated proper hygienic conditions were maintained during the preparation and storage of the product.

Chandra and Vinod (2015) optimized process for development of jamun (*Syzygium Cumini L.*) enriched shrikhand. Jamun enriched shrikhand contained 12.78% jamun pulp powder and 30.66% sugar. The jamun pulp powder showed maximum influence on colour, flavour and overall acceptability where as the sugar concentration greatly affected the sweetness, body and texture.

Singh *et al.*, (2014) evaluated microbial content of soy fortified shrikhand containing soymilk of 45% and cane sugar of 30.0%. This sample was considered most suitable formulation for with highly palatability and permissible microbial count.

Nadaf *et al.*, (2012) confirmed that gulkand and rose petal powder can be used as flavoring and coloring agent in shrikhand without adversely affecting the quality of the product. The product made with the addition of gulkand and rose petal powder in

combination of 2:1.5 was selected as optimum on the basis of various sensory parameters and could be stored for 21 days under refrigeration temperature at  $4\pm 1^{\circ}\text{C}$ .

Devshete *et al.*, (2013) prepared omega-3 enriched probiotic shrikhand using walnut powder as it contained omega-3 fatty acids. The walnut powder added at 0%, 5%, 10% and 15% were prepared and shrikhand with 10% walnut powder was most acceptable than remaining treatments.

Kumar *et al.*, (2011) evaluated the effect of apple pulp on the quality characteristics of shrikhand by adding apple pulp viz. 0, 10, 20 and 30% levels. Further the use of dried flower part of '*Celosia argentea*' as a colouring agent in the preparation of the shrikhand was found acceptable. The protein, fat and ash content of the shrikhand decreased significantly ( $p < 0.05$ ) whereas moisture content increased significantly ( $p < 0.05$ ) with increased level of apple pulp. On the basis of various sensory parameters, the product was acceptable for a period of three weeks under refrigerated conditions.

Chandan and Kilara (2013) observed that the shelf life of shrikhand depended largely on its initial microflora and can be preserved up to 40 days under refrigerated condition at  $4^{\circ}\text{C}$ . It can be further extended for 6-12 months, if the product is pasteurized at  $65^{\circ}\text{C}$  for 10 minutes and preserved under deep freezing at  $-18^{\circ}\text{C}$ .

#### 4.8 Consumer acceptance of value added shrikhand

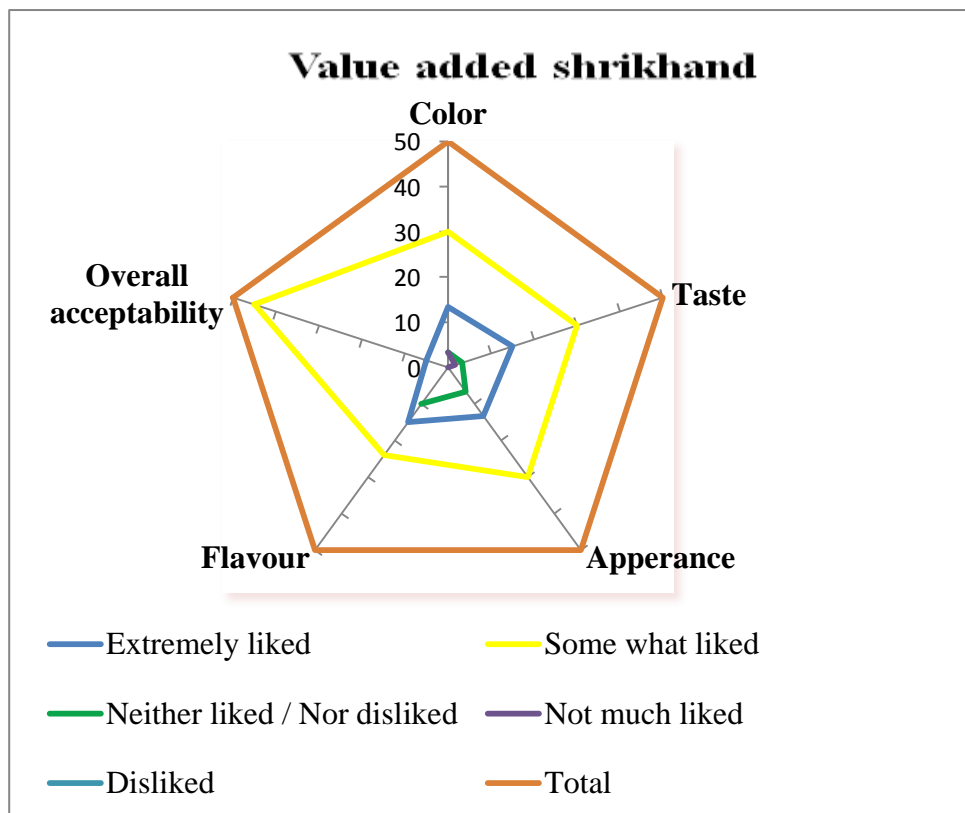
Consumer evaluation studies were carried out using structured questionnaire for 50 persons and the sensory properties were tabulated in Table 4.12 and Figure 4.5.

**Table 4.11 Consumer evaluation scores for value added shrikhand**

Sensory properties	Extremely liked	Some what liked	Neither liked / nor disliked	Not much liked	Disliked
Color	13 (26%)	30 (60%)	4 (8%)	3 (6%)	--
Taste	15 (30%)	30 (60%)	3 (6%)	2 (4%)	--
Apperance	13 (26%)	30 (60%)	7 (14%)	0	--
Flavour	15 (30%)	24 (48%)	10 (20%)	0	1 (2%)

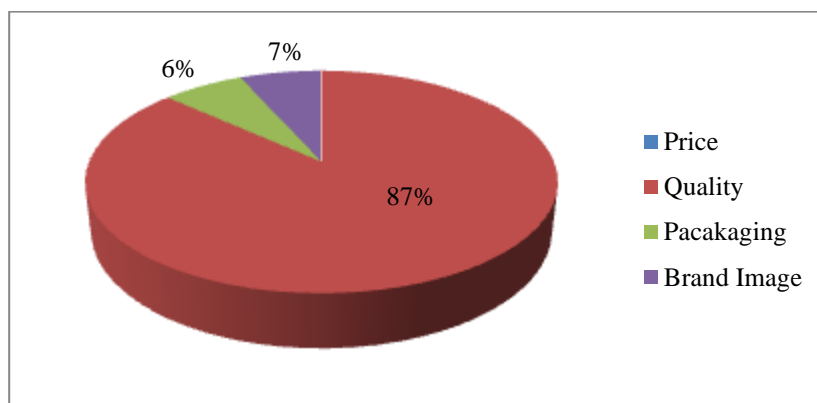
Overall acceptability	5 (10%)	45 (90%)	--	--	--
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Note: Figures in the brackets denotes the percentage value correspondingly to the total 100%



**Figure 4.5 Percentage acceptances of sensory quality characteristics of shrikhnad by consumers**

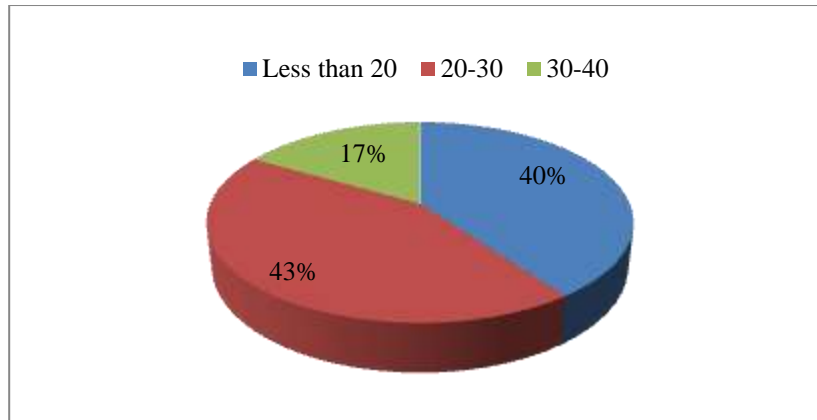
The consumer study showed that 97% of the consumers heard of fermented products and 53% were aware of shrikhand. The value added shrikhand was “somewhat liked” by 60% of consumers for its color, taste and texture whereas 90% of them found it to be acceptable. About 25 to 30 % of consumers “extremely liked” the product for its color, taste and texture but the overall acceptability to only 10% of them. Only one person disliked the product. The reason was that this sweet dish is not frequently consumed in south India. 48% of them neither liked nor disliked the product.



**Figure 4.6 Preferred attributes for purchase of shrikhand**

Next, the other attributes like quality of the product and preferred packaging was evaluated. In this 87 % consumers stressed on the quality product but a meagre 6-7 % preferred packing style and brand image as show in Figure 4.6.

Price was a major deciding factor in buying the non traditional foods. About 43% consumers preferred the price of Rs.20-30, 40% of them preferred it to be less than Rs 20 / with 17% preferring cost above Rs 30/ as shown in Figure 4.7.



**Figure 4.7 Preferred cost of value added shrikhand**

**CONCLUSION:** The present investigation showed that shrikhand incorporated with 3% WPC and 0.5 % beet root powder had best sensory properties viz, colour, appearance, body texture, flavour, taste and overall acceptability. The consumer survey results showed that 50-60% of consumers “somewhat liked” the value added shrikhand. Majority of consumers preferred the price to be less than Rs 30/-.

*SUMMARY*

*&*

*CONCLUSIONS*

## CHAPTER V

### SUMMARY AND CONCLUSIONS

Now-a-days an increased amount of attention is being focused on the development of value added foods with by products that promote well being and improve health. The increasing awareness amongst consumers is placing greater demand on products that offer maximum health benefits.

Milk and milk products are the most commonly produced and consumed throughout the world today as they are readily available for over nine billion people. Milk contains approximately 3.4-8.5% protein, 3.0-6.9% fat, 45.3% available carbohydrates and upto 1% ash. Shrikhand is a traditional fermented dairy product, which is consumed frequently in Maharashtra and Gujarat. It is eaten as either a side-dish with breads or as a dessert in the vegetarian thalis. It is popular as part of wedding feasts, often served chilled with nutritional and health benefits.

Whey, the by-product obtained majorly from the cheese and other allied dairy industries is discarded as a waste product during processing in India. It comprises 80-90% of the total volume of milk entering the cheese production and contains about 50% of the nutrients in the original milk. Demineralised whey powder is made by removing dissolved salts and water. Whey protein concentrate (WPC) is made by ultra filtration of whey to concentrate the proteins into a small volume which are then dried to a soluble powder. It chemically contains about 9% protein, 1.5% fat, 1.5% ash and 3.5% moisture and a pH of 5.9–6.6. WPC products are sold as ingredients to food processing companies that can be added to food products and as it has good shelf life when stored at ambient temperatures.

Whey is widely accepted as food ingredients in confectionery, bakery, health and sport supplement formulations. It possess relevant nutritional (high content of essential amino acids), functional (gelation, foaming and emulsifying agent) and biological (antimicrobial, anticarcinogenic and immunomodulatory) properties for health.

In the present study, pasteurized milk was procured from the local market of Hyderabad. The milk was heated at 85 °C for 30 min and cooled to 32 °C, inoculated with 1-2 % LAB culture and was set aside for curd formation. The firm curd formed was taken

in a muslin cloth and hanged for removal of whey for 8-10 hrs. The chakka thus obtained was added with 40% sugar and kneaded uniformly to obtain shrikhand.

Whey powder concentrate and beetroot were procured from the local market in Hyderabad. The beetroot collected was washed, grated and spread uniformly on the trays, dried at temperature of 60 °C in a tray dryer for 5 hr. The dried powder was sieved and was packed in air tight container till further use.

Whey protein concentrate and beet root powder were incorporated to the shrikhand at different levels. The developed value added shrikhand along with control was subjected to evaluation by semi-trained sensory panel using 9 point hedonic scale. The most accepted value added shrikhand and control sample were analysed for their physical properties, proximate, nutritional quality characteristics, shelf life and consumer acceptance.

#### **The results of the study revealed the following data**

- Control shrikhand added with WPC at three different levels of 1, 3 and 5% were used to select suitable product.
- Based on the sensory evaluation scores of the three variations used, 3% WPC incorporated shrikhand was rated the best. This sample was used along with the control to proceed further with value addition in the investigation.
- Further value addition was done by adding beet root powder at three levels viz. 0.1, 0.3 and 0.5%. The product with 0.5% beet root powder incorporated shrikhand has the best score for sensory parameters.
- Control shrikhand with 3% WPC addition and with 0.5% addition beet root powder had significantly highest rating for colour, flavor, taste, texture and overall acceptability on the 9 point hedonic scale and this was selected for further analysis.
- The maximum  $\Delta L$  value was observed for value added shrikhand and least was for control sample. The control shrikhand was light in colour than the value added product as beetroot contained anthocyanins. The color values for control and value added shrikhand i.e.  $L^*$  value was significantly lower ( $p < 0.05$ ) for control 46.45 compared to the value added shrikhand 62.96. The  $a^*$  and  $b^*$  values were significantly lower ( $p < 0.05$ ) for the control 10.75 and 6.16 compared to the value added shrikhand 6.16 and 6.99 respectively.
- Control shrikhand had significantly higher moisture 50.32% but low protein 8.39%, fat 7.95%, carbohydrate 30.86% and energy content 228.6 Kcal/100g than value added

shrikhand with moisture 48.52%, protein 8.78%, fat 8.58%, carbohydrate 32.22% and energy content 241.27 Kcal/100g.

- The incorporation of WPC and beet root powder increased the ash content by 21.3% in the product in comparison with control. During storage the ash content decreased by 12.3% and 17.6 % for control and value added shrikhand respectively, may be due to loss of moisture content.
- High protein content was seen in value added shrikhand (8.78) and control (8.39) on day zero. The values ranged from 8.78 to 9.30% for value added shrikhand during storage. The increasing order was Day 21 > Day 15 > Day 7 > Day 0 for both the samples.
- The fat content decreased by 4.9% in the control sample and 4.3% in value added shrikhand during the days of storage. It may be due to the conversion of fat into free fatty acids and metabolic activity of micro organisms during storage.
- There was a decreasing trend of sensory scores for color, texture, taste, flavor, and overall acceptability for control value added shrikhand during shelf life study.
- The TPC and TMC were calculated in both the products at regular intervals 0<sup>th</sup>, 7<sup>th</sup>, 15<sup>th</sup> and 21<sup>st</sup> days of storage. The products were microbiologically safe throughout the storage period. On 24<sup>th</sup> day visible surface mould formation was observed in value added shrikhand indicating the spoilage of the product and made it unfit for consumption.
- Statistically significant difference ( $p < 0.05$ ) was observed in all the nutritional quality parameters like moisture, ash, protein, fat, carbohydrate and the energy content in the control sample compared to value added shrikhand.
- The consumer acceptability survey on 50 members revealed that 53% were aware of shrikhand. About 25 to 30 % of consumers “extremely liked” the product for its color, taste and texture. The value added shrikhand was “somewhat liked” by 60% of consumers for its color, taste and texture whereas 90% of them found it to be overall acceptable.
- The other attributes like quality of the product and preferred packaging was evaluated. In this 87 % consumers stressed on the quality product but a meagre 6-7 % preferred packing style and brand image.

- Price was a major deciding factor in buying the non traditional foods. About 43% consumers preferred the price of Rs.20-30, 40% of them preferred it to be less than Rs 20 / with 17% preferring cost above Rs 30/.

The present study conducted is a preliminary step towards assessing the feasibility of utilization of whey and beet root powder in the development of value added shrikhand. It was concluded that the 3% WPC and 0.5 % beet root powder incorporation enhanced the nutritional quality and functional properties of shrikhand. Consumption of this nutrient dense product will not only improve the nutritional status of the population but also improves the health benefits. Hence, a bright future is envisaged for the use of by products in dairy industry.

### **Recommendations for future research**

- Development of faster whey draining techniques.
- Addition of appropriate additives to improve the sensory properties specially texture and colour during storage.
- Consumer acceptance studies of shrikhand incorporated with fruit pulps.
- To develop shrikhand suitable for diabetics by incorporating dry fruits and nuts.

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# *APPENDIX*

## APPENDIX-I

### SENSORY EVALUATION CARD FOR VALUE ADDED SHRIKHAND

Name of the judge: \_\_\_\_\_

Age: \_\_\_\_\_

Sex: Male /Female: \_\_\_\_\_

Date: \_\_\_\_\_

**Directions:** Please taste the samples one by one and evaluate them according to your preference for the attributes color, texture, taste, flavor and overall acceptability by using the nine point scale given below:

**9 Liked extremely**

**4 Disliked slightly**

**8 Liked very much**

**3 Disliked moderately**

**7 Liked moderately**

**2 Disliked very much**

**6 Liked slightly**

**1 Disliked extremely**

**5 Neither Liked nor Disliked**

**Note:** It is very important to rinse mouth thoroughly with clean water after evaluation of each sample.

Attribute Sample	Color	Texture	Taste	Flavor	Overall acceptability

Comments/suggestion: .....

Signature

## Appendix-II

### Questionnaire on Shrikhand

**Name:**

**Mobile:**

**Age:**

**Sex:**

I would be thankful to you if you could please spare your time and provide your valuable feedback/suggestions regarding the product. Please put  wherever applicable.

1. Have you heard of the fermented dairy products?

Yes       No

2. Have you seen/observed any fermented products in the markets? Yes/No.

If “yes” please mention it

1.

2.

3.

3. What are the brands that are selling the fermented dairy products?

1.

2.

3.

4. Which brands do you prefer to buy?

1.

2.

3.

5. Have you heard about “Shrikhand”?

Yes       No

6. If “Yes” what is it made of \_\_\_\_\_

7. Mark your sensory perception about the product shrikhand on a 5-point scale

a) Color ○-----○-----○-----○-----○  
○

Extremely liked    Somewhat Liked    Neutral    Not much liked    Disliked

b) Taste ○-----○-----○-----○-----○

Extremely liked    Somewhat Liked    Neutral    Not much liked    Disliked

c) Appearance ○-----○-----○-----○-----○

Extremely liked    Somewhat Liked    Neutral    Not much liked    Disliked

d) Flavor ○-----○-----○-----○-----○

○

Extremely liked    Somewhat Liked    Neutral    Not much liked    Disliked

e) Overall Acceptability ○-----○-----○-----○-----○

○

Excellent    Good    Neither good/nor bad    Average    Poor

8. How much price would you prefer to pay for 100 gm?

Less than 20  20-30  30-40

9. If this product is available in market, what will you be buying it for?

Price  Quality  Packaging  Brand Image

10. How often will you prefer to buy the product?

Weekly once/twice  Bi-weekly  Monthly  Occasionally

11. Would you like to buy the product if it is readily available in the market?

Yes  No

12. Would you like to recommend this product to your friends or family members?

Yes  No

13. Suggestions, if any \_\_\_\_\_

Place:

Signature

