DEVELOPMENT OF *Aloe vera* GEL SUPPLEMENTED READY TO SERVE FRUIT BEVERAGES

by

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THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"DEVELOPMENT OF *Aloe vera* GEL SUPPLEMENTED READY TO SERVE FRUIT BEVERAGES"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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LIST OF ABBREVATIONS

^0C	Degree Celsius
%	Per cent
mL	Milli litre
CD	Critical difference
Cfu	Colony forming unit
CRD	Completely Randomised Design
CV	Critical Value
et al.	And co-workers
g	Gram
mM	Milli molar
H	Hour
$\mu g\ g^{-1}$	Micro gram per gram
i. e.,	That is
mg	Milligram
mL^{-1}	Per millilitre
NS	Non significant
viz.,	Namely
TSS	Total Soluble Solids
OD	Osmotic Dehydration
SG	Solid gain
WL	Weight loss
WR	Weight reduction
RTS	Ready To Serve

Introduction

1. INTRODUCTION

Advanced research in food technology and nutritional sciences had paved the way for development and marketability of novel food products. Now people are more health conscious and food or beverage which provides extra benefits beyond basic nutrition are preferred (Boghani *et al.*, 2012). Blended beverages are an alternative for the development of novel products which provide benefit of taste, nutrition as well as medicinal properties.

Fruit based beverages are major segment of food industry and are enjoyed by all age groups of the society (Balaswamy *et al.*, 2011). Fruit based beverage is one of the fastest growing categories in national and international market. Consumers increased interest in health and nutrition and also wide range of different juice varieties in market catering for all tastes and needs was responsible for the rise in popularity of fruit beverages (Mintel, 2009). In recent years the fruit juice market has also seen the introduction of more 'functional' fruit juice products with added ingredients. This is one section of the fruit juice market that will increase over the coming years. India can capitalize on consumer's interest in functional food by considering its resources. Introduction of new types of value added beverages might improve socio-economic status of the country (Singh *et al.*, 2004). One of the best and commonly acceptable beverages is Ready to-Serve (RTS) (Tiwari and Deen, 2015).

Recent scientific investigations on medicinal properties of *Aloe vera* made it worldwide novel valuable ingredient for food, cosmetic and pharmaceutical industry. Processing of aloe gel derived from the leaf pulp of the plant, has become a big industry worldwide due to its application in food industry as functional ingredient in food and health drinks and beverages. Aloe gel contains functional polysaccharides like acemannan and pectin which made it as valuable ingredient in food processing and presence of aloin and high moisture limits its use.

Medicinal and therapeutic properties offered by aloe have led to its use for several thousands of years and has been designated as a plant of immortality

(Shubhra *et al.*, 2014). Aloe drinks are gaining popularity internationally due to various health effects offered by aloe and could be used to supplement beneficial attributes and develop nutritionally balanced health products.

Aloe vera has a bitter taste which can be unpleasant in raw state and its palatability could be enhanced with addition of some other fruit juices. Aloe gel contains about 98 per cent water and osmotic dehydration is an energy efficient technique for partial reduction of moisture content and improving palatability. As osmotic dehydration of aloe gel in sugar syrup at constant temperature removes aloin below the maximum level allowed in food while reducing the moisture content, the osmotically dehydrated gel can be recommended as an ingredient in food processing. This offers higher retention of initial food characteristics such as aroma, color, nutritional constituents and flavor compounds (Pisalkar *et al.*, 2014).

Hence the present study has been proposed to optimize the process variables for osmotic dehydration of aloe gel and supplementation of aloe gel in RTS fruit beverages and to evaluate the quality of the product during storage.

Review of Literature

2. REVIEW OF LITERATURE

Development of functional food is an emerging sector of food processing. The growing demand of people shows the necessity of incorporating novel ingredients in commonly consumed foods rather than developing novel new food products (Zakir *et al.*, 2012). People now prefer food or beverage which provides extra benefit beyond basic nutrition as it can reduce the risk of chronic diseases. The use of these value added functional food has been increasing not only because it can keep oneself healthy but also prevents various diseases ranging from heart diseases to cancer. India, as a capitalized country, major researches could be done in this area which can capture consumer's interest in functional food and also resources for these functional beverages are cheaply available (Syed *et al.*, 2010). Fruit beverages are major segment of food industry and are enjoyed by all age groups of the society (Balaswamy *et al.*, 2011). An alternative for development of novel products is blended drinks which provide benefit of taste, nutrition as well as medicinal properties and aloe gel can be used for the formulation of a blended beverage. Thus the present study focused on supplementation of aloe gel in Ready To Serve fruit beverages. This chapter describes the research work done in previous years.

According to Korean Food and Drug administration (KFDA) functional health foods containing aloe when taken orally support immune function. People have become more health conscious and are viewing diet as a component for achieving good health, maintenance and body improvement. Fruit beverages, major segment of food industry, serve as dietary supplement and are rich in vitamins, minerals, vital micronutrients with many potential health benefits. In some beverages, vitamins, especially vitamin C and certain minerals have been fortified to make a balanced drink (Shubhra *et al.*, 2014).

The development of nutritionally value added product could therapeutically help on improving the health of consumers. Introduction of new types of value added beverages might improve socio-economic status of the country also (Singh *et al.*, 2004). Blended drinks are good alternative for development of new products to provide benefit of taste, nutrition as well as medicinal properties (Sasikumar *et al.*, 2013) and Ready to- Serve beverages are one of the best and commonly acceptable beverages (Tiwari and Deen, 2015).

2.1 ALOE VERA AS FUNCTIONAL FOOD

Aloe vera (*Aloe barbadensis* Miller) is a medicinal plant which belongs to Liliacea family. It has been used as traditional contemporary folk remedy (Volger and Ernest, 1999). Out of the 250 species of *Aloe vera*, the most important species of *Aloe vera* are *A. barbadensis* Miller and *A. aborescens* (Valverde *et al.*, 2005).

Aloe vera has been used as a natural product with medicinal and therapeutic properties (Dutt, 2002). Recently *Aloe vera* has been used as an ingredient in food, cosmetic and pharmaceutical industry and used to make cream, lotions, soaps, shampoos, facial cleansers and other products in cosmetic and toiletry industry (Hamman, 2008). Due to its biological activities and functional properties it's been used in food industry as an ingredient for functional foods, development and production of gel-containing health drinks and beverages in food industry (Kojo and Qian, 2010).

Aloe vera plant has stiff, fleshy, grey-green, lance-shaped leaves with serrated edges that arise from a central base and grow to nearly 30-50 cm long and 10cm width at the base (Chandegara and Varshney, 2013). According to Chandegara and Varshney (2013) the three layers of aloe leaves are thick outer rind, jelly like viscous mucilage layer and the fillet, water storage area of the plant which had hexagonal structure containing fillet fluid. They also stated that the two components of fresh aloe leaves are *Aloe vera* sap, the bitter yellow latex is obtained from specialized cells known as pericyclic tubules that occur just beneath the epidermis or rind of the leaves and aloe gel, colourless mucilaginous gel obtained from parenchymatous cells of fresh *Aloe vera* leaves. High concentrations of aloin and similar anthraquinones present in aloe latex exert a powerful laxative action when taken internally and other chemical constituents are Methanol Precipitable Solids (MPS) and polysaccharides (Chandegara and Varshney, 2013).

Aloe vera gel has been increasingly used in the field of health care and cosmetics (Devi and Rao, 2005). Palatability of aloe gel can be increased with addition of some other fruit juices since the bitter taste of *Aloe vera* is unpleasant in raw state (Boghani *et al.*, 2012; Sasikumar *et al.*, 2013). The presence of more than 200 active substances including vitamins, minerals, enzymes, sugars, anthraquinones of phenol compounds, lignin, saponins, sterols, amino acids and salicylic acid were revealed on the phytochemistry of aloe gel (Tiwari and Deen, 2015).

Biologically active chemical constituents of aloe leaves are water and polysaccharides. Aloe gel contains 98.5 percent water with a pH of 4.5 and polysaccharides, glucomannan and acemannan in the active form. Glucomannan is widely used in cosmetic products since it's a good moisturizer (Henry, 1979). The major carbohydrate fraction in the gel is acemannan which helps in wound healing, modulates immune function and had antiviral effects. According to Chandegara and Varshney (2013) microbial decaying of the gel resulted in the loss of biological activity of aloe gel.

2.2 ALOE GEL EXTRACTION

Study conducted by Boghani *et al.* (2012); Sasikumar *et al.* (2013) and Sasikumar (2015a) revealed that maximum gel yield can be obtained from long fully developed *Aloe vera* leaves.

Robert (1997) stated within 36 hour of harvesting of aloe leaf, the filleting operation must be completed to avoid the decomposition of biological activity. To keep all the active ingredients at full concentration, the aloe leaves should be sound, undamaged, disease free and matured (Lawless and Allan, 2000). The gel extracted from the leaf had greater stability than gel left in the leaf (Ramachandra and Rao, 2008; Chandegara and Varshney, 2013).

Differences in leaf structures and gel yield can be attributed to different growing stages and maturity profile of aloe leaves. During the extraction of mucilaginous gel from parenchyma cells of aloe leaf, gel is exposed to air and rapidly get oxidizes, decomposes and looses much of its biological activities due to decomposition by enzymatic reactions as well as growth of bacteria (Ramachandra and Rao, 2008). Biological activity of leaves began to lose after harvest and storage at ambient condition within 24 hours and refrigerated storage helped in reducing the loss (Ramachandra and Rao, 2008; Chandegara and Varshney, 2013).

To avoid the bad flavour and the loss of biological activity of the *Aloe vera* gel, HTST treatment (at 85-95°C for 1-2 min) was reported as an effective method (Eshun, 2003, Ramachandra and Rao, 2008 and Chandegara and Varshney, 2013).

The flavour and stability of unpasteurized aloe gel juice was improved by fortifying with vitamin C and citric acid and also to avoid browning reaction (Eison-Perchonok and Downes, 1982; Kacem *et al.*,1987; Kennedy *et al.*,1992 and Tramell *et al.*,1986). The pH of aloe gel juice was adjusted between 3.0 and 3.5 by adding citric acid to improve the flavour of *Aloe vera* juice (Ramachandra and Rao, 2008; Chandegara and Varshney, (2013).

Preconditioning of aloe leaves can be done by sun drying, shade drying and by steaming in order to get stabilised gel and to maintain purity, precautions should be taken to avoid contamination of gel with exudate secretion (Chandegara and Varshney, 2013). Talib *et al.* (2016) reported that hand filleting of leaves during gel extraction and its value addition can be done for alleviating the bitterness in the gel.

2.2.1 Biochemical Properties of Aloe Gel

The moisture percentage in fresh aloe gel was 97.2 per cent as reported by Goyal and Sharma (2009) and moisture content of 97.34 per cent was recorded by Boghani *et al.* (2012). Sasikumar *et al.* (2013), Sasikumar (2015a) stated that moisture content as 97.6 percent. Elbandy *et al.* (2014) found the moisture percentage in *Aloe vera* gel as 96.31%. According to Shubhra *et al.* (2014) moisture content of blanched aloe gel was 97.10 per cent while for unblanched it was 97.20 per cent. In the study conducted by Talib *et al.* (2016) moisture content of *Aloe vera* gel was found to be 97.86 ± 0.30 per cent.

Total Soluble Solids of aloe juice was reported as 2.1°B (Boghani *et al.*, 2012; Sasikumar *et al.*, 2013 and Sasikumar, 2015a). TSS of *Aloe vera* gel was found to be 3.00 per cent by Elbandy *et al.* (2014). Shubhra *et al.* (2014) found that TSS of blanched and unblanched aloe gel was 2.2 and 2.0^0B respectively. Aloe gel with TSS of 1^0B was found in the study conducted by Talib *et al.* (2016).

pH of aloe gel ranges between 3.5 to 4.7 (Chandegara andVarshney, 2013). In a study conducted by Elbandy *et al.* (2014), pH of *Aloe vera* gel was reported as 4.33 and Sasikumar *et al.* (2013), Sasikumar, (2015a) reported pH as 4.4. Talib *et al.*, (2016) observed aloe gel pH as 4.34.

Studies conducted by Boghani *et al.* (2012), Sasikumar *et al.* (2013) and Sasikumar, (2015a) found that aloe juice was acidic in nature and with 1.2 per cent acidity. Acidity of aloe gel was reported as 0.10 per cent by Elbandy *et al.* (2014) and 1.15 per cent by Talib *et al.* (2016).

Studies conducted by Sasikumar *et al.* (2013) and Sasikumar (2015a) reported ascorbic acid content of aloe gel as 7 mg/ 100 g and Elbandy *et al.* (2014) observed it as 41.4 mg /100g. According to Shubhra *et al.* (2014) ascorbic acid content of blanched aloe gel was 1.7 mg/ 100g while that of unblanched aloe gel was 1.9 mg /100g. Talib *et al.* (2016) reported ascorbic acid content of aloe juice as 1.54mg/100ml.

Polysaccharides present in the aloe gel are the main factor that contributes to the health benefits associated with aloe (Hamman, 2008). Boghani *et al.* (2012) reported that reducing sugar and total sugar content of aloe juice was negligible to quantify. Nejatzadeh-Barandozi and Enferadi (2012) reported that acidic polysaccharides from the aloe juice consisted of glucuronic acid, galactose, glucose, mannose, and xylose with variable proportions. In a study conducted by Shubhra *et al.* (2014) found that blanching had negligible effect on reducing sugar and reported reducing sugar of unblanched and blanched aloe gel as 0.25 per cent (dextrose) and total sugar of blanched and unblanched aloe gel as 0.73 per cent and 0.71 per cent (dextrose) respectively. Sugar analysis of the polysaccharides of aloe gel by chromatography revealed that glucose as the most abundant monosaccharide in the neutral polysaccharides from the aloe gel juice (Vidic *et al.*, 2014). Total, reducing and non-reducing sugars of aloe juice were found to be 0.70, 0.22 and 0.48 per cent respectively by Talib *et al.* (2016).

Ash content of aloe gel was reported as 0.25 per cent by Chandegara and Varshney (2013) and 0.242 per cent by Elbandy *et al.* (2014). Study conducted by Shubhra *et al.* (2014) reported ash content of blanched aloe gel as 0.26 per cent and 0.25 per cent for unblanched aloe gel. According to Talib *et al.* (2016) the ash content of aloe juice was 0.23 per cent.

Crude fibre content of aloe gel was reported as 0.10 per cent by Chandegara and Varshney (2013). Study conducted by Shubhra *et al.* (2014) found blanching had negligible effect on crude fibre content of aloe gel and crude fibre content was reported as 0.26 per cent.

The reducing ability of aloe gel extracts on DPPH radical was reported by Hu *et al.* (2003) and Lopez *et al.* (2013). Antioxidant activity of aloe gel was reported by Hu *et al.* (2005); Beppu *et al.* (2003); Botes *et al.* (2008) and Kumalaingsih and Wijana (2013). Ozsoy *et al.* (2009) reported that IC_{50} values of aqueous extract of aloe gel were higher than those for ascorbic acid and α-tocopherol. Study conducted by Saritha *et al.* (2010) found that methanol extraction of aloe gel reported 93.14 per cent scavenging effect for aloe gel. Maximum DPPH activity for ethanolic and methanolic extracts of aloe gel was reported by Khaing (2011). Vidic *et al.* (2014) stated that the DPPH free radical scavenging activity of aloe gel was evaluated using ethanol solution of the stable free radical, DPPH and also reported that higher the antioxidant activity; lower will be the IC_{50} value. They also reported that the efficiency aloe gel extracts in reducing the concentration of DPPH free radical was lower than quercetin and thymoquinone which are good antioxidants and observed that antioxidant activity (DPPH, IC_{50}) of ultrasound extract of aloe gel as 80.2± 4.2 mg/mL and soxhlet extract of aloe gel as 558.9± 55.2 mg/mL.

Studies conducted by Miladi and Damak (2008) and Kammoun *et al.* (2011) reported that phenol content of water extract of aloe gel was low (2mg(GAE)/g) where as chloroform-ethanol extract was 40 mg(GAE)/g. Phytochemical analysis of aloe gel revealed the presence of alkaloid, carbohydrate, tannin, steroid, triterpenoid (Patel *et al.*, 2012). According to Shubhra *et al.* (2014) total phenol content of unblanched and blanched aloe gel was 23.0 and 21.0 mg/100g respectively and reported that lower total phenol content of blanched aloe gel was due to high instability and oxidation nature of phenolic compounds. Vidic *et al.* (2014) reported phenol content of ultrasound extract of aloe gel as 2.80± 0.07 mg (GAE)/g and soxhlet extract of aloe gel as 2.06± 0.25 mg (GAE)/g.

2.2.2 Physical Properties of Aloe Gel

The viscous pseudo plastic nature of aloe gel was mainly attributed to the presence of polysaccharides composed of mixture of acetylated glucomannans and loss of viscous nature after extraction occur due to enzymatic degradation (Gowda *et al.*, 1979). Chiou (2003) stated that decrease in viscosity of aloe gel was observed with increase in heating time. With increase of time after extraction, viscosity of aloe gel decrease was reported by Chandegara and Varshney (2013). Dynamic viscosity of aloe gel was found to be 35.33± 0.21 cP

(Khatkar, 2013). For better quality product, the viscosity of aloe gel should be higher (Chandegara *et al.*, 2015).

Refractive index is one of the physical properties for determining the purity of aloe gel. The best method for aloe gel extraction is considered as process which yields gel with lowest refractive index (Chandegara and Varshney, 2013) Chandegara and Varshney (2013) reviewed the refractive index of aloe gel as1.3340 to 1.3355 as reported by Aloe CORP and as 1.33789 to 1.34390 reported by M/s Delta International. Chandegara *et al.* (2015) observed that the refractive index of pure aloe gel is near to that of distilled water and more impurities lead to higher refractive index and reported a refractive index of 1.33603 for aloe gel with 1.31^0B.

The physical parameter, optical density indicates the purity and transparency of aloe gel. Wang and Strong (1993) reported the optical density of aloe gel ranged between1.020 to 1.437 and higher optical density relates higher impurity in extracted gel. The best aloe gel extraction process had the gel with lowest optical density (Chandegara and Varshney, 2013). Chandegara *et al.* (2015) observed that with the increase in extraction temperature, optical density of aloe gel increases.

Chandegara and Varshney (2013) reviewed the specific gravity of aloe gel as 1.0030 to 1.0070 reported by Aloe CORP and ranged from 1.0221 to 1.0339 as reported by M/s Delta International.

2.2.3 Sensory Evaluation of Aloe Gel

Steaming of aloe leaves remove residual amount of aloin and reduce bitterness (Chandegara and Varshney, 2013). Sasikumar *et al.* (2013), Elbandy *et al.* (2014), Sasikumar (2015a) and Sasikumar (2015b) reported that sensory analysis of aloe gel incorporated fruit beverages recorded the highest sensory scores and were acceptable.

2.3 OSMO DEHYDRATION OF ALOE GEL

Osmotic dehydration is the incomplete removal of water from fruit as a pre-treatment before further processing or to obtain product of intermediate moisture by means of an osmotic agent (usually either sugar or salt solution) (Torreggiani and Bertolo, 2004 and Pisalkar *et al.*, 2014). One of the best pre-treatment for drying of vegetables and fruits was osmotic dehydration (Beaudry, 2001). It's a low energy consumption method at low temperature which had influenced on the principal drying method and shortened the drying process (Pisalkar *et al.*, 2011 and Pisalkar *et al.*, 2014). Pisalkar *et al.*, (2014) stated that osmotic dehydration provides high retention of colour, aroma, nutritional constituents, and flavour compounds.

Lerici *et al.* (1985), Rastogi and Raghavarao (1997), Erle and Schubert (2001) and Rastogi *et al.* (2004) stated that the process variables of osmotic dehydration *viz.,* pre-treatment, temperature, concentration of the solution, agitation, additives and immersion time had influenced mass transfer and product quality.

The best osmotic substance was sucrose and it acts as a barrier to oxygen and reduced oxidative reactions (Lenart, 1996). Lenart and Cerkowniak (1996) and Singh and Gupta (2007) reported that, a substantial decrease of water removal rates occurs in simple immersion of raw material into an osmotic solution in convective dehydration.

The shelf life quality of the final product is better with osmotic treatment due to increase in the sugar/ acid ratio, improvement in texture and the stability of the colour pigment during storage (Garcia-Segovia *et al.*, 2010). They also stated that on osmo dehydration, bulk flow of solution, water and solute diffusion occur in the intercellular spaces when the broken external cells are occupied by osmotic solution and molecular changes occurred in proteins, sugars or phospholipids.

According to Akbarian *et al.* (2014) osmotic dehydration removes 30 to 70 per cent of water from fruits.

On heating, substances that provide health effects in aloe gel are damaged and spoiled (Eshun and He, 2004). Aloe products have been used in health foods for medicinal and preservative purposes and processing methods such as heating, dehydration and grinding have been used in for making of aloe products. Processing leads to irreversible changes to the polysaccharides and affects its original structure which causes change in the physiological and pharmaceutical properties of these constituents (Ramachandra and Rao, 2008). Literature regarding osmotic dehydration of aloe gel is limited.

2.3.1 Mass Transfer Characters

Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits and vegetables and solid gain and water loss depends on osmotic variables (Chavan, 2012). The increase in kinetic constant with increase in osmotic concentration can be attributed to the enhanced diffusion mechanism and acceleration of water transport (Fito and Chiralt, 1997; Bui *et al.*, 2009).

Water loss was found to increase with increase in temperature and sucrose concentration in osmotic dehydration (Torreggiani, 1993; Raoult-Wack, 1994; Yao and Le Maguer, 1996; Fito and Chiralt, 1997; Spiess and Behsnilian, 1998; Tortoe, 2004; Garcia-Segovia *et al.*, 2010; Pisalkar *et al.*, 2011).

With respect to different sugar syrup concentration, time and temperature had more effect on water loss and solid gain (Sagar and Kumar, 2009). Water loss and solid gain increased linearly with the increase in sucrose concentrations and temperatures of the solution during osmosis (Kumar and Devi, 2011; Sasikumar *et al.*, 2013). Water loss and solid gain rates increased with increase in solute concentrations during prolonged osmotic treatment of cantaloupes (Phisut *et al.*, 2013a and Phisut *et al.*, 2013b). Kedarnath *et al.* (2014a) and Kedarnath *et* *al.* (2014b) reported that on osmotic dehydration process of sapota, mass transfer characters were influenced by syrup concentration, temperature and duration of osmosis and with increase in syrup concentration and temperature solid gain and water loss increased. Khanom (2014) reported that water loss, solid gain, weight reduction and TSS during osmotic dehydration of pineapple slices increased with increase in concentration. Pedapathi and Tiwari (2014) reported increase in solid gain, water loss, weight reduction with increase in the osmotic concentration.

Study on the kinetics of the hot-air drying of aloe gel and influence of temperature on the kinetic parameters was done by Vega *et al.* (2007). Effect of temperature on rehydration kinetics of rehydrated aloe slabs was studied by Vega-Galveza *et al.* (2009). Study conducted by Garcia-Segovia *et al.* (2010) reported that among the peeled and unpeeled aloe slices of 15 mm thickness and 50 mm length, peeled samples showed highest water loss during osmotic dehydration and kinetic constant was not affected by temperature and high kinetic values were recorded for unpeeled aloe slices. Pisalkar *et al.* (2011) reported that aloe gel at low concentration and low temperature (30°B and 30°C) gave lower water loss (63.1% after 4 h of osmosis) and high temperature and concentration condition (50°C–50°B) gave higher water loss (71.3% after 4 h of osmosis) during osmotic dehydration.

The concentration gradient between the solution and intracellular fluid is the driving force for water removal (Chavan *et al.*, 2010). The final composition, sensorial quality and stability of the osmo dehydrated product are affected by the mass transfer characters; water loss and sugar gain and highest sugar gain for osmo dehydration of aloe slices was recorded for treatment with 50^0B and sugar gain velocity decreased with increase in osmotic concentration (Garcia-Segovia *et al.*, 2010). Solid gain was found to increase with the increase in sugar concentration and rate of water loss increased initially and decreased gradually with increase in time (Pisalkar *et al.*, 2011). Isurini *et al.* (2014) reported that osmo dehydration of aloe gel in 50°B at 40°C removed the aloin content below the maximum level approved in food and reduced the moisture content by 26.4 per cent.

2.3.2 Biochemical Properties

According to Geetha *et al.* (2006) moisture content of osmosed aonla decreased with the increase in sugar syrup concentration and temperature. Sagar and Kumar (2009) reported that moisture content of the product on osmosis decrease linearly with increase in sugar concentration up to 60 per cent during osmotic dehydration of mango slices. About 30 to 70 per cent water was removed on osmotic dehydration of fruits (Akbarian *et al.*, 2014).

Femenia *et al.* (1999) and Chang *et al.* (2006) reported that moisture content of aloe gel decreased on drying and percentage of decrease increased with temperature and drying time. Miranda *et al.* (2009) studied the effect of air temperature on the biochemical properties and antioxidant capacity of aloe gel and found that it decreased with increase in air temperature. Isurini *et al.* (2014) reported a moisture content of 72.3 per cent for osmo dehydrated aloe gel cubes in 50^0B sugar at 40°C for 4 h. Sasikumar (2015a) reported that chances of spoilage increase with the increase in moisture content of aloe gel.

Study conducted by Geetha *et al.* (2006) on osmotic concentration kinetics of aonla preserve reported that total sugar and TSS increased with the increase in sugar syrup concentration and temperature. Dionello *et al.* (2009) reported that TSS of pineapple slices increased about three times on osmotic dehydration. Isurini *et al.* (2014) reported a TSS of 25.2^0 B for osmo dehydrated aloe gel cubes in 50^0B sugar at 40°C for 4 h.

Eshun and He (2004) and Miranda *et al.* (2009) reported that no variations in pH were observed on drying of aloe gel. Sapata *et al.* (2009) reported that osmotic dehydration did not influence the pH. Fasogbon *et al.* (2013) observed decrease in pH of osmo dehydrated pineapple slices. pH of osmo dehydrated cantaloupes slightly increased when compared with fresh sample (Phisut *et al.*, 2013a and Phisut *et al.*, 2013b).

Total titratable acidity decreased with pre-treatment time in apricot cubes in sucrose (Riva *et al.*, 2005). Variation in percentage acidity from 0.037± 0.007 to 0.065 ±0.002 g malic acid /100g during drying of aloe gel was reported by Hernandez *et al.*(2006) and Miranda *et al.* (2009). Sagar and Kumar (2009) reported that with increase in sugar concentration, acidity of osmo dehydrated mango slices decreased due to leaching of acid from fruits to the osmotic solution through a semi- permeable membrane. During osmotic process increase in product saltiness or sweetness decreases the acidity (Tortoe, 2010). Phisut *et al.* (2013a) and Phisut *et al.* (2013b) reported that total acidity of osmo dehydrated cantaloupes decreased when compared with fresh sample.

Azoubel and Murr (2003) found loss in ascorbic acid during osmotic dehydration of kiwi fruits which might be due to leaching of vitamin into the osmotic solution. Ascorbic acid intake increased with the pre-treatment time (Riva *et al.*, 2005). Sagar and Kumar (2009) stated that decrease in ascorbic acid during osmosis is due to thermal degradation and the loss was less for with high sugar concentration and low temperature where sugar acted as a protective layer. Ascorbic acid content of cantaloupes decreased on osmotic dehydration (Phisut *et al.*, 2013a and Phisut *et al.*, 2013b). With the increase in processing time, osmotic concentration and temperature ascorbic acid content decreased for osmodehydrated apples (Devic *et al.*, 2010).

Madamba and Lopez (2002) found increase in reducing sugar and total sugar on osmo dehydrated mango slices with increase in osmtic concentration. Elbeltagy *et al.* (2008) reported that during osmo-air dehydration of strawberries reducing sugar and total sugar at 65^0 B was higher than that of in 50^0 B and 45 ^{0}B. Shedame *et al.* (2008) reported total, reducing and non-reducing sugar increased with increase in syrup concentration, temperature of solution and time of immersion on osmotic dehydration of grapes. Reducing sugar and total sugar were found higher in osmosed mango slices than fresh slices due to more penetration of sugars during osmosis (Sagar and Kumar, 2009).

Drying of aloe gel at higher temperature caused reduction in antioxidant activity was reported by Miranda *et al.* (2009). Antioxidant activity and phenolic content of osmo dehydrated cantaloupes decreased when compared with fresh sample (Phisut *et al.*, 2013a and Phisut *et al.*, 2013b). Osmotic treatment caused significant losses in the antioxidant activity and total phenolic compounds of osmo dehydrated blue berries (Giovanelli *et al.*, 2013).

2.3.3 Physical Properties

As the refractive index of aloe gel increases purity decreases (Chandegara and Varshney, 2013). Chandegara *et al.* (2015) stated that with the increase in temperature refractive index of aloe gel increases. Lowest optical density indicates the purity of aloe gel (Chandegara and Varshney, 2013). Chandegara *et al.* (2015) stated that with the increase in temperature optical density of aloe gel increases. The specific gravity of aloe gel was reviewed by Chandegara and Varshney (2013) as 1.0030 to 1.0070 reported by Aloe CORP and 1.0221 to 1.0339 as reported by M/s Delta International.

2.3.4 Sensory Qualities

Femenia *et al.* (2003); Hawlader *et al.* (2006); Miranda *et al.* (2009) reported that during drying of aloe gel amount of colour variation increased with increase in drying temperature which might be mainly due to the effect of temperature on heat sensitive compounds present in aloe. Garcia-Segovia *et al.* (2010) reported that water loss and solid gain during osmotic dehydration affect not only the final composition but also the sensory quality and stability of aloe gel.

Krokida *et al.* (2000) stated that osmotic dehydration promotes stabilization of colour parameters, reduce non-enzymatic browning reactions and improves fruit product colour. Chavan *et al.* (2010) found that highest score for all sensory attributes like colour, appearance, flavour, texture, taste and, overall acceptability was recorded for osmo dehydrated banana slices at high sugar concentration and duration. Colour of the pineapple slices was negatively affected by high temperature and concentration (Kumar and Devi, 2011). Nadia *et al.* (2013) reported color parameter increased significantly along the osmotic process of pear fruits. Kedarnath *et al.* (2014a) reported that sapota slices immersed in osmotic solution of 50 ^{0}B for 1 h recorded good sensory attributes. Kumar and Sagar (2014) found that sensory scores with respect to colour, taste , flavour and overall acceptability of osmo dehydrated mango, guava and aonla segments in sugar concentration (60°B) followed by vacuum drying were superior.

2.4. FORMULATION OF RTS AND ITS STORAGE

2.4.1 Formulation of RTS Beverages

Beverages made from fruits and vegetables are important in human diet and are an excellent medium for the supplementation of neutraceutical components for enrichment (Sheela and Sruthi, 2014). The blending technology has become an important tool in modern fruit beverage processing and ready to serve (RTS) beverages are popular among people of all age groups (Bhagwan and Awadhesh, 2014).

2.4.1.1 Biochemical Properties

Biochemical properties play an important role in nutritional and sensory qualities of RTS beverage. Addition of aloe juice with bael juice increased the TSS content of blended RTS beverages from 14.10 to 14.25^0 B (Sunita and Ananya, 2013). Aloe gel supplemented mango nectar showed slight increase of Total Soluble Solids (TSS) 15.0 per cent to 15.4 per cent on 25 per cent aloe gel supplementation in comparison to control (without aloe gel) (Elbandy *et al.*, 2014). Hamid *et al.* (2014) reported increase in TSS of aloe gel supplemented orange-carrot blend nectar. TSS of kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice was observed as 15^0 B (Shubhra *et al.*, 2014). Sasikumar (2015b) reported that TSS increased from 12.30 to 16.37^0 B in blended beverage with aloe and bael fruit juice (60:40) when compared with control aloe juice as control. Talib *et al.* (2016) reported aloe juice supplemented pear fruit RTS beverage showed a slight decrease in TSS with 10 per cent supplementation and TSS increased with addition of 20 and 30 per cent aloe juice.

Sunita and Ananya (2013) reported pH of aloe juice supplemented in bael juice at 5, 10and 15 per cent was recorded as 5.1, 4.27 and 4.65 respectively. Slight decrease in pH values (3.76 to 3.57) was observed when aloe gel was added in mango nectar (Elbandy *et al.*, 2014). Hamid *et al.* (2014) reported that aloe gel supplemented orange- carrot nectar recorded slight decrease in pH. Sasikumar (2015b) reported decrease in pH values from 4.71 to 4.35 in blended RTS beverage with 60 per cent aloe and bael fruit juice as compared to aloe juice alone.

Elbandy *et al.* (2014) found that total acidity slightly increased from 0.41 per cent to 0.44 per cent in mango nectar with 25 per cent aloe gel supplementation as compared to without supplementation of aloe gel. Hamid *et al.* (2014) reported supplementation of aloe gel in orange-carrot blend nectar increased the total acidity of the nectar. Sasikumar (2015b) reported increase in acidity from 0.861 to 0.992 per cent in blended beverage with 60 per cent aloe and bael fruit juice as compared to aloe juice.

The ascorbic acid content increased from 41.4 to 43.7 mg/100 g as a result of 25 per cent aloe gel addition in mango nectar in comparison to without aloe supplementation (Elbandy *et al.*, 2014). Hamid *et al.* (2014) reported no noticeable change in ascorbic acid on supplementation of aloe gel in orange-carrot blend nectar. Study conducted by Shubhra *et al.* (2014) found that ascorbic acid content of kinnow nectar supplemented with 4 per cent blanched (2.52 mg/100g) and unblanched aloe juice (2.53 mg/100g) was higher than that of control (2.50 mg/100g). Increase in ascorbic acid from 10.21 to 18.34 mg/100 mL of juice was observed for blended RTS beverage with 60 per cent aloe gel supplementation in bael fruit juice (Sasikumar, 2015b).

Elbandy *et al.* (2014) stated that the addition of 25 per cent aloe gel in mango nectar resulted in increase of total sugar (14.08 to 14.12 per cent) and reducing sugar (2.52 to 2.55 per cent). Hamid *et al.* (2014) reported supplementation of aloe gel in orange-carrot blend nectar increased the reducing sugar but decreased total sugar and non- reducing sugar of the blend nectar. In a study conducted by Shubhra *et al.* (2014), reducing sugar and total sugar content of kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice was more than control sample of without aloe juice. Sasikumar (2015b) reported increase in reducing sugar from 6.93 to 11.21 per cent and total sugar from 7.53 to 12.32 per cent in blended beverage with 60 per cent aloe juice supplementation in bael juice.

Chauhan *et al.* (2012) reported that antioxidant activity of RTS beverage increased with the addition of 6 per cent basil and 1.5 per cent *tinospora* extract. Srividya and Ramachandran (2012) stated that antioxidant activity increased with the addition of spice extracts. Hamid *et al.* (2014) reported that antioxidant activity of orange- carrot blend nectars supplemented with aloe gel increased when compared with control. Studies conducted by Hridyani (2015) and Hridyani and Soni (2016) reported that antioxidant activity of juice blend increased with the addition of basil. Sukapriya and Krishnaprabha (2015) found increased antioxidant activity of gooseberry incorporated watermelon RTS.

Hamid *et al.* (2014) reported that total phenolic content of orange- carrot blend nectars supplemented with aloe gel increased as compared to control. Shubhra *et al.* (2014) reported that total phenol content of kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice was higher than that without aloe gel supplementation.

Study conducted by Shubhra *et al.* (2014) found that supplementation of 4 per cent aloe juice in kinnow nectar have considerable improvement in crude fibre content. Hamid *et al.* (2014) reported crude fibre of orange-carrot nectar increased with increase of amount of aloe gel supplementation.

2.4.1.2 Sensory Evaluation of formulated RTS

Boghani *et al.*, (2012) stated that with the increase in concentration of aloe juice up to the level of 10 per cent in papaya juice, appearance, taste and overall acceptability of beverage improved while further increase in aloe juice content reduced the appearance, taste and overall acceptability of the juice. They reported that colour score decreased gradually with increase in concentration of aloe juice incorporation in papaya juice and control sample secured maximum score for colour. They also found that flavour profile of papaya juice with aloe juice 5 per cent and 10 per cent found to be superior to that of control sample due to improvement mouth feel while further increase resulted in decrease of flavour.

Sasikumar (2015b) reported that blended functional beverages scored higher for appearance than control and 60 per cent aloe supplemented bael juice recorded the highest score for appearance. He also reported that colour, taste, flavour and overall acceptability score increased for blended beverages of aloe and bael fruit juice with 60 per cent supplementation recorded the highest score for colour, taste flavour and overall acceptability.

According to Sasikumar *et al.* (2013) with increase in concentration of aloe gel up to the level of 70 per cent improved appearance, colour, taste, flavour and overall acceptability of aonla ginger RTS beverage. Hamid *et al.* (2014) reported that aloe vera gel could be supplemented up to 40 per cent in orange-carrot blended nectar without affecting the overall acceptability. Highest overall acceptability score was observed for unblanched aloe juice (4 per cent) supplemented in kinnow (Shubhra *et al.*, 2014). Sasikumar (2015a) reported that appearance, colour, taste, flavour and overall acceptability of beverage scored highest with decrease in concentration of aloe gel and increase of aonla fruit juice in aloe-aonla blended beverage.

In the study conducted by Talib *et al.* (2016) pear juice without aloe supplementation recorded the highest score for colour. They also reported that highest sensory scores for flavour, taste, appearance and overall acceptability were observed for pear juice with 20 per cent aloe supplementation.

2.4.2 Storage of RTS Formulation

2.4.2.1 Biochemical Properties

Chauhan *et al.* (2012) reported that functional herbal RTS beverage showed negligible change in TSS throughout two months storage. Elbandy *et al.* (2014) found TSS of aloe gel added mango nectar increase and it can be due to conversion of non-soluble pectin into soluble phase. Sasikumar, (2015b) found minimum increase (12.30^{o} B to 14.94^{o} B) in TSS for aloe juice alone where as blended beverages showed an increasing trend. Tiwari and Deen (2015) reported gradual increase in TSS after one month of storage of bael – aloe RTS beverage from 12.00^{0} B to 12.60^{0}B. Hridyani (2015) and Hridyani and Soni (2016) stated that TSS of RTS beverage made from traditional medicinal plants increased during storage. Gradual increase in TSS during storage can be attributed to the conversion of polysaccharides into monosaccharide and oligosaccharides and other constituents of juice into sugar (Jakhar and Pathak, 2012; Singh and Kumar, 1995; Sasikumar, 2015a, Tiwari and Deen, 2015; Talib *et al.*, 2016).

pH and acidity are inversely proportional to each other and pH of beverage decreased and acidity increased during storage as reported by Pawar *et al.* (2011); Sasikumar (2015a); Sasikumar (2015b). Elbandy *et al.* (2014) observed slight increase in acidity of mango nectar during storage which might be due to fermentation. Hamid *et al.* (2014) reported increase in acidity of aloe gel supplemented orange-carrot blend nectar during three months storage. Sasikumar (2015b) found that increase in acidity during storage was due to the addition of citric acid into the functional beverages and reported higher acidity in aloe juice blended bael fruit juice than aloe juice alone during storage. In a study conducted by Tiwari and Deen (2015) reported gradual increase in total acidity of RTS from 0.25 per cent to 0.30 per cent during storage. Talib *et al.* (2016) reported that acidity will be more in RTS with high aloe content and bacterial spoilage also caused increase in acidity.

Girdharilal (1988) and Yadav *et al.* (2010) had found that changes in chemical properties are the reason for variations in pH during storage of RTS beverage. The increase in acidity was the reason for decrease in pH which affects the organoleptic quality of juice (Sasikumar *et al.*, 2013).

Nagpal and Rajalakshi (2009) reported that during storage ascorbic acid content of the juice decreases due to the oxidation of ascorbic acid which is being sensitive to oxygen, light and heat by both enzymatic and non-enzymatic catalyst. Gradual reduction in ascorbic acid content was observed during storage of aloe blended mango nectar which might be due to was due to oxidation effect (Elbandy *et al.*, 2014). According to Shubhra *et al.* (2014) losses of vitamin during storage can be attributed to the effect of light, interaction with metallic ions and prevailing high room temperature conditions and observed significant decrease in ascorbic acid content from 2.5 to 0.5 mg per cent both in blanched and unblanched aloe juice supplemented kinnow nectar at the end of of storage period of 6 months at ambient conditions. A better retention of ascorbic acid by aloe juice supplemented kinnow nectar compared to the control sample was reported and might be due to the antioxidant properties of phenolic compounds present in aloe juice (Zheng and Wang, 2001). Losses of ascorbic acid during storage were attributed to direct influence of temperature and light exposure on ascorbic acid which leads to oxidation of ascorbic acid to dehydroascorbic acid (Shubhra *et al.*, 2014; Tiwari and Deen, 2015). Sasikumar (2015b) found that on blending aloe juice and bael juice maximum ascorbic acid (18.34 mg/100 ml juice) was recorded in 60 per cent aloe juice supplemented blended beverage. Study conducted by Tiwari and Deen (2015) found that throughout the storage period of bael- aloe RTS beverage decrease in vitamin C content was observed from 2.38 mg/100g to 1.93 mg/100g at the end of storage. Talib *et al.* (2016) reported that during storage ascorbic acid content of aloe based RTS beverage decrease over 90 days period and the loss was more in high aloe contained RTS but replacement of 20 percent juice with aloe provided a shelf life of 60 days.

Hamid *et al.* (2014) reported increase in reducing and total sugar of aloe gel supplemented orange- carrot blend nectar during three months storage. Elbandy *et al.* (2014) reported that sugar content of mango nectar increased during storage due to inversion of sucrose into glucose and fructose under acidic condition of nectar. According to Sasikumar (2015b), during storage period reducing sugar of functional beverages showed a significant increase from initial 11.21 to 15.8 per cent for the blended beverage of aloe and bael fruit. Gradual increase in reducing sugar during the advancement of storage can be attributed to the hydrolysis of non reducing sugar and also due to inversion of sucrose into glucose and fructose by the acid in the beverage (Mishra and Chopra, 2006; Wisal *et al.*, 2013; Sasikumar, 2015b; Tiwari and Deen, 2015). In the study of Tiwari and Deen (2015) increase in reducing sugar from 2.30 per cent to 5.29 per cent and total sugar from 10.21 per cent to 11.12 per cent was observed during the entire period of storage of bael- aloe RTS beverage for 3 months. The apparent increase in total sugar content during storage of fruit beverages can be attributed to the hydrolysis of polysaccharides in to monosaccharide and oligosaccharides (Sasikumar, 2015b; Tiwari and Deen, 2015). Sasikumar (2015b) observed minimum increase (12.32 to 17.44%) of total sugar in 60 per cent aloe supplemented bael fruit beverage and increase in total sugar was due to the higher metabolic rate of juice and slowdown of microbial growth by 60 per cent aloe juice blended beverage.

Klimczak *et al.* (2007) reported that increase in the antioxidant activity during storage can be attributed to Maillard's reaction products. Morales-de la Pena *et al.* (2011) reported that increase in the antioxidant activity during storage is due to the polymerization reactions of polyphenols. Gao and Rupasinghe

(2012) reported antioxidant activity of apple carrot juice blends decreased during storage. Chauhan *et al.* (2012) found decrease in antioxidant activity of the RTS beverages with basil and *tinospora* extract during storage. Saberian *et al.* (2013) reported that DPPH inhibition percent of aloe juice increased significantly during storage for 30 days at 25^0C compared to storage at 4^0C. Hamid *et al.* (2014) stated that antioxidant activity of of orange- carrot blend nectars supplemented with aloe gel and control increased during storage at room temperature. Studies conducted by Hridyani (2015) and Hridyani and Soni (2016) reported that antioxidant activity of juice blend with holy basil decreased during storage.

The oxidation of phenolic compounds due to its volatile nature was responsible for the decrease in total phenolic content with the progression of storage period (Ranganna, 1986). Nejatzadeh-Barandozi (2013) stated that the majority of the polyphenol compounds in aloe leaf gel includes non-flavonoid group of polyphenols which contribute to 93% of the total polyphenols. Hamid *et al.* (2014) reported that unsteady phenomena of phenol content during storage period were due to polymerization reactions and synthesis of new compounds during storage and he found that phenol content of orange- carrot blend nectars supplemented with aloe gel and control increased during storage at room temperature. Decrease in phenolic content was observed in aloe juice supplemented kinnow nectar from unblanched, blanched aloe and without supplementation after a storage period of 6 months (Shubhra *et al.*, 2014). Retention of phenolic content was higher in kinnow nectar supplemented with aloe juice from unblanched aloe compared to blanched and control.

According Shubhra *et al.*, (2014) supplementation of aloe juice in kinnow nectar had not much effect on crude fibre content and crude fibre content of the products recorded a stable value till the end of storage period.

2.4.2.2 Sensory Evaluation

The sensory quality profile of beverage is a prime factor to consider the marketability of product. During storage, it was observed that overall sensorial quality profile of papaya- aloe RTS beverage and aloe, aonla and ginger RTS beverage slightly decreased during storage of 4 months but was accepatable up to three months storage (Boghani *et al.*, 2012; Sasikumar *et al.*, 2013). Decrease in sensory profile of RTS beverage during storage was also reported by Larmond (1985); Dachiya and Dhawan (2001); Gomez *et al.* (2005); Yadav *et al.* (2010); Balaswamy *et al.* (2011); Unde *et al.* (2011); Jakhar and Pathak (2012); Gaikwad *et al.* (2013); Sasikumar (2015a) and Sasikumar (2015b).

Boghani *et al.* (2012) reported that storage studies of blended papaya-aloe gel revealed that 10 per cent aloe gel can be incorporated in blended RTS beverages and can be stored for the period of 3 months without significant loss in chemical and organoleptic qualities. Overall acceptability scores of aloe juice supplemented kinnow nectar from unblanched aloe secured the highest score (8.2) followed by control (8.1) and blanched aloe juice (8.0) and it decreased during storage due to loss of flavor and colour of the kinnow nectar (Shubhra *et al.*, 2014).

Elbandy *et al.* (2014) reported that color scores for mango nectar decreased while mango nectar with aloe gel was stable during storage period and scores for taste and odour decreased and consistency score was stable for all treatments during storage. But colour and consistency scores was best for treatments with 20 per cent and 25 per cent aloe gel supplemented mango nectar and taste scores was maximum for mango nectar without aloe gel and 5 per cent aloe gel addition while odour scores was best for mango nectar without aloe gel.

In a study conducted by Sasikumar (2015b), on storage of aloe blended bael fruit juice beverage reported that with the advancement of storage period flavour, colour and organoleptic taste scores of juice blends decreased and the highest score for appearance, colour, taste, flavour and overall acceptability was recorded by the juice blend of 60 per cent aloe juice with bael fruit juice when compared to other blends at the end of storage period of 6 months.

2.4.2.3 Enumeration of Microbial Load during Storage

Chauhan *et al.* (2012) reported that total colony count of functional herbal RTS beverage increased slightly but was not increased significantly during storage period. The level of bacterial counts were reduced in high concentrations of aloe gel in mango nectar and total bacterial count during storage at room temperature was only small amount which revealed the anti bacterial property of aloe gel (Elbandy *et al.*, 2014). Sasikumar (2015b) found the level of total viable count population was within the accepatable limit and the lowest range of total viable count (12.4×10^{-3} to 10.8×10^{-3}) was recorded for 60 per cent aloe juice added aloe-bael fruit juice beverage at the end of 6 months storage period. Hridyani (2015) and Hridyani and Soni (2016) reported that microbial load of RTS beverage from traditional medicinal plants increase but was not significantly increased during storage period.

Materials and Methods

3. MATERIALS AND METHODS

The materials used and methodologies adopted during the investigation "Development of *Aloe vera* gel supplemented Ready To Serve fruit beverages' conducted with the objective to optimize the process variables for osmotic dehydration of aloe gel and supplementation of aloe gel in Ready To Serve fruit beverages and to evaluate the quality of the product during storage are described in this chapter.

3.1. ALOE GEL EXTRACTION

The experiment was conducted at Department of Processing Technology, College of Agriculture, Vellayani, Kerala Agricultural University, Thiruvananthapuram during the year 2014-2016.

3.1.1. Selection of *Aloe vera* Leaves

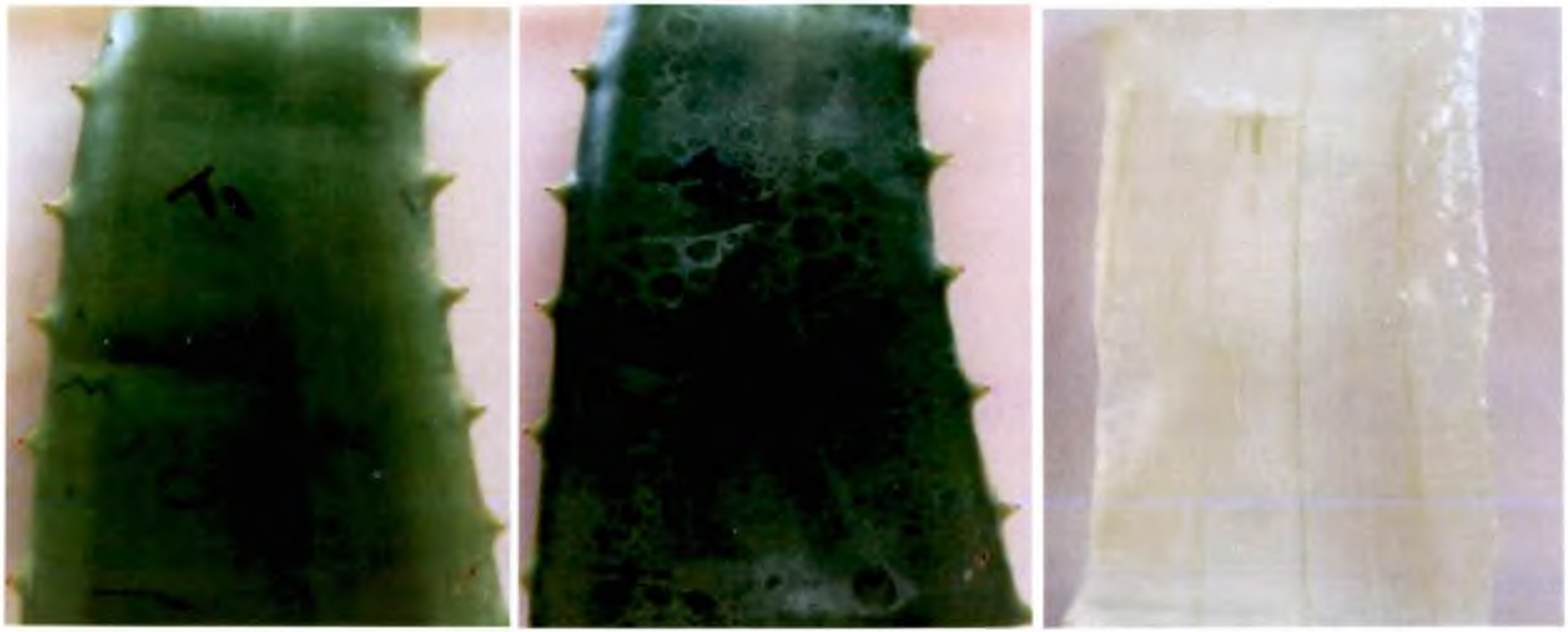
Aloe leaves of uniform size, maturity, free from pests, diseases and mechanical damages procured from farmer's field were taken for the study.

3.1.2. Blanching Treatments

Top and bottom ends of aloe leaves were trimmed off and the leaves were blanched for 2 minutes. The blanching treatments include steam blanching (T_1), hot water blanching (T_2) and control (without blanching) (T_3).

3.1.3 Aloe Gel Extraction

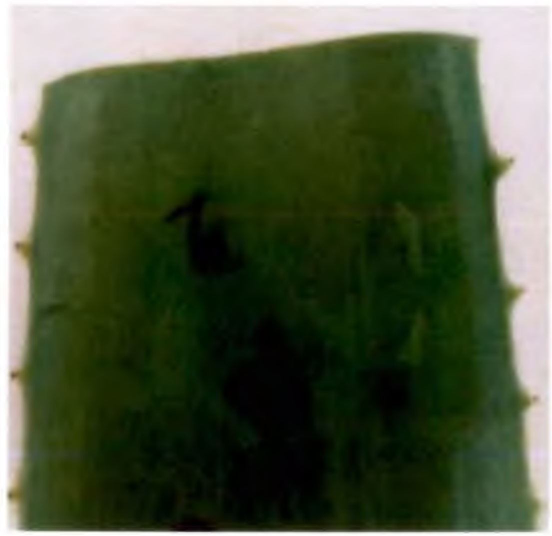
Extraction of aloe gel from the blanched and unblanched aloe leaves was done by the traditional hand-filleting method (Plate 1, 2 and 3). Spines along the leaf margins, top and bottom rind of the leaves were removed and aloe gel was extracted.



Leaves before steam blanching | Leaves after steam blanching | Gel extracted after steam blanching

Plate 1. Aloe gel extraction after steam blanching

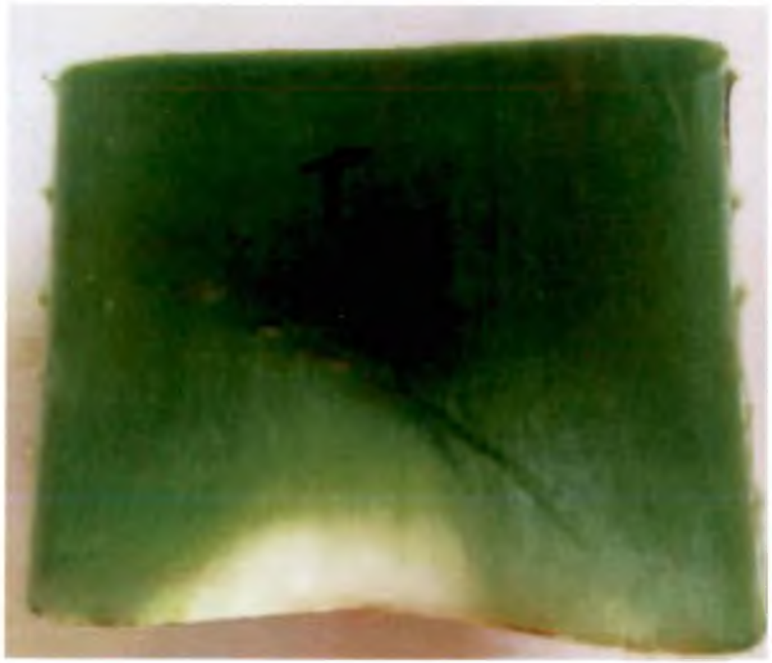
Leaves before hot water blanching



Leaves after hot water blanching

Gel extracted after hot water blanching

Plate 2. Aloe gel extraction after hot water blanching



Leaf without blanching(control)

Gel extracted without blanching

Plate 3. Aloe gel extraction without blanching (control)

Aloe gel extracted from different treatments was analyzed for biochemical, physical and sensory parameters.

3.1.3.1 Biochemical Properties of Aloe Gel

Biochemical properties *viz.*, moisture, Total Soluble Solids (TSS), pH, titratable acidity, reducing sugar, total sugar, ascorbic acid, antioxidant activity, crude fibre, ash content and total phenol were analysed.

3.1.3.1: a Moisture Content

Moisture content of one gram aloe gel was estimated using moisture analyser (Essae, AND MAX 50) which dries the sample using a halogen lamp and gives the moisture content in percentage based on the principle of thermo gravimetric analysis (Plate 4).

3.1.3.1.b Total Soluble Solids (°B)

Total Soluble Solids (TSS) was recorded by using digital refractometer (Atago - 0 to 53%) and expressed in ° Brix.

3.1.3.1.c pH

pH of the *Aloe vera* gel was measured by using pocket pH tester (HANNA instruments,pHep Tester).

3.1.3.1.d Titratable Acidity (%)

The method described by Ranganna (1986) was followed to measure titratable acidity. The titratable acidity was expressed in terms of per cent citric acid equivalent using following formula:

$$\text{Acidity} = \frac{\text{Titre value x Normality of NaOH (0.1N) x Volume made up (100 mL) x Equivalent weight of citric acid (0.064)} \times 100}{\text{Volume of aliquot (25 mL) x Weight / volume of the sample (5g)}}$$

3.1.3.1.e Ascorbic Acid (mg/ 100g)

Ascorbic acid content was estimated by 2,6- dichloro phenol indophenol (DCPIP) dye method Sadasivam and Manickam (1992) and expressed as mg/ 100g.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre } (V_2 \text{ mL}) \text{ x Dye factor x Volume made up (mL)}}{\text{Aliquot of extract taken (mL) x Wt. of sample (g)}} \times 100$$

Dye factor = $0.5 / V_1$ mL

3.1.3.1.f Reducing Sugar

The titrimetric method of Lane and Eynon as described by Ranganna (1986) was adopted for the estimation of reducing sugar.

$$\text{Reducing sugar} = \frac{\text{Glucose Eq.(0.05) x Total volume made up (mL)} \times 100}{\text{Titre value (mL) x Weight of the pulp (g)}}$$

3.1.3.1.g Total Sugar

The total sugar content was expressed as per cent in terms of invert sugar according to the following formula (Ranganna, 1986).

$$\text{Total sugar} = \frac{\text{Glucose Eq. (0.05) x Total volume made up (mL) x Volume made up after inversion (mL)} \times 100}{\text{Titre value x Weight of pulp taken (g) x Aliquot taken for inversion (mL)}}$$

3.1.3.1.h Antioxidant Activity

Total antioxidant activity of extracted aloe gel was determined using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. The scavenging effect on DPPH free radical was measured according to the procedure described by Sharma and Bhat (2009).

Aloe gel sample (1 mL) was added to 2.0 mL 0.1 mM DPPH solution, mixed thoroughly and left for 30 minutes at room temperature. The absorbance was read at 517 nm. Scavenging effect was expressed as percent inhibition of DPPH as shown in the following equation:

$$\% \text{ inhibition of DPPH} = \frac{\{A_{blank} - A_{sample}\} \times 100}{A_{blank}}$$

Where,

A_{blank} – Absorbance of DPPH solution without sample, read against ethanol blank.

A_{sample} – Absorbance of the test sample after 30 min.

3.1.3.1.i ***Crude fibre***

Crude fibre content of the extracted aloe gel was estimated using the method described by Sadasivam and Manickam (1992). Percentage of crude fibre in the sample was calculated as follows:

$$\% \text{ of crude fibre} = \text{loss in weight in ignition } \frac{\{(W_2\text{-}W_1) - (W_3\text{-}W_1)\} \times 100}{\text{Weight of the sample}}$$

3.1.3.1.j Ash content

Per cent ash content was estimated using the following formula (Raghuramulu *et al.*, 1983).

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

W_1.- Pre-weighed silica crucible

W_2 - W eight of ash + crucible

3.1.3.1.k Total phenol

Total phenol of aloe gel were estimated by using the method described by Sadasivam and Manickam (1992).

One gram of the sample was weighed and ground in a pestle and mortar with 10 times volume of 80 per cent ethanol. The homogenate was centrifuged at 10,000 rpm for 20 minutes. The supernatant was evaporated to dryness. The residue was dissolved in a known volume of distilled water (5 mL). Pipetted out 0.5 mL of the aliquot in test tubes and made up the volume to 3 mL with distilled water and add 0.5 mL Folin- Ciocalteau reagent. Na_2CO_3 20 percent (2 mL) was added to the test tubes after 3 minutes and mixed it thoroughly. The test tubes were placed in boiling water for one minute, cooled and the absorbance was measured at 765 nm against the reagent blank. Standard curve using different concentrations of gallic acid was recorded and phenol content of the test sample was expressed as mg phenols g^{-1} sample of aloe gel.

3.1.3.2 *Physical Properties of Aloe Gel*

Physical parameters such as viscosity, refractive index, optical density and specific gravity of aloe gel were analysed.

Plate 4. Moisture Analyser

Plate 5. Brookefield Viscometer

Plate 6. Specific Gravity bottle

3.1.3.2.a Viscosity

Viscosity, one of the important properties in the analysis of liquid behaviour is defined as the resistance of a liquid to flow. It was measured in units of centipoises (cP) using Brookefield Viscometer (Plate 5).

3.1.3.2.b Refractive index

Refractive index is the ratio of sine of the angle of incidence to the sine of angle of refraction, when a monochromatic sodium light of wavelength 589.3^0 A passes from air into the material, keeping temperature as constant. Refractive index had been found out using USDA sucrose conversion table.

3.1.3.2.c Optical density

Optical density is a measure of transparency of a liquid and it determines the quality of the aloe gel. Optical density was measured using spectrophotometer. Direct absorbance reading of *Aloe vera* gel was done by setting the wavelength at 400 nm using distilled water as blank (Chandegara *et al.*, 2015).

3.1.3.2.d Specific gravity

The specific gravity of aloe gel was determined using the specific gravity bottle with toulene as the displacement fluid. An empty 50-ml specific gravity bottle (Plate 6) was weighed (W_1), filled with toulene and wiped off the excess and the weight was noted (W_2). A known weight of sample was taken (W_3) and quantitatively transferred into the specific gravity bottle. The excess solvent was wiped off and the bottle with aloe gel was weighed again (W_4). The specific gravity was calculated from the following equation:

$$\text{Specific gravity} = \frac{\text{Density of toluene X weight of sample } (W_3)}{W_3 - (W_4 - W_2)}$$

3.1.3.3 Sensory Evaluation of Aloe Gel

Aloe gel extracted by different treatments were evaluated for sensory characteristics *viz.*, appearance, colour, flavour, taste and texture by 32 member semi trained panel comprising of research scholars of College of Agriculture, Vellayani. The panel were asked to score the appearance, colour, flavour, taste and texture of the sample using 9-point hedonic scale (Ranganna, 1986) in the order of preferance as shown below.

Like extremely	-9
Like very much	-8
Like moderately	-7
Like slightly	-6
Neither like or dislike	-5
Dislike slightly	-4
Dislike moderately	-3
Dislike very much	-2
Dislike extremely	-1

The score was statistically analysed using Kruskall-Wallis test (chi-square value) and ranked (Shamrez *et al.*, 2013).

Based on physical, chemical and sensory quality parameters, the best aloe gel extraction method was selected for further treatments.

3.2 OSMO DEHYDRATION OF ALOE GEL

Aloe gel was extracted by the best method selected from part 3.1 of the experiment and uniformly cut into cubes of 1 cm^3 (Plate 7). The cubes were then immersed in osmotic solution (sucrose) of three different concentrations *viz.*, 30,

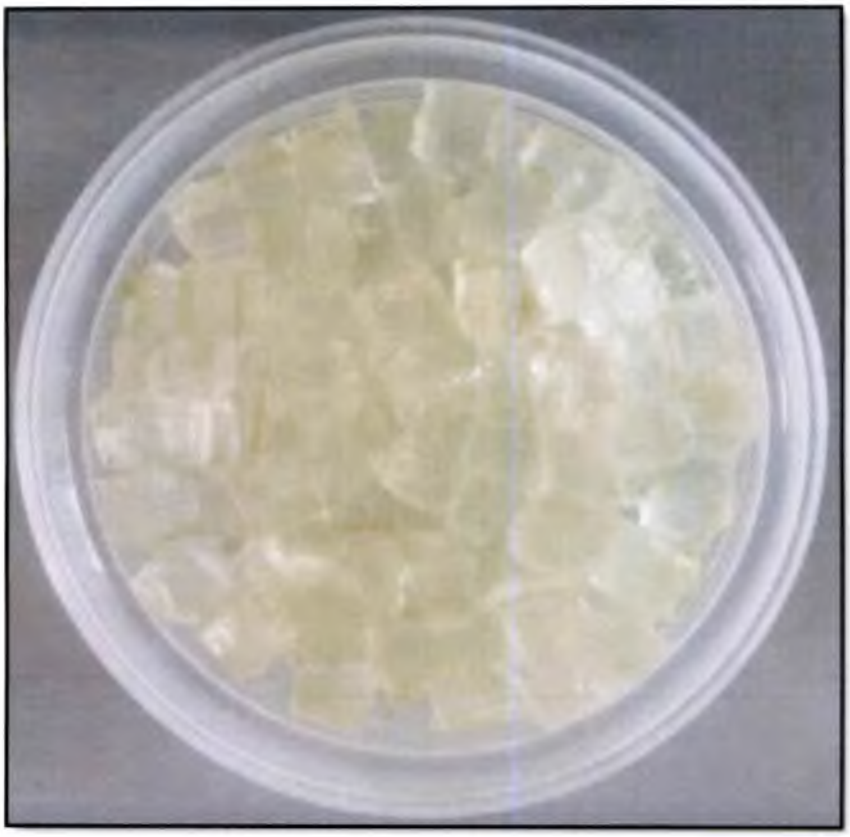
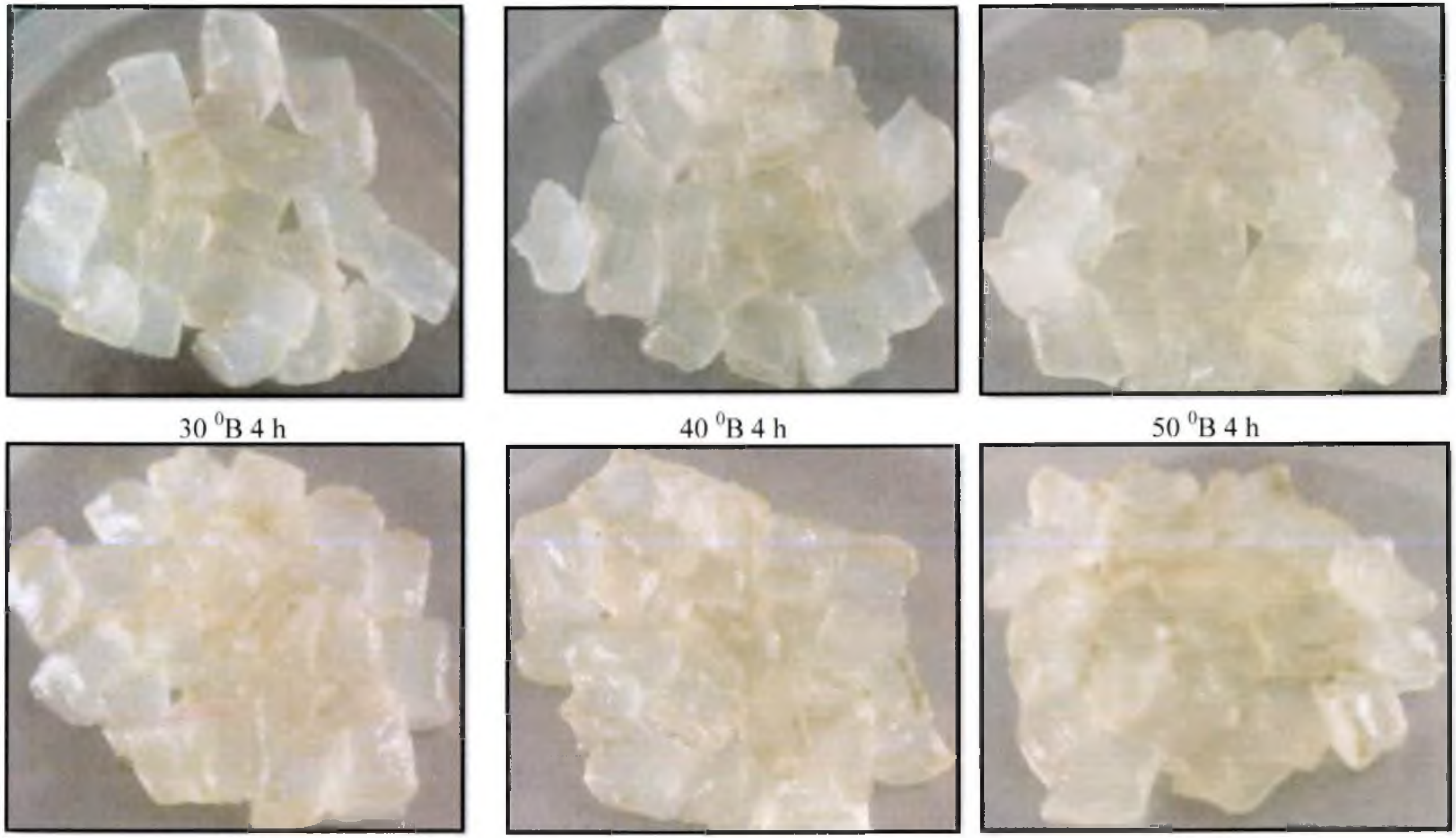


Plate 7. 1 cm^3 sized steam blanched aloe gel



30 ^{0}B 4 h | 40 ^{0}B 4 h | 50 ^{0}B 4 h

30 ^{0}B 6 h | 40 ^{0}B 6 h | 50 ^{0}B 6 h

Plate 8. Osmo dehydrated aloe gel cubes

40, and 50 ^{0}B for two different immersion time of 4 and 6 hour (Plate 8). Potassium metabisulphite (0.1%) and citric acid (0.1%) were added to the osmotic solution and the pH was adjusted to 3.0 - 3.5. Osmosed aloe cubes were analysed for mass transfer characters (solid gain, weight reduction), biochemical, physical and sensory analysis.

3.2.1. Mass Transfer Characters of Osmosed Aloe Cubes

Mass transfer describes the transport of mass from one point to another and is one of the main pillars in transport phenomena of osmotic dehydration. Mass transfer characters *viz.* solid gain (SG) and weight reduction (WR) were determined and optimised values were calculated.

3.2.1.a Solid Gain (SG)

Solid gain (%) was determined using the procedure followed by (Kowalski and Mierzwa, 2011).

$$SG\ (\%) = \frac{S_t - S_i}{m_i} \times 100$$

Where,

S_t = mass of dry body at time t, S_i = Initial mass of dry body (of fresh) and m_i= initial mass of wet sample

3.2.1.b Weight Reduction (WR)

Weight reduction in terms of percentage was calculated using the method described by Yadav *et al.* (2012).

$$WR(\%) = \frac{Mo - M}{Mo} \times 100$$

Mo = Initial mass of fruit slices prior to osmosis (g)

M = Mass of fruit slices after osmosis (g)

3.2.2 Biochemical Properties

Biochemical parameters *viz.*, moisture, TSS, pH, titratable acidity, reducing sugar, total sugar, ascorbic acid, antioxidant activity and total phenol of osmosed cubes were analysed.

3.2.2.a *Moisture Content*

Moisture content of aloe cubes after osmo dehydration was determined as described in 3.1.3.1.a.

3.2.2.b *Total Soluble Solids* (°B)

Total Soluble Solids (TSS) of aloe cubes after osmo dehydration was determined as described in 3.1.3.1.b.

3.2.2.c *pH*

pH of aloe cubes after osmo dehydration was determined as described in 3.1.3.1.c.

3.2.2.d *Titratable Acidity* (%)

Titratable acidity of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.d.

3.2.2.e *Ascorbic acid (mg/ 100g)*

Ascorbic acid content of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.e.

3.2.2.f *Reducing Sugar*

Reducing sugar of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.f.

3.2.2.g *Total Sugar*

Total sugar of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.g.

3.2.2.h ***Antioxidant activity***

Antioxidant activity of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.h.

3.2.2.i ***Total phenol***

Total phenol of aloe cubes after osmo dehydration was calculated as described in 3.1.3.1.k.

3.2.3 Physical Properties

Physical properties such as refractive index, optical density and specific gravity for osmosed aloe cubes were analysed.

3.2.3.a ***Refractive index***

Refractive index of aloe cubes after osmo dehydration was calculated as described in 3.1.3.2.b.

3.2.3.b ***Optical density***

Optical density of aloe cubes after osmo dehydration was calculated as described in 3.1.3.2.c.

3.2.3.c *Specific gravity*

Specific gravity of aloe cubes after osmo dehydration was calculated as described in 3.1.3.2.d.

3.2.4. Sensory Evaluation

Sensory evaluation of osmodehydrated aloe cubes were done as described in 3.1.3.3

3.3. FORMULATION OF RTS BEVERAGE AND STORAGE

3.3.1 Formulation of RTS Beverage

Ready To Serve (RTS) beverages were formulated with aloe gel supplementation at different concentration and compared with RTS without aloe gel supplementation (Plate 9).

Fruit juices taken for the study are

F_1 – Pineapple

F_2 – Lime

F_3 – Cashew apple

Aloe gel supplementation treatments

S_1 – Osmodehydrated aloe gel 5 %

S_2 – Osmodehydrated aloe gel 10 %

S_3 – Total aloe juice 5 %

S_4 – Without aloe (control)

RTS beverages were formulated as per FSSAI specifications using the above combinations.

Pineapple RTS formulations

Lime RTS formulations

Cashew apple RTS formulations

Plate 9. Formulation of RTS beverage

FSSAI specification for RTS is

(i) Total Soluble Solids (m/m) – not less than 10 per cent
(ii) Fruit juice content (m/m):

Lime - not less than 5 per cent and

Pineapple and cashew apple – not less than 10 percent

(iii) Acidity as citric acid – not less than 0.3 per cent
(iv) Preservatives : Sulphur dioxide – 70 ppm or Benzoic acid – 120 ppm

Biochemical and sensory parameters of the formulations were analysed and the best formulation was selected from each fruit juice (pineapple, lime, cashew apple) and used for the storage stability studies.

3.3.1.1 Biochemical Properties of RTS Formulations

Biochemical properties *viz.*, TSS, pH, titratable acidity, reducing sugar, total sugar, ascorbic acid, antioxidant activity, total phenol and fibre content of the formulated RTS beverages were analysed.

3.3.1.1.a Total Soluble Solids (°B)

Total Soluble Solids (TSS) of RTS formulation was determined as described in 3.1.3.1.b.

3.3.1.1.b pH

pH of RTS formulation was determined as described in 3.1.3.1.c.

3.3.1.1.c Titratable Acidity (%)

Titratable acidity of RTS formulation was calculated as described in 3.1.3.1.d.

3.3.1.1.d Ascorbic acid (mg/ 100g)

Ascorbic acid content of RTS formulation was calculated as described in 3.1.3.1.e.

3.3.1.1.e Reducing Sugar

Reducing sugar of RTS formulation was calculated as described in 3.1.3.1.f.

3.3.1.1.f Total Sugar

Total sugar of RTS formulation was calculated as described in 3.1.3.1.g.

3.3.1.1.g Antioxidant activity

Antioxidant activity of RTS formulation was calculated as described in 3.1.3.1.h.

3.3.1.1.h Total phenol

Total phenol of RTS formulation was calculated as described in 3.1.3.1.k.

3.3.1.1.i Crude Fibre

Crude fiber content of RTS formulation was calculated as described in 3.1.3.1.i.

3.3.1.2 Sensory Evaluation of Formulated RTS Beverages

Sensory evaluation of formulated RTS beverages were done as described in 3.1.3.3

3.3.2 Storage of RTS Formulation

The best RTS formulation selected from each fruit juice was kept under room temperature and storage stability study was conducted for three months. Stored RTS beverages were analysed for biochemical, sensory and microbial qualities at fortnight intervals.

3.3.2.1 Biochemical Properties of Stored RTS Formulations

Biochemical parameters *viz*., TSS, pH, titratable acidity, reducing sugar, total sugar, ascorbic acid, antioxidant activity, total phenol and fibre content were analysed.

3.3.2.1.a Total Soluble Solids (°B)

Total Soluble Solids (TSS) of stored RTS formulation was determined as described in 3.1.3.1.b.

3.3.2.1.b pH

pH of stored RTS formulation was determined as described in 3.1.3.1.c.

3.3.2.1.c Titratable Acidity (%)

Titratable acidity of stored RTS formulation was calculated as described in 3.1.3.1.d.

3.3.2.1.d Ascorbic acid (mg /100g)

Ascorbic acid content of stored RTS formulation was calculated as described in 3.1.3.1.e.

3.3.2.1.e Reducing Sugar

Reducing sugar of stored RTS formulation was calculated as described in 3.1.3.1.f.

3.3.2.1.f Total Sugar

Total sugar of stored RTS formulation was calculated as described in 3.1.3.1.g.

3.3.2.1.g Antioxidant activity

Antioxidant activity of stored RTS formulation was calculated as described in 3.1.3.1.h.

3.3.2.1.h Total phenol

Total phenol of stored RTS formulation was calculated as described in 3.1.3.1.k.

3.3.2.1.i Crude Fibre

Crude fiber content of stored RTS formulation was calculated as described in 3.1.3.1.i.

3.3.2.2 Sensory Evaluation of Stored RTS Beverages

Sensory evaluation of stored RTS formulations were done as described in 3.1.3.3

3.3.2.3 Enumeration of Microbial Load During Storage

The quantitative assay of the micro flora in stored samples was carried out by serial dilution spread plate techniques. Nutrient agar and Rose Bengal agar medium were used for the enumeration of bacterial and fungal population of the RTS beverages respectively.

$$\text{No. of colony forming units per mL of samples} = \frac{\text{Total no. of colony formed X dilution factor}}{\text{Aliquot taken}}$$

3.4. Statistical Analysis

The data generated from experiments were statistically analyzed using Completely Randomized Design (CRD). Sensory parameters were statistically analysed using Kruskall – Wallis Chi-square test.

Results

4. RESULTS

Results of the experiment entitled "Development of *Aloe vera* gel supplemented Ready To Serve fruit beverages" are presented under the following headings:

4.1 Aloe gel extraction

4.2 Osmo dehydration of aloe gel

4.3 Formulation of RTS beverage and storage

4.1 ALOE GEL EXTRACTION

Influence of blanching treatments on biochemical and physical properties of aloe gel extracted is studied in this experiment. Aloe gel was extracted by hand filleting method after heat treatments *viz.*, steam blanching (T_1) and hot water blanching (T_2) for two minutes. Biochemical, physical and organoleptic qualities of gel extracted by these treatments was compared with the gel extracted without blanching (T_3- control).

4.1.1 Biochemical Properties of Aloe Gel

Biochemical properties of aloe gel extracted after different heat treatments are depicted in Table 1.

Water is the major constituent in aloe gel. On analysing the influence of treatments on moisture content of aloe gel extracted, the treatments were found significant. Aloe gel extracted after steam blanching recorded the lowest moisture percentage of 92.58. The highest moisture of 98.49 per cent was recorded with aloe gel extracted without any blanching (T_3) which showed no significant difference with hot water blanched aloe (T_2) with 97.86 per cent moisture content.

Table 1. Effect of blanching on biochemical properties of aloe gel

Treatments	Moisture (%)	TSS (^{0}B)	pH	Acidity (%)	Ascorbic acid (mg/100g)	Reducing sugar (%)	Total sugar (%)	Antioxidant activity (%)	Crude fibre (%)	Ash content (%)	Total phenol (μg g^{-1})
T_1 - Steam blanch	92.58	1.84	4.38	0.17	4.06	0.43	0.53	81.30	0.198	0.29	40.98
T_2 - Hot water blanch	97.86	1.78	4.32	0.15	4.06	0.42	0.52	72.88	0.198	0.29	18.77
T_3 - Control (without blanching)	98.49	1.7	4.32	0.12	8.12	0.41	0.51	71.12	0.200	0.28	12.49
CD (0.05)	3.936	NS	NS	0.038	1.646	0.001	0.001	6.687	NS	NS	4.519

Total Soluble Solids (TSS) of aloe gel extracted after different treatments were found to be non-significant and it ranged between 1.7^0 B and 1.84^0 B with the highest TSS of 1.84^0 B recorded by steam blanched aloe gel.

pH of aloe gel extracted after the treatments ranged between 4.32 to 4.38. Steam blanched aloe gel recorded the highest pH of 4.38 even though there was no significant differences between the treatments.

The highest percentage of acidity of 0.17 was recorded for aloe gel extracted after steam blanching (T_1) which was on par with gel extracted with hot water blanch (T_2) with an acidity of 0.15 per cent. The lowest acidity of 0.12 per cent was recorded for gel extracted without any blanching (T_3).

The highest ascorbic acid of 8.12 mg/100g was recorded with aloe gel extracted without blanching (T_3). Steam blanched (T_1) aloe gel and hot water blanched (T_2) aloe gel recorded the lowest ascorbic acid (4.06 mg/100g) and the differences between these treatments were not statistically significant.

The reducing sugar content of aloe gel extracted after different treatments ranged from 0.41 to 0.43 per cent and the treatments were significant. The higher percentage of 0.43 per cent reducing sugar was recorded by steam blanched aloe gel (T_1) followed by hot water blanched aloe (0.42 per cent). The least amount (0.41per cent) of reducing sugar was noticed in aloe gel extracted without blanching

On analysing the total sugar content of extracted aloe gel, steam blanched aloe (T_1) recorded the highest total sugars of 0.53 per cent than hot water blanched (T_2) aloe (0.52 per cent). The lowest total sugar of 0.51 per cent was obtained by aloe gel extracted without any blanching.

Antioxidant activity was computed by DPPH radical scavenging activity and the highest DPPH activity of 81.30 per cent was recorded by steam blanched (T_1) aloe gel. The least DPPH radical scavenging activity of 71.12 per cent was recorded for aloe gel extracted without any blanching (T_3) which was on par with hot water blanched aloe gel for which the DPPH activity was 72.88 per cent.

Aloe gel extracted by blanching treatments had negligible effect on crude fibre content. The differences between the treatments were not statistically significant. Crude fibre content of the aloe gel extracted by different methods ranged between 0.198 to 0.2 per cent.

Ash content of aloe gel extracted after different treatments were found to be non significant among the treatments and it ranged within 0.28 to 0.29 per cent. Steam blanched aloe gel (T_1) and hot water blanched aloe gel (T_2) showed an ash content of 0.29 per cent compared to aloe gel extracted without blanching with 0.28 per cent.

Blanching treatments influenced total phenol content of aloe gel extracted after different treatments. The highest phenol content of 40.98 $\mu g\ g^{-1}$ was observed for steam blanched aloe gel followed by hot water blanched one with 18.77 $\mu g\ g^{-1}$. Aloe gel extracted without any blanching recorded the lowest phenol content of 12.49 $\mu g\ g^{-1}$.

4.1.2. Physical Properties of Aloe Gel

Physical properties of aloe gel play an important role in determining the quality and purity of extracted gel. The physical parameters of extracted aloe gel after different blanching treatments are depicted in Table 2.

Viscosity is measure of a fluid's resistance to flow. Maximum viscosity of 9.98 cP, 4.34 cP and 3.60 cP were observed for aloe gel extracted with steam blanching (T_1) at 60, 120 and 180 rpm respectively. This was followed by unblanched aloe gel (T_3) with viscosity of 5.40 cP, 3.36 cP, and 2.26 cP at 60, 120 and 180 rpm respectively. The aloe gel extracted after hot water blanching had the lowest viscosity of 3.76 cP, 2.16 cP and 1.48 cP at 60,120 and 180 rpm respectively.

Table 2. Effect of blanching on physical properties of aloe gel

Treatments	Viscosity (cP)			Optical density	Refractive index	Specific gravity
	60 rpm	120 rpm	180 rpm			
T_1 – Steam blanch	9.98	4.34	3.60	0.805	1.3366	1.0200
T_2 – Hot water blanch	3.76	2.16	1.48	1.097	1.3366	1.0196
T_3 – control (without blanching)	5.40	3.36	2.26	1.048	1.3364	1.0169
CD (0.05)	0.312	0.236	0.198	0.096	NS	NS

The refractive index of aloe gel extracted after different treatments were calculated and it was found that blanching treatments had negligible effect on refractive index. Among the treatments, steam blanched aloe gel and hot water blanched aloe gel had refractive index of 1.3366 which was slightly higher than the refractive index of unblanched aloe gel (1.3364).

Optical density is one of the physical properties that determine the purity of extracted aloe gel. Steam blanched aloe gel recorded the lowest optical density of 0.805. The highest value for optical density of 1.097 was noted for hot water blanched aloe gel which did not differ significantly from aloe gel extracted without blanching (1.048).

Maximum specific gravity of 1.0200 was observed for steam blanched aloe gel followed by hot water blanched aloe with specific gravity of 1.0196. The lowest specific gravity of 1.0169 was noted for aloe gel extracted without blanching and the differences were not statistically significant.

4.1.3. Sensory Evaluation of Aloe Gel

Aloe gel extracted after heat treatment and control (T_3) were analysed for various sensory attributes for their acceptance by using 9 point hedonic scale. The

Table 3. Effect of blanching on organoleptic qualities of aloe gel

Treatments	Appearance		Colour		Flavour		Taste		Consistency		Texture	
	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score
T_1 -Steam blanch	62.06	7.91	57.31	7.91	65.75	7.47	66.87	7.71	73.50	7.88	60.70	7.78
T_2 - Hot water blanch	51.06	7.56	44.93	7.56	41.00	6.75	52.87	7.25	48.50	7.25	60.43	7.5
T_3 - control (without blanching)	32.37	7.00	43.25	7.50	38.75	6.50	25.75	6.25	23.50	6.50	23.25	6.50
K value	22.06		5.98		21.49		40.64		60.89		43.89	
CV (0.05)	5.991											

sensory scores obtained with respect to appearance, colour, flavour, taste, consistency and texture are presented in Table 3. It was observed that the steam blanched (T_1) aloe gel with the mean score of 7.91 for appearance was more preferred as compared to hot water blanch (7.56) and control (7.0).

The mean scores for the quality attribute, colour revealed that the highest score for colour was noted in steam blanched aloe gel (7.91) followed by gel extracted by hot water blanch (7.56). The lowest mean score for colour was obtained for aloe gel extracted without blanching (7.5). The lowest mean score of 6.5 for flavour was recorded for aloe gel extracted without blanching (T_3) while gel extracted by steam blanching with a mean score of 7.47 recorded as the highest. Aloe gel extracted after steam blanching recorded the highest mean score of 7.71 for taste while gel extracted with hot water blanch and without blanching recorded a mean score of 7.25 and 6.25 respectively. The bitter taste was high for the aloe gel extracted without blanching as compared to the blanching treatments.

The highest mean score of 7.88 for consistency was viewed for steam blanched aloe gel while lowest mean score of 6.5 was recorded for gel extracted without blanching. The textural properties of aloe gel extracted after different treatments revealed that steam blanched aloe gel had higher mean score (7.78) with a soft texture followed by hot water blanched aloe gel with a mean score of 7.5 and firm texture. The lowest mean score for texture (6.5) was found to be in aloe gel extracted without blanching.

On analysing the biochemical, physical and sensory qualities of aloe gel extracted after different blanching treatments and without blanching revealed that aloe gel extracted after steam blanching for 2 minutes yielded the highest quality of gel. Hence for conducting the osmo dehydration studies, aloe gel extracted after steam blanching for 2 minutes was selected.

4.2 OSMO DEHYDRATION OF ALOE GEL

Aloe gel extracted by hand filleting method after steam blanching was cut into 1cm^3 sized cubes and were subjected to different osmotic treatments with three levels of osmotic concentration (30, 40 and 50^{0}B) and two levels of immersion time (4 h and 6 h). Mass transfer characters, biochemical and physical properties of osmo dehydrated aloe gel were studied and the results are described below.

4.2.1 Mass Transfer Characters

Mass transfer characters *viz.*, solid gain and weight reduction of osmo dehydrated aloe gel in different osmotic concentrations and immersion time were analysed.

4.2.1.1 Solid Gain

Solid gain of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 4. Osmotic concentrations and immersion time significantly influenced the solid gain. Osmo dehydrated aloe gel in osmotic concentration of 30 ^{0}B (S_1) showed the lowest solid gain of 8.86 per cent which did not differ significantly from those osmosed in 40 ^{0}B (S_2) with solid gain of 9.03 per cent. The maximum solid gain of 10.19 per cent was observed in 50^{0}B (S_3). Among the immersion time, T_2 (6 h) showed the higher solid gain of 9.78 per cent while T_1 (4 h) recorded the lower solid gain of 8.94 per cent.

Under the interaction effects, S_3T_2 (50^{0}B, 6 h) recorded the maximum solid gain of 10.68 per cent followed by S_3T_1 (50^{0}B, 4 h). The minimum solid gain of 8.52 per cent was observed in S_1T_1 (30^{0}B, 4 h).

4.2.1.2 Weight Loss

Weight loss of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 5. Osmotic concentrations significantly

Table 4. Effect of osmotic concentration and immersion time on solid gain (%) of aloe gel

Osmotic concentrations	Solid gain (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	8.52	9.19	8.86
S_2 (40^0 B)	8.57	9.47	9.03
S_3 (50^0 B)	9.72	10.68	10.19
Mean	8.94	9.78	
CD (0.05)	S - 0.214	T - 0.175	SxT - 0.303

Table 5. Effect of osmotic concentration and immersion time on weight loss (%) of aloe gel

Osmotic concentrations	Weight loss (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	43.63	48.88	46.26
S_2 (40^0 B)	56.19	57.94	57.07
S_3 (50^0 B)	58.81	63.45	61.13
Mean	52.88	56.76	
CD (0.05)	S -3.261	T- 2.663	SxT-4.612

Table 6. Effect of osmotic concentrations and immersion time on moisture content (%) of aloe gel

Osmotic concentrations	Moisture content (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	72.35	70.41	71.38
S_2 (40^0 B)	65.34	61.02	63.18
S_3 (50^0 B)	60.52	57.39	58.95
Mean	66.07	62.94	
CD (0.05)	S-0.296	T-0.242	SxT-0.419

contributed to weight loss. Osmo dehydrated aloe gel in osmotic concentration of 50^0 B (S_3) recorded the highest weight loss of 61.13 per cent followed by 40^0 B (S_2). The lowest weight loss of 46.26 per cent was observed in 30^0B (S_1). When the effect of immersion time is considered, T_1 (4 h) showed the lower weight loss of 52.88 per cent where as T_2 (6 h) showed the higher weight loss of 56.76 per cent.

When the interaction effects were studied, S_3T_2 (50^0B, 6 h) recorded the maximum weight loss of 63.45 per cent followed by S_3T_1 (50^0B, 4 h). The minimum weight loss of 43.63 per cent was noticed in S_1T_1 (30^0B, 4 h).

4.2.2 Biochemical Properties of Osmo Dehydrated Aloe Gel

Biochemical properties of osmo dehydrated aloe gel at different osmotic concentrations and immersion time are described below.

4.2.2.1 Moisture Content

Moisture content of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 6. Both osmotic concentrations and immersion time influenced moisture content of osmo dehydrated aloe gel. The highest moisture content of 71.38 per cent was observed in osmotic concentration of 30^0 B followed by 40^0 B (S_2). The minimum moisture content of 58.95 per cent was observed in 50^0 B (S_3).

Under different immersion time, 4 h (T_1) recorded the highest moisture content of 66.07 per cent where as 6 h (T_2) recorded the minimum moisture content of 62.94 per cent. When interaction effects were studied S_1T_1 (30^0 B, 4 h) showed the highest moisture content of 72.35 per cent and minimum moisture content of 57.39 per cent was observed in S_3T_2 (50^0 B, 6 h).

4.2.2.2 Total Soluble Solids

Total Soluble Solids of osmo dehydrated aloe gel in 50^0 B (S_3) showed the highest TSS of 42.96^0 B (Table 7). It was followed by S_2 (40^0 B) and S_1 (30^0 B) showed the minimum TSS of 24.56^0 B. Under different immersion time T_2 (6 h) recorded the highest TSS of 36.42^0 B where as T_1 (4 h) recorded the lowest TSS of 33.34^0 B.

The highest TSS of 44.90^0 B was observed in 50^0 B, 6 h (S_3T_2) followed by S_3T_1 (50^0 B, 4 h). The lowest TSS of 22.98^0 B was noticed in 30^0 B, 4 h (S_1T_1).

4.2.2.3 pH

Osmo dehydrated aloe gel in 40^0 B (S_2) recorded the highest pH of 3.31 followed by 30^0 B (S_1) and the lowest pH of 3.29 was shown by 50^0 B (S_3) (Table 8). With respect to immersion time, T_1 (4 h) and T_2 (6 h) recorded pH of 3.30 and there was no significant difference between the immersion time. Among the interaction effects, pH of 3.33 was shown by S_2T_1 (40^0 B, 4 h) and the lowest pH was noticed in S_3T_1 (50^0 B, 4 h) though there was no significant difference.

4.2.2.4 Acidity

Acidity of the osmo dehydrated aloe gel in different osmotic concentrations and immersion time is depicted in Table 9 and showed no significant difference among the treatments. The highest acidity of 0.132 percent was observed in osmotic concentration 30^0B (S_1) and 40^0B (S_2) where 50^0B (S_3) showed the lowest acidity of 0.125 percent. On analyzing two levels of immersion time, 4 h (T_1) recorded the maximum acidity of 0.147 percent while the minimum acidity of 0.122 percent was noticed in 6 h (T_2). Among the interaction effects, the lowest acidity (0.115 percent) was observed in 50^0 B, 6 h (S_3T_2). The highest percent of acidity (0.157) was noticed in 40^0B, 4 h (S_2T_1), though there was no significant difference.

Table7. Effect of osmotic concentrations and immersion time on Total Soluble Solids (^{0}B) of aloe gel

Osmotic concentrations	Total Soluble Solids (^{0}B)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	22.98	26.15	24.56
S_2 (40^0 B)	36.03	38.20	37.11
S_3 (50^0 B)	41.03	44.90	42.96
Mean	33.34	36.42	
CD (0.05)	S - 1.351	T- 1.103	SxT- 1.909

Table 8. Effect of osmotic concentrations and immersion time on pH of aloe gel

Osmotic concentrations	pH		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	3.30	3.30	3.30
S_2 (40^0 B)	3.33	3.30	3.31
S_3 (50^0 B)	3.23	3.30	3.29
Mean	3.30	3.30	
CD (0.05)	S- NS	T- NS	SxT- NS

Table 9. Effect of osmotic concentrations and immersion time on acidity (%) of aloe gel

Osmotic concentrations	Acidity (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	0.155	0.128	0.132
S_2 (40^0 B)	0.157	0.121	0.132
S_3 (50^0 B)	0.135	0.115	0.125
Mean	0.147	0.122	
CD (0.05)	S-NS	T-0.016	SxT-NS

4.2.2.5 Ascorbic Acid

Ascorbic acid content of osmo dehydrated aloe gel in different osmotic concentrations showed no significant difference among the treatments (Table 10). The highest ascorbic acid of 7.94 mg/100g was observed in osmotic concentration 30^0B (S_1) followed by 40^0 B (S_2). The lowest ascorbic acid of 7.21 mg /100g was shown by 50^0 B (S_3). With respect to immersion time, 4 h (T_1) recorded the maximum ascorbic acid of 8.52 mg/100g while the minimum ascorbic acid of 6.54 mg /100g was noticed in 6 h (T_2). Among the interaction effects, the lowest ascorbic acid (6.09 mg/100g) was observed in 50^0B, 6 h (S_3T_2). The highest percent of ascorbic acid (9.46 mg /100g) was noticed in 30^0B, 4 h (S_1T_1).

4.2.2.6 Reducing Sugar

Osmo dehydrated aloe gel in 50^0B osmotic concentration (S_3) showed the highest reducing sugar of 3.04 per cent (Table 11). It was followed by S_2 (40^0B) and S_1 (30^0B) showed the minimum reducing sugar of 1.78 per cent. Under different treatments of immersion time, T_2 (6 h) recorded the higher reducing sugar of 2.56 per cent and T_1 (4 h) recorded the lower reducing sugar of 2.17 per cent.

Among the interaction effects, osmo dehydrated aloe gel in 50^0B, 6 h (S_3T_2) had highest reducing sugar of 3.11 per cent followed by S_3T_1 (50^0B, 4 h). The lowest reducing sugar of 1.65 per cent was noticed in 30^0B, 4 h (S_1T_1).

4.2.2.7 Total Sugar

Total sugar of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 12. The lowest total sugar of 10.51 percent was recorded by S_1 (30^0 B). Osmo dehydrated aloe gel in 50^0B (S_3) showed the highest total sugar of 16.16 per cent. Total sugar of osmotic concentrations differed significantly.

Table 10. Effect of osmotic concentrations and immersion time on ascorbic acid (mg /100g) of aloe gel

Osmotic concentrations	Ascorbic acid (mg /100g)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	9.46	6.43	7.94
S_2 (40^0 B)	7.78	7.09	7.44
S_3 (50^0 B)	8.34	6.09	7.21
Mean	8.52	6.54	
CD (0.05)	S-NS	T- 1.802	SxT- NS

Table 11. Effect of osmotic concentrations and immersion time on reducing sugar (%) of aloe gel

Osmotic concentrations	Reducing sugar (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	1.65	1.92	1.78
S_2 (40^0 B)	1.91	2.65	2.28
S_3 (50^0 B)	2.97	3.11	3.04
Mean	2.17	2.56	
CD (0.05)	S-0.021	T-0.017	SxT-0.029

Table 12. Effect of osmotic concentrations and immersion time on total sugar (%) of aloe gel

Osmotic concentrations	Total sugar (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	7.59	13.44	10.51
S_2 (40^0 B)	9.09	14.19	11.64
S_3 (50^0 B)	14.92	17.39	16.16
Mean	10.53	15.01	
CD (0.05)	S-0.459	T-0.375	SxT- 0.649

Among different immersion time, T_2 (6 h) recorded the higher total sugar of 15.01 per cent and T_1 (4h) recorded the lower total sugar of 10.53 per cent. When the interaction effects were studied, osmo dehydrated aloe gel in 50^0B, 6 h (S_3T_2) had highest total sugar of 17.39 per cent followed by S_3T_1 (50^0B, 4 h). The lowest total sugar of 7.59 per cent was noticed in 30^0B, 4 h (S_1T_1).

4.2.2.8 Antioxidant Activity

Antioxidant activity of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 13. Osmotic concentrations significantly differed in antioxidant activity. Osmo dehydrated aloe gel in osmotic concentration of 40^0B (S_2) showed the lowest antioxidant activity of 68.79 per cent. The highest antioxidant of 74.26 per cent was observed in 50^0B (S_3) which was on par with 30^0B (S_1).

Under different immersion time, 4 h (T_1) recorded the higher antioxidant activity of 73.07 per cent where as 6 h (T_2) recorded the minimum antioxidant activity of 71.13 per cent. When interaction effects were studied S_3T_1 (50^0B, 4 h) showed the highest antioxidant activity of 75.95 per cent followed by S_1T_1 (30^0B, 4 h). The minimum antioxidant activity of 67.84 per cent was observed in S_2T_2 (40^0B, 6 h).

4.2.2.9 Total Phenol

Total phenol content of osmo dehydrated aloe gel in different osmotic concentration and immersion time is depicted in Table 14. The lowest phenol content of 5.06 $\mu g\ g^{-1}$ was observed in 30^0 B (S_1) while the highest phenol content of 5.69 $\mu g\ g^{-1}$ was shown by 50^0 B (S_3). Under the immersion time, T_2 (6 h) showed minimum phenol content (3.61 $\mu g\ g^{-1}$) where as T_1 (4 h) showed the higher phenol content of 7.16 $\mu g\ g^{-1}$.

Table 13. Effect of osmotic concentrations and immersion time on antioxidant activity (%) of aloe gel

Osmotic concentrations	Antioxidant activity (%)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	73.51	72.97	73.24
S_2 (40^0 B)	69.73	67.84	68.79
S_3 (50^0 B)	75.95	72.57	74.26
Mean	73.07	71.13	
CD (0.05)	S-1.718	T-1.403	SxT-2.429

Table 14. Effect of osmotic concentrations and immersion time on total phenol ($\mu g\ g^{-1}$) of aloe gel

Osmotic concentrations	Total phenol ($\mu g\ g^{-1}$)		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	6.71	3.42	5.06
S_2 (40^0 B)	7.19	3.62	5.41
S_3 (50^0 B)	7.59	3.81	5.69
Mean	7.16	3.61	
CD (0.05)	S- 0.148	T-0.121	SxT-0.209

Table 15. Effect of osmotic concentrations and immersion time on refractive index of aloe gel

Osmotic concentrations	Refractive index		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	1.3702	1.3756	1.3729
S_2 (40^0 B)	1.3936	1.3978	1.3957
S_3 (50^0 B)	1.4033	1.4111	1.4072
Mean	1.3890	1.3948	
CD (0.05)	S- 0.0025	T-0.0020	SxT-0.0035

When the interaction effects were studied, the highest amount of phenol content of 7.59 µg g^{-1} was observed for S_3T_1 (50^0B, 4 h) followed by S_2T_1 (40^0B, 4 h). The minimum phenol content of 3.42 µg g^{-1} was noticed in S_1T_2 (30^0B, 6 h).

4.2.3 Physical Properties of Osmo Dehydrated Aloe Gel

Results of physical properties of osmo dehydrated aloe gel such as refractive index and specific gravity are given below.

4.2.3.1 Refractive Index

Refractive indices of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 15. Osmotic concentrations and immersion time differed significantly in refractive index. Osmo dehydrated aloe gel in osmotic concentration of 50^0B (S_3) showed the maximum refractive index of 1.4072 followed by 40^0B (S_2). The minimum refractive index of 1.3729 was observed in 30^0B (S_1). Among the immersion time, T_2 (6 h) showed the higher refractive index of 1.3948 while T_1 (4h) recorded the lower refractive index of 1.3890.

When the interaction effects, S_3T_2 (50^0B, 6 h) recorded the maximum refractive index of 1.4111 followed by S_3T_1 (50^0B, 4 h). The minimum refractive index of 1.3702 was observed in S_1T_1 (30^0B, 4 h).

4.2.3.2 Optical Density

Optical density of osmo dehydrated aloe gel in different osmotic concentrations and immersion time are depicted in Table 16. Osmotic concentrations and immersion time showed significant difference in optical density. Osmo dehydrated aloe gel in osmotic concentration of 30^0B (S_1) showed the lowest optical density of 0.953. The highest optical density of 1.565 was observed in 50^0B (S_3). Among the immersion time, maximum optical density of

Table 16. Effect of osmotic concentrations and immersion time on optical density of aloe gel

Osmotic concentrations	Optical density		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	0.917	0.997	0.953
S_2 (40^0 B)	1.062	1.185	1.128
S_3 (50^0 B)	1.442	1.687	1.565
Mean	1.140	1.287	
CD (0.05)	S-0.001	T-0.009	SxT-0.005

Table 17. Effect of osmotic concentrations and immersion time on specific gravity of aloe gel

Osmotic concentrations	Specific gravity		
	Immersion time		
	T_1 (4 h)	T_2 (6 h)	Mean
S_1 (30^0 B)	1.0702	1.0745	1.0724
S_2 (40^0 B)	1.0386	1.1005	1.0695
S_3 (50^0 B)	1.0848	1.1051	1.0949
Mean	1.0645	1.0934	
CD (0.05)	S-0.0019	T-0.0016	SxT-0.0028

Table 18. Effect of osmo dehydration on organoleptic qualities of aloe gel

Treatments	Appearance		Colour		Flavour		Taste		Consistency		Texture	
	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score
S_1T_1 (30^0B, 4 h)	93.50	7.00	83.39	7.03	20.65	5.81	52.63	6.75	102.69	7.19	44.41	6.79
S_2T_1 (40^0B, 4 h)	95.56	7.00	68.34	6.63	75.50	6.63	54.97	6.81	72.31	6.81	39.25	6.81
S_3T_1 (50^0B, 4 h)	127.19	7.44	98.09	7.25	156.13	8.03	114.38	8.06	108.75	7.25	116.98	8.03
S_1T_2 (30^0B, 6 h)	115.50	7.25	83.13	7.00	96.88	7.00	111.26	7.75	85.50	7.0	110.00	8.00
S_2T_2 (40^0B, 6 h)	55.75	6.25	104.95	6.75	112.25	7.25	113.38	7.75	84.75	6.75	115.50	8.00
S_3T_2 (50^0B, 6 h)	91.50	6.75	137.38	7.00	112.25	7.25	129.88	7.75	108.75	7.25	151.59	7.75
K value	38.94		34.24		115.10		61.55		23.95		117.06	
CV (0.05)	11.07											

The lowest mean score for colour was obtained in 40^{0}B, 4 h aloe gel (6.63). The lowest mean score of 5.81 for flavour was recorded for 30^{0}B, 4 h aloe gel (S_1T_1) while gel in 50^{0}B, 4 h with a mean score of 8.03 recorded as the highest. Osmo dehydrated aloe gel in 50^{0}B, 4 h recorded the highest mean score of 8.06 for taste while gel in 30^{0}B, 4 h recorded the lowest mean score of 6.75.

The highest mean score of 7.25 for consistency was viewed for aloe gel in 50^{0}B osmotic concentration for 4 h and 6 h immersion time while mean score of 6.75 was recorded the lowest for 40^{0}B, 6 h aloe gel. The textural properties of aloe gel after different osmotic treatments revealed that aloe gel in 50^{0}B, 4 h had highest mean score (8.03) with a soft texture followed by 30^{0}B, 6 h and 40^{0}B, 6 h with a mean score of 8.00 and firm texture. The lowest mean score for texture (6.79) was found to be in 30^{0}B, 4 h aloe gel.

Mass transfer characters, biochemical, physical parameters and sensory analysis of osmo dehydrated aloe gel revealed that osmotic treatments of aloe gel at 50^{0}B for 4 h recorded the highest acceptability with good retention of nutritional properties. Hence the treatment 50^{0}B for 4 h was selected for the formulation of RTS beverage.

4.3 FORMULATION OF RTS BBEVERAGE AND STORAGE

4.3.1 Formulation of RTS Beverage

Aloe gel osmo dehydrated in 50^0 B syrup concentration for 4h at 5 per cent and 10 per cent level and 5 per cent total aloe juice were supplemented into Ready To Serve beverages (RTS) of pineapple, lime and cashew apple. The RTS was formulated according to FSSAI specifications with 15 per cent juice, TSS of 12^{0}B and with maximum acidity of 0.3 per cent. Biochemical and sensory parameters of aloe gel supplemented RTS were studied and compared with RTS without aloe gel supplementation. The results are described below.

4.3.1.1 Biochemical Properties of RTS Formulation

Biochemical properties *viz.*, TSS, pH, acidity, reducing sugar, total sugar, ascorbic acid, antioxidant assay and total phenol of RTS beverage formulated were analyzed.

4.3.1.1.a Total Soluble Solids

Total Soluble Solids (TSS) of RTS formulation supplemented with osmo dehydrated aloe gel at 10 per cent (S_2) showed the highest TSS of 12.97^0 B (Table 19). It was followed by RTS formulation supplemented with osmo dehydrated aloe gel at 5 per cent (S_1) in which the TSS was noted as 12.70^0 B. RTS formulation without aloe (S_4) showed the minimum TSS of 12.10^0 B. Under different RTS, lime RTS (F_2) recorded the highest TSS of 12.55^0 B and cashew apple (F_3) and pineapple (F_1) RTS recorded a TSS of 12.53^0 B and 12.51^0B respectively and there was no significant difference among the three fruit RTS beverages.

The highest TSS of 12.93^0B was observed for osmo dehydrated aloe gel 10 per cent in pineapple RTS (S_2F_1) followed by osmo dehydrated aloe gel 5 per cent in pineapple RTS (S_1F_1) with a TSS of 12.67^0B. The lowest TSS of 12.07^0 B was noticed in pineapple RTS without aloe (S_4F_1).

Total Soluble Solids of osmo dehydrated aloe gel 10 per cent in lime RTS (S_2F_2) recorded the highest of 12.97^0 B followed by lime RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_2) with a TSS of 12.77^0 B. Lime RTS prepared without aloe (S_4F_2) recorded the lowest TSS of 12.13^0 B.

The highest TSS of 13.00^0B was observed in cashew apple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_3) followed by cashew apple RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_3) with a TSS of 12.67^0 B. The lowest TSS of 12.10^0 B was noticed in cashew apple RTS without aloe (S_4F_3).

Table 19. Effect of aloe gel supplementation on Total Soluble Solids (^{0}B) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	12.67	12.77	12.67	12.70
S_2 (Osmo dehydrated aloe gel 10%))	12.93	12.97	13.00	12.97
S_3 (Total aloe juice 5%)	12.37	12.33	12.37	12.36
S_4 (Without aloe, control)	12.07	12.13	12.10	12.10
Mean	12.51	12.55	12.53	
CD (0.05)	S- 0.064	F- NS	SxF-0.112	

Table 20. Effect of aloe gel supplementation on pH of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	3.77	3.73	3.77	3.76
S_2 (Osmo dehydrated aloe gel 10%))	3.77	3.77	3.77	3.77
S_3 (Total aloe juice 5%)	3.87	3.83	3.83	3.84
S_4 (Without aloe, control)	4.13	4.20	4.17	4.17
Mean	3.88	3.88	3.88	
CD (0.05)	S- 0.061	F- NS	SxF-0.105	

Among the RTS formulations, there was no significant difference between different fruit RTS beverages but within the fruit RTS beverages significant difference was observed. The highest TSS of 13.00^{0}B was observed for cashew apple RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_3), 12.97^{0}B for lime RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_2) and 12.93^{0}B for osmo dehydrated aloe gel 10 per cent pineapple RTS (S_2F_1) and there was no significant difference between the RTS. This was followed by lime RTS with osmo dehydrated aloe gel 5 per cent (S_1F_2) with a TSS of 12.77^{0}B which did not differ significantly with 12.67^{0}B for pineapple and cashew apple RTS with 5 per cent osmo dehydrated aloe gel. Total aloe juice 5 per cent in pineapple RTS (S_3F_1) with TSS of 12.37^{0}B which did not show any significant difference with total aloe juice 5 per cent in lime RTS (S_3F_2) and cashew apple RTS (S_3F_3). The minimum TSS of 12.07^{0}B was noted in pineapple RTS without aloe (S_4F_1) and lime and cashew apple RTS without aloe recorded a TSS of 12.13^{0}B and 12.10 ^{0}B respectively and there was no significant difference among the treatments.

4.3.1.1.b pH

The pH of RTS formulation without aloe (S_4) showed the highest pH of 4.17 (Table 20) and supplementation with 5 per cent osmo dehydrated aloe gel (S_1) recorded the lowest of pH of 3.76 which showed no significant difference with 10 per cent osmo dehydrated aloe gel in RTS formulation (S_2) with a pH of 3.77. Under different RTS, pineapple (F_1), lime (F_2) and cashew apple (F_3) did not show any significant difference and recorded a pH of 3.88.

The highest pH of 4.13 was observed in pineapple RTS without aloe (S_4F_1). It was followed by total aloe juice 5 per cent in pineapple RTS (S_3F_1) with a pH of 3.87 which did not show any significant difference with 5 per cent and 10 per cent osmo dehydrated aloe gel in pineapple RTS with a pH of 3.77.

Lime RTS without aloe (S_4F_2) recorded the maximum pH of 4.20 and 3.83 for formulation supplemented with 5 per cent total aloe juice (S_3F_2) which showed no significant difference with osmo dehydrated aloe gel 5 per cent (S_1F_2) and 10 per cent with a pH of 3.73 and 3.77 respectively.

The highest pH of 4.17 was observed in cashew apple RTS without aloe (S_4F_3) followed by RTS supplemented with total aloe juice 5 per cent (S_3F_3) with a pH of 3.83 and cashew apple RTS with 5 per cent and 10 per cent osmo dehydrated aloe gel and did not show any significant difference.

RTS formulations without aloe gel supplementation recorded the highest pH in pineapple, lime and cashew apple RTS followed by RTS formulations supplemented with 5 per cent aloe juice which did not show any significant difference with 10 per cent and 5 per cent osmo dehydrated aloe gel in RTS formulations of pineapple, lime and cashew apple.

4.3.1.1.c Acidity

Acidity of RTS formulation supplemented with aloe gel is given in Table 21. RTS formulation supplemented with total aloe juice 5 per cent (S_3) showed the maximum acidity of 0.28 per cent and 0.27 per cent acidity was recorded by RTS supplemented with osmo dehydrated aloe gel 5 per cent (S_1) and 10 per cent (S_2) without any significant difference between them. The lowest acidity of 0.26 per cent was observed in RTS formulation without aloe (S_4). Among different RTS, pineapple (F_1), lime (F_2) and cashew apple (F_3) recorded an acidity of 0.27 per cent and showed no significant difference.

The highest acidity of 0.28 per cent was observed in pineapple RTS supplemented with 5 per cent total aloe juice (S_3F_1) which did not differ significantly with RTS supplemented with 5 per cent (S_1F_1) and 10 per cent osmo dehydrated aloe gel (S_2F_1). Pineapple RTS without aloe (S_4F_1) recorded the lowest acidity of 0.26 per cent.

Table 21. Effect of aloe gel supplementation of aloe gel on acidity (%) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	0.27	0.27	0.27	0.27
S_2 (Osmo dehydrated aloe gel 10%))	0.27	0.27	0.27	0.27
S_3 (Total aloe juice 5%)	0.28	0.28	0.28	0.28
S_4 (Without aloe, control)	0.26	0.26	0.25	0.26
Mean	0.27	0.27	0.27	
CD (0.05)	S-0.006	F- NS		SxF-0.010

Table 22. Effect of aloe gel supplementation on reducing sugar (%) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	4.69	4.62	4.76	4.69
S_2 (Osmo dehydrated aloe gel 10%))	4.96	4.84	4.92	4.91
S_3 (Total aloe juice 5%)	4.41	4.38	4.38	4.39
S_4 (Without aloe, control)	4.32	4.29	4.26	4.29
Mean	4.59	4.53	4.58	
CD (0.05)	S- 0.075	F- NS		SxF- 0.130

Lime RTS supplemented with total aloe juice 5 per cent (S_3F_2) recorded the maximum acidity of 0.28 per cent which did not show any significant difference with 5 per cent (S_1F_2) and 10 per cent osmo dehydrated aloe gel supplementation (S_2F_2). The lowest acidity of 0.26 per cent was noticed in lime RTS without aloe (S_4F_2).

Cashew apple RTS with 5 per cent total aloe juice (S_2F_3) recorded the highest acidity of 0.28 per cent followed by 0.27 per cent acidity for 5 per cent and 10 per cent osmo dehydrated aloe gel supplementation and there was no significant difference between them. Cashew apple RTS without aloe supplementation recorded the lowest acidity (0.25 per cent).

Among the RTS formulations, 5 per cent total aloe juice (S_2F_3) supplemented pineapple, lime and cashew apple RTS did not show any significant difference and recorded an acidity of 0.28 per cent. Pineapple, lime and cashew apple RTS with 10 per cent and 5 per cent osmo dehydrated aloe gel recorded an acidity of 0.27 per cent and there was no significant difference among them.

4.3.1.1.d Reducing Sugar

Reducing sugar of RTS formulation without aloe (S_4) showed the minimum reducing sugar of 4.29 per cent. RTS formulation supplemented with osmo dehydrated aloe gel at 10 per cent (S_2) showed the maximum reducing sugar of 4.91 per cent (Table 22). It was followed by RTS formulation supplemented with 5 per cent osmo dehydrated aloe gel (S_1) with reducing sugar of 4.69 per cent. With respect to different RTS, pineapple RTS (F_1) recorded the highest reducing sugar percentage of 4.59 followed by 4.58 per cent for cashew apple RTS (F_3) and lime RTS (F_1) recorded the lowest reducing sugar of 4.53 per cent and the differences were not significant.

Pineapple RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_1) recorded the highest reducing sugar percentage of 4.96 followed by pineapple RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_1)

with reducing sugar of 4.69 per cent. The lowest reducing sugar of 4.32 per cent was noticed in pineapple RTS without aloe (S_4F_1) which was on par with 5 per cent total aloe juice (S_3F_1).

Reducing sugar of lime RTS supplemented osmo dehydrated aloe gel 10 per cent (S_2F_2) recorded the highest percentage of 4.84 and 4.62 per cent for lime RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_2). Lime RTS without aloe (S_4F_2) recorded the lowest reducing sugar of 4.29 per cent and did not show significant difference with 5 per cent total aloe juice (S_3F_2).

The highest reducing sugar of 4.92 per cent was observed in cashew apple RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_3) followed by 4.76 per cent for cashew apple RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_3). The lowest reducing sugar of 4.26 per cent was noticed in cashew apple RTS without aloe (S_4F_3) which did not differ significantly with 5 per cent total aloe juice (S_4F_3).

Pineapple RTS with 10 per cent osmo dehydrated aloe gel (S_2F_1) recorded the highest reducing sugar of 4.96 per cent and did not show significant difference with lime RTS and cashew apple RTS with 10 per cent osmo dehydrated aloe gel with reducing sugar of 4.96 and 4.92 per cent respectively. The lowest reducing sugar of 4.26 per cent was recorded for cashew apple RTS without aloe and did not differ significantly with 5 per cent total aloe juice in lime and cashew apple RTS.

4.3.1.1.e **Total Sugar**

Total sugar of RTS formulation supplemented with osmo dehydrated aloe gel at 10 per cent (S_2) showed the maximum total sugar of 7.95 per cent (Table 23), 7.67 per cent for 5 per cent osmo dehydrated aloe gel (S_1) and 7.21 per cent RTS for 5 per cent total aloe juice (S_3) and without aloe (S_4) showed the minimum total sugar of 7.13 per cent. Among different fruit RTS, no significant difference was observed and total sugar content ranged from 7.46 to 7.52 per cent.

Table 23. Effect of aloe gel supplementation on total sugar (%)of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	7.60	7.66	7.74	7.67
S_2 (Osmo dehydrated aloe gel 10%))	7.88	8.02	7.95	7.95
S_3 (Total aloe juice 5%)	7.23	7.23	7.17	7.21
S_4 (Without aloe, control)	7.11	7.17	7.11	7.13
Mean	7.46	7.52	7.49	
CD (0.05)	S- 0.119	F-NS		SxF- 0.207

Table 24. Effect of aloe gel supplementation on ascorbic acid (mg /100g) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	15.28	15.28	18.06	16.21
S_2 (Osmo dehydrated aloe gel 10%))	18.06	19.45	20.84	19.45
S_3 (Total aloe juice 5%)	15.28	16.67	18.06	16.67
S_4 (Without aloe, control)	12.50	13.89	16.67	14.35
Mean	15.28	16.32	18.41	
CD (0.05)	S- 2.242	F- 1.942		SxF- 3.884

Pineapple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_1) recorded the highest total sugar percentage of 7.88 followed by 7.60 per cent for pineapple RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_2F_1). Pineapple RTS without aloe (S_4F_1) recorded the lowest total sugar of 7.11 per cent and did not show any significant difference with 5 per cent total aloe juice in pineapple RTS (S_3F_1).

Total sugar of lime RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_2) recorded the highest percentage of 8.02 and 7.66 per cent for lime RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_2). Lime RTS without aloe (S_4F_2) recorded the lowest total sugar of 7.17 per cent and 7.23 per cent for 5 per cent total aloe juice and there was no significant difference between them.

The highest total sugar of 7.95 per cent was observed for osmo dehydrated aloe gel 10 per cent in cashew apple RTS (S_2F_3) followed by 7.74 per cent for cashew apple RTS with 5 per cent osmo dehydrated aloe gel (S_1F_3). The lowest total sugar of 7.11 per cent was noticed in cashew apple RTS without aloe (S_4F_3) which did not differ significantly with 5 per cent total aloe juice (S_3F_3).

Among all RTS formulations, total sugar of 10 per cent osmo dehydrated aloe gel in pineapple, lime and cashew apple RTS was recorded as 7.88, 8.02, 7.95 per cent respectively and the RTS formulations did not differ significantly. No significant difference was observed for total sugar content of RTS formulation without aloe and with 5 per cent total aloe juice supplementation in RTS of pineapple, lime and cashew apple.

4.3.1.1.f Ascorbic Acid

Ascorbic acid of RTS formulation supplemented with osmo dehydrated aloe gel 10 per cent (S_2) recorded highest ascorbic acid of 19.45 mg/100g (Table 24). Ascorbic acid of RTS formulation supplemented with osmo dehydrated aloe gel 5 percent was recorded as 16.21 mg/100g which did not show significant difference with 5 per cent total aloe juice (S_3) (16.67 mg/100g) and without aloe (S_4) (14.82 mg/100g). Under different fruit RTS, the highest ascorbic acid content of 18.41 mg/100g was observed for cashew apple RTS (F_3) followed by 16.32 mg/100g for lime RTS (F_2) which shows no significant difference with pineapple RTS (F_1) (15.28 mg/100g).

Pineapple RTS formulations with 10 per cent osmo dehydrated aloe gel (S_2F_1) recorded the highest ascorbic acid of 18.06 mg/100g followed by 5 per cent osmo dehydrated aloe gel (S_1F_1) and total aloe juice 5 per cent (S_3F_1), both recorded an ascorbic acid of 15.28 mg/100g which showed no significant difference. The lowest ascorbic acid content of 12.5 mg/100g was recorded with RTS without aloe supplementation (S_4F_1).

Lime RTS with osmo dehydrated aloe gel 10 per cent (S_2F_2) recorded an ascorbic acid of 19.45 mg/100g followed by 16.67 mg/100g for 5 per cent total aloe juice (S_3F_2) and 15.28 mg/100g for osmo dehydrated aloe gel 5 per cent (S_1F_2). Lime RTS without aloe (S_4F_2) recorded the lowest ascorbic acid content.

Ascorbic acid of 20.84 mg/100g was observed for cashew apple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_3), 18.06 mg/100g for both osmo dehydrated aloe gel 5 per cent (S_1F_3) and 5 per cent total aloe juice (S_3F_3)which did not show significant difference. The lowest ascorbic acid of 16.67 mg/100g was recorded for RTS without aloe (S_4F_3).

Cashew apple RTS with 10 per cent osmo dehydrated aloe gel recorded the highest ascorbic acid of 20.84 mg/100g (S_2F_3) followed by 19.45 mg/100g for lime RTS with 10 per cent osmo dehydrated and pineapple RTS without aloe (S_4F_1) recorded lowest ascorbic acid of 12.5 mg/100g.

4.3.1.1.g Antioxidant Activity

RTS formulation supplemented with osmo dehydrated aloe gel at 10 per cent (S_2) showed the maximum antioxidant activity of 82.74 per cent (Table 25).

Table 25. Effect of aloe gel supplementation on antioxidant activity (%) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	85.28	80.20	79.52	81.67
S_2 (Osmo dehydrated aloe gel 10%))	86.29	81.22	80.72	82.74
S_3 (Total aloe juice 5%)	83.08	77.16	78.31	79.52
S_4 (Without aloe, control)	78.34	70.73	77.11	75.39
Mean	83.25	77.33	78.92	
CD (0.05)	S- 0.472	F- 0.409		SxF-0.818

Table 26. Effect of aloe gel supplementation on total phenols ($\mu g\ g^{-1}$) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	89.17	91.23	89.47	89.96
S_2 (Osmo dehydrated aloe gel 10%))	90.89	92.52	90.51	91.31
S_3 (Total aloe juice 5%)	89.41	91.66	88.52	89.86
S_4 (Without aloe, control)	81.95	85.27	74.14	80.46
Mean	87.86	90.17	85.66	
CD (0.05)	S- 0.350	F- 0.303		SxF- 0.606

Antioxidant activity of osmo dehydrated aloe gel at 5 per cent (S_1) was 81.67 per cent and 79.52 per cent for RTS formulation with 5 per cent total aloe juice (S_3) and without aloe (S_4) showed the minimum antioxidant activity of 75.39 per cent. Among different fruit RTS, pineapple (F_1) recorded the highest antioxidant percentage of 83.25, 78.92 per cent for cashew apple (F_3) and lime (F_2) recorded the lowest antioxidant of 77.33 per cent.

Pineapple RTS with 10 per cent osmo dehydrated aloe gel (S_2F_1) recorded the highest antioxidant of 86.29 per cent and 85.28 per cent for 5 per cent osmo dehydrated aloe gel (S_2F_1). The lowest antioxidant activity of 78.34 per cent was shown by pineapple RTS without aloe (S_4F_1).

Antioxidant of lime RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_2) recorded the highest percentage of 81.22 followed by 80.20 per cent for lime RTS supplemented with 5 per cent osmo dehydrated aloe gel (S_1F_2). Lime RTS without aloe (S_4F_2) recorded the lowest antioxidant activity of 70.73 per cent.

Antioxidant activity of 80.72 per cent was observed for cashew apple RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_3), 79.52 per cent for 5 per cent osmo dehydrated aloe gel (S_1F_3) and the lowest antioxidant activity of 77.11 per cent was noticed in cashew apple RTS without aloe (S_4F_3).

With respect to all RTS formulations, the highest antioxidant activity of 86.29 per cent was observed for pineapple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_1) and lowest antioxidant percentage of 70.73 was recorded for lime RTS without aloe (S_4F_2).

4.3.1.1.h Total Phenol

Total phenol content of RTS formulation supplemented with 10 per cent osmo dehydrated aloe gel (S_2) recorded the highest phenol content of 91.31 $\mu g\ g^{-1}$ (Table 26). Phenol content of RTS formulation supplemented with 5 per cent osmo dehydrated aloe gel (S_1) was recorded as 89.96 µg g-1 which did not show significant difference with 5 per cent total aloe juice (S_3) (89.86 µg g^{-1}) and without aloe (S_4) recorded the minimum phenol content of 80.46 µg g^{-1}. With respect to different fruit RTS, the highest phenol content of 90.17 µg g^{-1} was recorded for lime (F_2), 87.86 µg g^{-1} for pineapple (F_1) and cashew RTS (F_3) recorded the lowest phenol of 85.66 µg g^{-1}.

The highest phenol content of 90.89 µg g^{-1} was observed for pineapple RTS supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_1) followed by RTS with 5 per cent total aloe juice (S_3F_1) with phenol content of 89.41 µg g^{-1}. The lowest phenol content of 81.95 µg g^{-1} was observed for pineapple RTS without aloe (S_4F_1).

Lime RTS formulation supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_2) recorded the highest phenol content of 92.52 µg g^{-1} and 91.66 µg g^{-1} for 5 per cent total aloe juice (S_3F_2) and RTS without aloe (S_4F_2) recorded the lowest phenol content of 85.27 µg g^{-1}.

Among cashew apple RTS formulations, maximum phenol content of 90.51 µg g^{-1} was observed for osmo dehydrated aloe gel 10 per cent (S_2F_3), 89.47 µg g^{-1} for 5 per cent osmo dehydrated aloe gel (S_1F_3). Minimum phenol content of 74.14 µg g^{-1} was recorded for cashew apple RTS without aloe (S_4F_3).

Among all the RTS formulations, the highest phenol content of 92.52 µg g^{-1} was recorded for lime RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_2) and the lowest phenol content of 74.14 µg g^{-1} was observed for cashew apple RTS without aloe (S_4F_3).

4.3.1.1.i Crude Fibre

Crude fibre content of RTS formulation supplemented with 10 per cent osmo dehydrated aloe gel (S_2) recorded the highest crude fibre of 1.22 per cent (Table 27). Crude fibre of RTS formulation supplemented with 5 per cent osmo dehydrated aloe gel (S_1) was recorded as 0.68 per cent, 0.045 per cent for 5 per cent total aloe juice (S_3) and without aloe (S_4) recorded the minimum crude fibre of 0.018 per cent. With respect to different fruit RTS, the highest crude fibre of 0.55 per cent was recorded for lime (F_2), 0.49 per cent for pineapple (F_1) and cashew RTS (F_3) recorded the lowest crude fibre of 0.45 per cent.

The highest crude fibre of 1.30 per cent was observed for pineapple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_1) followed by RTS with 5 per cent total aloe juice (S_3F_1) with crude fibre of 0.65 per cent. The lowest crude fibre of 0.006 per cent was observed for pineapple RTS without aloe (S_4F_1).

Lime RTS formulation supplemented with osmo dehydrated aloe gel 10 per cent (S_2F_2) recorded the highest crude fibre of 1.37 per cent and 0.60 per cent for 5 per cent total aloe juice (S_3F_2) and RTS without aloe (S_4F_2) recorded the lowest crude fibre of 0.026 per cent.

Among cashew apple RTS formulations, maximum crude fibre of 0.99 per cent was observed for 10 per cent osmo dehydrated aloe gel (S_2F_3), 0.79 per cent for 5 per cent osmo dehydrated aloe gel (S_1F_3). Minimum crude fibre of 0.003 per cent was recorded for cashew apple RTS without aloe (S_4F_3).

Among all the RTS formulations, the highest crude fibre of 1.37 per cent was recorded for lime RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_2) and the lowest crude fibre of 0.003 per cent was observed for cashew apple RTS without aloe (S_4F_3).

Table 27. Effect of aloe gel supplementation on crude fibre (%) of RTS beverages

Supplementation of aloe gel	RTS beverages			Mean
	F_1 (Pineapple)	F_2 (Lime)	F_3 (Cashew apple)	
S_1 (Osmo dehydrated aloe gel 5%)	0.67	0.60	0.79	0.68
S_2 (Osmo dehydrated aloe gel 10%))	1.30	1.37	0.99	1.22
S_3 (Total aloe juice 5%)	0.036	0.07	0.033	0.045
S_4 (Without aloe, control)	0.006	0.026	0.003	0.012
Mean	0.49	0.52	0.45	
CD (0.05)	S- 0.008	F- 0.004		SxF- 0.007

4.3.1.2 Sensory Evaluation of Formulated RTS Beverages

Ready To Serve beverages of pineapple, lime and cashew apple supplemented with osmo dehydrated aloe gel (50^0B for 4 h), total aloe juice (5 per cent) and RTS without supplement were analysed for various sensorial attributes for their acceptance by using 9 point hedonic scale. The sensory scores obtained with respect to appearance, colour, flavour, taste and overall acceptability are presented in Table 28.

Pineapple RTS supplemented with 10 per cent osmo dehydrated aloe gel (S_2F_1) recorded the highest mean score for appearance (8.47) followed by lime RTS with 10 per cent osmo dehydrated aloe gel (S_2F_2) (8.41) and osmo dehydrated aloe gel 10 per cent in cashew apple RTS (S_2F_3) (8.38). The lowest mean score for appearance was observed for total aloe juice 5 per cent supplemented in pineapple, lime and cashew apple RTS (8.03).

Table28. Effect of supplementation of aloe gel in the organoleptic qualities of RTS beverages

Treatments	Appearance		Colour		Flavour		Taste		Overall acceptability	
	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score
S_1F_1	230.58	8.41	185.25	8.13	189.09	8.13	198.56	8.31	180.19	8.16
S_2F_1	242.36	8.47	203.06	8.22	230.52	8.22	216.28	8.41	209.88	8.31
S_3F_1	162.29	8.03	163.44	8.00	153.81	8.00	178.25	8.19	180.19	8.16
S_4F_1	176.87	8.12	191.19	8.16	184.78	8.16	182.50	8.22	186.31	8.19
S_1F_2	189.34	8.19	197.13	8.19	203.25	8.25	204.47	8.34	209.88	8.31
S_2F_2	230.58	8.41	232.75	8.38	234.03	8.41	222.19	8.43	227.69	8.41
S_3F_2	161.09	8.03	186.22	8.13	186.28	8.16	182.50	8.22	182.81	8.16
S_4F_2	178.77	8.13	191.19	8.16	217.47	8.16	186.75	8.25	186.13	8.19
S_1F_3	190.55	8.19	197.13	8.19	231.05	8.22	186.75	8.25	203.94	8.28
S_2F_3	224.69	8.38	226.81	8.34	252.72	8.41	210.36	8.38	215.81	8.34
S_3F_3	161.09	8.03	180.28	8.09	187.31	8.13	160.53	8.09	170.94	8.09
S_4F_3	172.88	8.09	179.31	8.09	191.97	8.16	180.84	8.22	174.25	8.13
K value	50.53		28.06		31.78		14.44		20.55	
CV(0.05)	19.68									

Sensory analysis on the quality attribute colour revealed that the highest score for colour was noted in osmo dehydrated aloe gel 10 per cent in lime RTS (S_2F_2) (8.38), followed by cashew apple RTS (S_2F_3) (8.34) and pineapple RTS (S_2F_1) (8.22). The lowest colour score was obtained for total aloe juice 5 per cent supplement in pineapple RTS (S_3F_1) (8.00).

Of all the RTS formulations, lime and cashew apple RTS with osmo dehydrated aloe gel 10 per cent recorded the highest mean score for flavour (8.41) followed by 5 per cent osmo dehydrated aloe gel in lime RTS (8.25) and pineapple RTS with total aloe juice 5 per cent (S_3F_1) recorded the lowest mean score (8.00).

Among the RTS formulations, lime RTS with 10 per cent osmo dehydrated aloe gel (S_2F_2) recorded the highest mean score for taste (8.43) followed by 10 per cent osmo dehydrated aloe gel in pineapple RTS (8.41) and cashew apple RTS (8.38). Cashew apple RTS supplemented with 5 per cent total aloe juice (S_3F_3) recorded the lowest mean score for taste (8.09).

Overall acceptability of the RTS formulations revealed that osmo dehydrated aloe gel 10 per cent in lime RTS (S_2F_2) recorded the highest mean score (8.41) followed by 10 per cent osmo dehydrated aloe gel in cashew apple RTS (S_2F_3) (8.34) and pineapple RTS (S_2F_1) (8.31). The lowest mean score (8.09) was noticed in cashew apple RTS supplemented with 5 per cent total aloe juice (S_3F_3).

When pineapple RTS formulations was analyzed, highest score for sensory attribute was observed for RTS with osmo dehydrated aloe gel 10 per cent (S_2F_1) which recorded highest score for appearance (8.47), colour (8.22), flavour (8.22), taste (8.41) and overall acceptability (8.31). On analyzing lime RTS formulations, osmo dehydrated aloe gel 10 per cent (S_2F_2) supplemented RTS recorded the highest score for appearance (8.41), colour (8.38), flavour (8.41), taste (8.43) and overall acceptability (8.41). Similarly when cashew apple RTS formulations were analyzed, the highest score for appearance (8.38), colour (8.34), flavour (8.41), taste (8.38) and overall acceptability (8.34) was observed for 10 per cent osmo dehydrated aloe gel in RTS (S_2F_3).

On analysing the biochemical and sensory parameters of aloe gel supplemented RTS beverages, 10 per cent osmo dehydrated aloe gel supplemented pineapple RTS, lime RTS and cashew apple RTS were found superior in biochemical and sensory qualities. Hence pineapple RTS, lime RTS and cashew apple RTS supplemented with 10 % osmo dehydrated aloe gel were taken for further storage stability study.

4.3.2 Storage of RTS Formulation

Pineapple, lime and cashew apple RTS supplemented with 10 percent osmo dehydrated aloe gel, selected as best RTS formulations were kept under room temperature and storage stability study was conducted for three months. The stored RTS formulations were analysed for biochemical, sensory and microbial qualities at fortnight intervals.

4.3.2.1 Biochemical Properties of Stored RTS Formulations

4.3.2.1.a Total Soluble Solids

Total Soluble Solids recorded for RTS formulations of pineapple (B_1) and cashew apple (B_3) was 12.80^0B and 12.83^0 B for lime RTS (B_2) at the time of storage and there was no significant difference among the formulations. After 15 days of storage, TSS increased to 13.53^0 B for pineapple RTS (B_1), 13.87^0 B for lime RTS (B_2) and 13.57^0 B for cashew apple RTS (B_3.). Pineapple RTS(B_1) formulation recorded a TSS of 14.30^0 B, 14.87^0 B, 15.57^0 B, 15.97^0 B, and 16.80^0 B after 30, 45, 60, 75 and 90 days of storage respectively. During storage, TSS of lime RTS formulation (B_2) was observed as 14.77^0 B after 30 days, 15.57^0 B after 45 days, 16.07^0 B after 60 days, 16.77^0 B after 75days and 17.57^0 B after 90 days of storage. TSS of cashew apple RTS formulation (B_3) also increased during

Table 29. Effect of storage on Total Soluble Solids (^{0}B) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	12.80	13.53	14.30	14.87	15.57	15.97	16.80	14.83
B_2(Lime)	12.83	13.87	14.77	15.57	16.07	16.77	17.57	15.35
B_3(Cashew apple)	12.80	13.57	14.53	15.30	15.87	16.57	17.17	15.11
Mean (D)	12.81	13.66	14.53	15.24	15.83	16.43	17.18	
CD (0.05)	B – 0.041			D – 0.063			BxD- 0.109	

Table 30. Effect of storage on pH of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	3.97	3.57	3.13	2.77	2.37	2.03	1.77	2.80
B_2(Lime)	3.97	3.37	2.97	2.63	2.27	1.83	1.57	2.65
B_3(Cashew apple)	3.97	3.63	3.37	2.87	2.43	1.97	1.73	2.85
Mean (D)	3.97	3.52	3.16	2.75	2.36	1.94	1.69	
CD (0.05)	B -0.047			D -0.071			BxD -0.125	

Table 31. Effect of storage on acidity (%) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	0.26	0.28	0.32	0.37	0.43	0.48	0.54	0.38
B_2(Lime)	0.26	0.29	0.33	0.38	0.47	0.54	0.65	0.42
B_3(Cashew apple)	0.25	0.27	0.29	0.34	0.39	0.47	0.55	0.37
Mean (D)	0.26	0.28	0.31	0.36	0.42	0.49	0.58	
CD (0.05)	R - 0.004			D - 0.006			TxD -0.010	

storage and recorded 14.53^0 B, 15.30^0 B,15.87^0 B,16.57^0 B and 17.17^0 B after 30, 45, 60, 75 and 90 days of storage respectively.

Among the three RTS formulations, the highest TSS of 15.35^0 B was recorded for lime RTS (B_2) followed by cashew apple RTS (B_3) with 15.11^0 B. The lowest TSS of 14.83^0 B was observed for pineapple RTS (B_1) during storage. Storage days had significant influence on the TSS of RTS beverages in which the highest TSS of 17.17^0 B was noticed on 90^{th} day of storage where as the lowest TSS of 12.81^0 B was observed before storage.

4.3.2.1.b pH

Pineapple (B_1), lime (B_2) and cashew apple (B_3) RTS formulations recorded a pH of 3.97 at the time of storage and the formulations did not show any significant difference. During storage, pH of pineapple formulation (B_1) was noticed as 3.57, 3.13, 2.77, 2.37, 2.03 and 1.77 after 15, 30, 45, 60, 75 and 90 days of storage respectively. Lime RTS (B_2) formulation recorded a pH of 3.37 after 15 days, 2.97 after 30 days, 2.63 after 45 days, 2.27 after 60 days, 1.83 after 75 days and 1.57 after 90 days of storage. pH of cashew apple RTS formulation (B_3) also decreased during storage and recorded 3.63, 3.37, 2.87, 2.43, 1.97 and 1.73 after 15, 30, 45, 60, 75 and 90 days of storage respectively.

RTS beverages and storage days had significant influence on pH. Cashew apple RTS (B_3) recorded the highest pH of 2.85 followed by pineapple RTS (B_1) with pH 2.80. During storage, lowest pH of 2.65 was observed for lime RTS (B_2). Among the storage days the highest pH of 3.97 was noticed at the time of storage whereas the lowest pH of 1.69 was observed on 90^{th} day of storage.

4.3.2.1.c Acidity

RTS formulations of pineapple (B_1) and lime (B_2) recorded an acidity of 0.26 per cent and for cashew apple RTS (B_3), 0.25 per cent (S_2F_3) was observed at the time of storage and there was no significant difference among RTS formulations. During storage, acidity of pineapple RTS (B_1) formulation was observed as 0.28, 0.32, 0.37, 0.43, 0.48 and 0.54 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. Lime RTS (B_2) formulation recorded an acidity of 0.29 per cent after 15 days, 0.33 per cent after 30 days, 0.38 per cent after 45 days, 0.47 per cent after 60 days, 0.54 per cent after 75 days and 0.65 per cent after 90 days of storage. Acidity of cashew apple RTS (B_3) formulation was noticed as 0.27, 0.29, 0.31, 0.36, 0.42, 0.49 and 0.58 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively.

With respect to the three RTS formulations, lime RTS (B_2) recorded the highest acidity of 0.42 per cent followed by pineapple RTS (B_1) with 0.38 per cent acidity during storage and cashew apple RTS (B_3) recorded the lowest acidity of 0.37 per cent during storage. Storage days impart significant influence on acidity in which the highest acidity of 0.58 per cent was noticed after 90 days of storage whereas the lowest acidity of 0.26 per cent was observed before storage.

4.3.2.1.d Reducing Sugar

Reducing sugar of pineapple RTS (B_1), lime RTS (B_2) and cashew apple RTS (B_3) at the time of storage was recorded as 4.84 per cent and the formulations did not differ significantly. Reducing sugar of pineapple RTS (B_1) formulation was noted as 5.41, 6.38, 7.69, 8.82, 10.52, and 13.33 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. Lime RTS (B_2) formulation recorded reducing sugar of 5.57 per cent after 15 days, 6.59 per cent after 30 days, 8.11 per cent after 45 days, 9.38 per cent after 60 days, 11.11 per cent after 75 days and 14.29 per cent after 90 days of storage. During storage, reducing sugar of cashew apple RTS (B_3) formulation increased and observed as 5.36, 6.46, 7.50, 8.83, 10.91 and 13.97 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively.

Among the RTS formulations, the highest reducing sugar of 8.56 per cent was recorded for lime RTS (B_2) followed by cashew apple RTS (B_3) with 8.27 per

Table 32. Effect of storage on reducing sugar (%) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	4.84	5.41	6.38	7.69	8.82	10.52	13.33	8.14
B_2(Lime)	4.84	5.57	6.59	8.11	9.38	11.11	14.29	8.56
B_3(Cashew apple)	4.84	5.36	6.46	7.50	8.83	10.91	13.97	8.27
Mean (D)	4.84	5.44	6.47	7.77	9.01	10.85	13.86	
CD (0.05)	B – 0.117			D – 0.179			BxD -0.311	

Table 33. Effect of storage on total sugar (%) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	7.74	8.65	9.72	11.36	13.42	16.98	22.07	12.85
B_2(Lime)	7.81	9.18	10.27	12.79	15.22	20.91	25.18	14.49
B_3(Cashew apple)	7.74	8.82	10.51	12.42	14.71	19.15	23.84	13.88
Mean (D)	7.76	8.88	10.17	12.19	14.45	19.01	23.69	
CD (0.05)	B – 0.324			D – 0.496			BxD -0.859	

Table 34.Effect of storage on ascorbic acid (mg /100g) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	18.06	16.67	15.28	13.89	12.5	9.72	5.56	13.09
B_2(Lime)	19.45	18.06	16.67	15.28	13.89	12.50	8.33	14.88
B_3(Cashew apple)	20.84	19.45	15.28	13.89	12.50	11.11	9.72	14.68
Mean (D)	19.45	18.06	15.74	14.35	12.96	11.11	7.87	
CD (0.05)	B–1.349		D – 2.060				BxD -3.569	

cent and the lowest reducing sugar of 8.14 per cent was observed for pineapple RTS (B_1) during storage. Under the storage days, the lowest reducing sugar percentage of 4.84 was noticed at the time of storage whereas the highest reducing sugar of 4.84 per cent was observed after 90 days of storage.

4.3.2.1.e Total Sugar

Total sugar recorded for RTS formulations of pineapple (B_1) and cashew apple (B_3) was 7.74 per cent and for lime RTS (B_2), it was 7.81 per cent at the time of storage and the RTS formulations did not differ significantly. Pineapple RTS (B_1) formulation recorded total sugar of 8.65, 9.72, 11.36, 13.42, 16.98 and 22.07 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. During storage, total sugar of lime RTS formulation (B_2) was observed as 9.18 per cent after 15 days, 10.27 per cent after 30 days, 12.79 per cent after 45 days, 15.22 per cent after 60 days, 20.91 per cent after 75 days and 25.18 per cent after 90 days of storage. Total sugar of cashew apple RTS formulation (B_3) increased during storage and recorded as 8.82, 10.51, 12.42, 14.71, 19.15 and 23.84 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively.

With respect to the three RTS formulations, lime RTS (B_2) recorded the highest total sugar of 14.49 per cent followed by cashew apple RTS (B_3) with 13.88 per cent. The lowest total sugar of 12.85 per cent was observed for pineapple RTS (B_1) during storage. Storage days had significant influence on the total sugar of RTS beverages and the lowest total sugar of 7.76 per cent was observed before storage which increased to 23.69 per cent on 90th day of storage.

4.3.2.1.f Ascorbic Acid

Ascorbic acid of pineapple RTS (B_1) formulation was recorded as 18.06 mg/100g and 19.45 mg/100g for lime RTS (B_2) and 20.84 mg/100g for cashew apple RTS (B_3) at the time of storage and there was no significant difference between the RTS formulations. During storage, ascorbic acid of pineapple RTS (B_1) formulation was observed as 16.67, 15.28, 13.89, 12.50, 9.72 and 5.56

mg/100g after 15, 30, 45, 60, 75 and 90 days of storage respectively. Lime RTS (B_2) formulation recorded ascorbic acid of 18.06 mg/100g after 15 days, 16.67 mg/100g after 30 days, 15.28 mg/100g after 45 days, 13.89 mg/100g after 60 days, 12.50 mg/100g after 75 days and 8.33 mg/100g after 90 days of storage. Ascorbic acid of cashew apple RTS (B_3) formulation was noticed as 19.45, 15.28, 13.89, 12.50, 11.11 and 9.72 mg/100g after 15, 30, 45, 60, 75 and 90 days of storage respectively.

Among the RTS formulations, the highest ascorbic acid content of 14.88 mg/100g was recorded for lime RTS (B_2) which did not differ significantly with cashew apple RTS (B_3) with ascorbic acid content of 14.68 mg/100g. During storage, the lowest ascorbic acid content of 13.09 mg/100gwas observed for pineapple RTS (B_1).. With respect to storage days, the highest ascorbic acid content of 20.84 mg/100g was noticed at the time of storage which did not show any significant difference with ascorbic acid content after 15 days of storage (18.06 mg/100g). Thereafter ascorbic acid decreased with storage and recorded the lowest ascorbic acid of 7.87 mg/100g after 90 days of storage.

4.3.2.1.g Antioxidant Activity

Antioxidant assay of RTS formulations revealed that pineapple RTS (B_1) formulation recorded the highest antioxidant activity of 86.12 per cent and 80.88 per cent for lime RTS (B_2) and 81.12 per cent for cashew apple RTS (B_3) at the time of storage. Antioxidant activity of pineapple RTS (B_1) formulation was noted as 84.77, 82.91, 81.56, 77.83, 75.47 and 73.43 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. During storage, antioxidant activity of lime RTS (B_2) formulation was observed as 78.85 per cent after 15 days, 76.14 per cent after 30 days, 74.96 per cent after 45 days, 72.08 per cent after 60 days, 70.73 per cent after 75 days and 68.36 per cent after 90 days of storage. Cashew apple RTS formulation recorded antioxidant activity of 78.71, 77.51, 72.29, 69.07, 66.26 and 58.64 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively.

Table 35. Effect of storage on antioxidant activity (%) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	86.12	84.77	82.91	81.56	77.83	75.47	73.43	80.29
B_2(Lime)	80.88	78.85	76.14	74.96	72.08	70.73	68.36	74.57
B_3(Cashew apple)	81.12	78.71	77.51	72.29	69.07	66.26	58.64	71.94
Mean (D)	82.71	80.78	78.85	76.27	72.99	70.82	66.81	
CD (0.05)	B – 0.350			D – 0.534			BxD -0.926	

Table 36. Effect of storage on total phenol ($\mu g\ g^{-1}$) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	90.99	89.72	88.67	87.04	85.32	84.24	82.77	86.97
B_2(Lime)	92.22	89.49	88.17	86.61	85.42	84.11	80.53	86.65
B_3(Cashew apple)	90.83	89.27	86.53	84.99	83.61	81.37	79.26	85.13
Mean (D)	91.35	89.49	87.79	86.22	84.79	83.24	80.85	
CD (0.05)	B – 0.198			D – 0.303			BxD – 0.525	

Table 37. Effect of storage on crude fibre (%) of RTS formulations

RTS beverages	Days after storage (D)							Mean (B)
	0	15	30	45	60	75	90	
B_1(Pineapple)	1.30	1.30	1.30	1.29	1.29	1.29	1.29	1.29
B_2(Lime)	1.38	1.38	1.38	1.38	1.37	1.37	1.37	1.38
B_3(Cashew apple)	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.99
Mean (D)	1.22	1.22	1.22	1.22	1.21	1.21	1.21	
CD (0.05)	B – NS			D – NS			BxD – NS	

Among the RTS formulations, the lowest antioxidant activity of 71.94 per cent was recorded for cashew apple RTS (B_3) and the highest antioxidant activity of 80.29 per cent was observed for pineapple RTS (B_1) followed by lime RTS (B_2) with antioxidant percentage of 74.57. During storage, the highest antioxidant activity of 82.71 per cent was observed at the time of storage which decreased and the lowest antioxidant percentage of 66.81 was observed after 90 days of storage.

4.3.2.1.h Total Phenol

Total phenol content of pineapple RTS (B_1) was recorded as 90.99 $\mu g\ g^{-1}$, 92.22 $\mu g\ g^{-1}$ for lime RTS (B_2) and 90.83 $\mu g\ g^{-1}$ for cashew apple RTS (B_3) at the time of storage. During storage, phenol content of pineapple RTS (B_1) formulation was observed as 89.72, 88.67, 87.04, 85.32, 84.24 and 82.77 $\mu g\ g^{-1}$ after 15, 30, 45, 60, 75 and 90 days of storage respectively. Lime RTS (B_2) formulation recorded phenol content of 89.49 $\mu g\ g^{-1}$ after 15 days, 88.17 $\mu g\ g^{-1}$ after 30 days, 86.61 $\mu g\ g^{-1}$ after 45 days, 85.42 $\mu g\ g^{-1}$ after 60 days, 84.11 $\mu g\ g^{-1}$ after 75 days and 80.53 $\mu g\ g^{-1}$ after 90 days of storage. Cashew apple RTS (B_3) formulation recorded a phenol content of 89.27, 86.53, 84.99, 83.61, 81.37 and 79.26 $\mu g\ g^{-1}$ after 15, 30, 45, 60, 75 and 90 days of storage respectively.

With respect to three RTS formulations, pineapple RTS formulations recorded the highest phenol content of 86.97 $\mu g\ g^{-1}$ and lime RTS (B_2) and cashew apple RTS (B_3) recorded 86.65 $\mu g\ g^{-1}$ and 85.13 $\mu g\ g^{-1}$ respectively. Among storage days, the highest phenol content of 91.35 $\mu g\ g^{-1}$ was noticed at the time of storage and it decreased to 80.85 $\mu g\ g^{-1}$ after 90 days of storage.

4.3.2.1.h Crude Fibre

Crude fibre content of RTS formulations showed no considerable effect on storage. Crude fibre content of RTS formulations revealed that lime RTS (B_2) formulation recorded the highest crude fibre of 1.38 per cent and 1.30 per cent for pineapple RTS (B_1) and 0.99 per cent for cashew apple RTS (B_3) at the time of storage. Crude fibre content of pineapple RTS (B_1) formulation was noted as

1.30, 1.30, 1.29, 1.29, 1.29 and 1.29 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. During storage, crude fibre of lime RTS (B_2) formulation was noticed as 1.38 per cent after 15 days, 1.38 per cent after 30 days, 1.38 per cent after 45 days, 1.37 per cent after 60 days, 1.37 per cent after 75 days and 1.37 per cent after 90 days of storage. Cashew apple RTS formulation recorded crude fibre of 0.99, 0.99, 0.98, 0.98, 0.98 and 0.98 per cent after 15, 30, 45, 60, 75 and 90 days of storage respectively. Among the RTS formulations, the lowest crude fibre of 0.99 per cent was recorded for cashew apple RTS (B_3) and the highest crude fibre of 1.38 per cent was observed for lime RTS (B_2) followed by pineapple RTS (B_1) with crude fibre of 1.29 per cent. During storage, the crude fibre content showed no significant difference and it ranges from 1.22 per cent at the time of storage to 1.21 per centafter 90 days of storage.

4.3.2.2 Sensory Evaluation of Stored RTS Beverages

Pineapple, lime and cashew apple RTS supplemented with 10 per cent osmo dehydrated aloe gel were analysed for various sensorial attributes for their acceptance by using 9 point hedonic scale. The sensory scores and mean ranks obtained with respect to appearance, colour, flavour, taste and overall acceptability of the stored RTS beverages for a period of three months at fortnightly intervals are presented in Table 38.

Among the RTS formulations, the highest mean score for appearance (8.56) was recorded for lime RTS (B_2) followed by cashew apple RTS (B_3) (8.47) and pineapple RTS (B_1) (8.41) at the time of storage. After 90 days of storage lime RTS recorded the highest mean score of 8.28 and cashew apple RTS and pineapple RTS recorded a mean score of 8.13 and 8.09 respectively. All RTS formulations recorded acceptable score for appearance after 90 days of storage.

On analyzing the sensory attribute colour of the RTS formulations, the highest mean score for colour (8.59) was recorded for lime RTS (B_2) followed by cashew apple RTS (B_3) (8.56) and pineapple RTS (B_1) (8.41), at the time of

Table 38. Effect of storage on sensory qualities of RTS beverages

Attributes	Days after storage													
Appearance	Before storage		15		30		45		60		75		90	
	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score	Mean rank	Mean score
S_2F_1	45.00	8.41	44.50	8.34	45.50	8.28	45.50	8.25	45.00	8.19	45.00	8.16	45.00	8.09
S_2F_2	52.50	8.56	53.50	8.53	54.50	8.47	54.50	8.44	54.00	8.38	54.00	8.34	54.00	8.28
S_2F_3	48.00	8.47	47.50	8.41	45.50	8.28	45.50	8.25	46.50	8.22	46.50	8.19	46.50	8.13
K value	1.57		2.36		3.29		3.45		3.32		3.62		4.60	
Colour														
S_2F_1	46.00	8.50	45.00	8.44	44.50	8.38	44.50	8.34	44.50	8.28	44.50	8.25	44.50	8.19
S_2F_2	50.50	8.59	51.00	8.56	50.50	8.50	50.50	8.47	50.50	8.41	50.50	8.38	50.50	8.31
S_2F_3	49.00	8.56	49.50	8.53	50.50	8.47	50.50	8.41	50.50	8.38	50.50	8.31	45.50	8.25
K value	0.58		1.07		1.33		1.35		1.42		1.48		1.67	
Flavour														
S_2F_1	47.00	8.59	46.50	8.53	45.545	8.47	46.50	8.44	46.50	8.37	46.50	8.34	46.50	8.28
S_2F_2	51.50	8.69	52.50	8.66	52.20	8.59	52.50	8.56	52.50	8.50	52.50	8.47	52.50	8.41
S_2F_3	46.50	8.44	46.50	8.38	46.50	8.34	46.50	8.28	45.50	8.25	46.50	8.19	46.50	8.13
K value	0.79		1.35		1.51		1.32		1.36		1.39		1.51	
Taste														
S_2F_1	47.50	8.62	47.00	8.56	47.00	8.50	47.00	8.47	47.00	8.41	47.00	8.38	47.00	8.31
S_2F_2	50.50	8.69	51.50	8.66	51.50	8.59	51.50	8.56	51.50	8.50	51.50	8.47	51.50	8.41
S_2F_3	47.00	8.59	46.27	8.47	47.00	8.41	47.00	8.38	47.00	8.31	45.50	8.25	46.50	8.19
K value	0.36		0.77		0.75		0.74		0.75		0.77		0.82	
Overall acceptability														
S_2F_1	47.50	8.75	47.00	8.69	47.00	8.62	47.50	8.59	47.50	8.53	47.50	8.50	47.50	8.44
S_2F_2	52.00	8.84	53.00	8.81	53.00	8.75	53.50	8.72	53.50	8.66	53.50	8.63	53.50	8.56
S_2F_3	46.00	8.72	43.50	8.66	45.50	8.59	44.50	8.53	44.50	8.47	44.50	8.44	44.50	8.38
K value	1.52		2.14		1.92		2.44		2.33		2.31		2.33	
CV (0.05)	31.41													

Like extremely- 9, Like very much- 8, Like moderately-7, Like slightly-6, Neither like or dislike- 5, Dislike slightly- 4, Dislike moderately- 3, Dislike very much- 2, Dislike extremely- 1 storage. Lime RTS recorded the highest mean score of 8.31, cashew apple RTS as 8.25 and mean score of 8.19 for pineapple RTS after 90 days of storage with respect to colour and all aloe gel supplemented RTS formulations recorded acceptable scores after 90 days of storage.

At the time of storage, the highest mean score (8.69) for flavour was recorded for lime RTS (B_2), 8.59 for pineapple RTS (B_1) and 8.44 for cashew apple RTS (B_3). After three months of storage, the highest mean score for flavour was recorded by lime RTS (8.41) followed by pineapple RTS (8.28) and cashew apple RTS (8.13) and all formulations were acceptable for flavour.

Among the RTS formulations, the highest mean score (8.69) for taste was recorded for lime RTS (B_2) followed by pineapple RTS (B_1) (8.62) and cashew apple RTS (B_3) (8.59) at the time of storage. After 90 days of storage, all formulations were acceptable for taste and lime RTS recorded the highest mean score of 8.41, 8.31 for pineapple RTS and 8.19 for cashew apple RTS with respect to taste.

Overall acceptability of lime RTS (B_2) recorded the highest mean score of 8.84, pineapple RTS (B_1) recorded 8.75 and 8.72 for cashew apple RTS (B_3) at the time of storage. After three months of storage, the highest mean score for overall acceptability was recorded for lime RTS (8.56) followed by pineapple RTS (8.44) and cashew apple RTS (8.38) and all formulations were acceptable.

4.3.2.3 Enumeration of Microbial Load during Storage

Nutrient agar medium was used for analysing the bacterial population and Rose Bengal medium was used for enumeration fungal population. Pour plate method without dilution and with dilution up to 10^{-2} were used for determining the colony forming units of bacterial and fungal population. Pineapple, lime and cashew apple RTS were found microbiologically safe for 3 months storage at room temperature and no bacterial and fungal colony forming units were detected during three months storage.

Discussion

5. DISCUSSION

The results obtained from the investigation on "Development of *Aloe vera* gel supplemented Ready To Serve fruit beverages" are discussed in this chapter under following headings:

5.1 Aloe gel extraction

5.2 Osmo dehydration of aloe gel

5.3 Formulation of RTS beverage and storage

5.1 ALOE GEL EXTRACTION

Aloe gel was extracted by hand filleting method after blanching treatments *viz.*, steam blanch and hot water blanch and without blanching was analysed for biochemical, physical and organoleptic qualities and are discussed below.

5.1.1 Biochemical Properties of Aloe Gel

Moisture content is one of the major biochemically active constituent present in aloe gel. Aloe gel extracted after steam blanching recorded the lowest moisture content of 92.58 per cent and it was 97.86 per cent after hot water blanching (Figure 1). Aloe gel extracted without any blanching recorded the highest moisture percentage of 98.49. Moisture content of aloe gel extracted without blanching was reported as 97.2 per cent by Goyal and Sharma (2009). Kumar *et al.* (2012) observed moisture percentage of fresh aloe gel as 97.8 to 99.00, Chandegara and Varshney (2013) as 98.5, Hamid *et al.* (2014) as 97.95, Sasikumar (2015a) as 97.6 and Talib *et al.* (2016) as 97.86 ± 0.30 per cent. The moisture content of aloe gel extracted after steam blanching was lower than the gel extracted without any blanching. This agrees with the findings of Shubhra *et al.* (2014) who reported that aloe gel without blanching recorded moisture of 97.20 per cent and gel after blanching recorded a moisture content of 97.10 per cent.

Total Soluble Solids is an important biochemical parameter that determines the quality of aloe gel. Aloe gel extracted after steam blanching recorded a TSS of 1.84^0 B, 1.78^0 B for hot water blanched and 1.7 ^{0} B for aloe gel without blanching. This was in conformity with the results of Boghani *et al.* (2012), Sasikumar *et al.* (2013) and Sasikumar, (2015a) who reported TSS of aloe gel as 2.1^0 B. Whereas Kumar *et al.* (2012) observed TSS of fresh aloe gel as 0.8 to 0.86^0 B, 3^0 B by Elbandy *et al.* (2014) and 1± 0.5^0 B by Talib *et al.* (2016) which indicate that TSS content of aloe gel varies with plant samples. Shubhra *et al.* (2014) reported that gel without blanching had a TSS of 2.0^0 B and 2.2^0 B for gel after blanching. Hamid *et al.* (2014) reported that slight increase in TSS after heat treatment was due to formation of soluble solids by the conversion of insoluble total solids which support our results.

pH share an important role in food analysis and it determines whether the product is acidic or basic in nature. Aloe gel extracted by different treatments recorded a pH of range 4.32 to 4.38 and was found to be stable after heat treatments. This was in line with the results of Adubofuor *et al.* (2016) who reported that blanching had no significant effect on pH of carrots. Aloe gel extracted after steam blanching recorded a pH of 4.38 and for hot water blanched aloe gel and gel extracted without blanching shown a pH of 4.32. These results are supported by Boghani *et al.* (2012) who reported that fresh aloe gel is acidic in nature and had a pH of 4.34. Similarly Sasikumar *et al.* (2013), Sasikumar, (2015a) observed a pH of 4.4 and Elbandy *et al.* (2014) reported a pH of 4.33 for fresh *Aloe vera* gel.

Acidity has vital importance in determining the quality of food. Aloe gel extracted after steam blanching recorded the highest acidity of 0.17 per cent and 0.15 per cent for hot water blanched aloe gel. Aloe gel extracted without blanching recorded the lowest acidity of 0.12 per cent. Kumar *et al.* (2012) reported acidity of aloe gel as 0.23 to 0.26 per cent. Elbandy *et al.* (2014) observed acidity of aloe gel as 0.10 per cent and he stated that high acidity of aloe

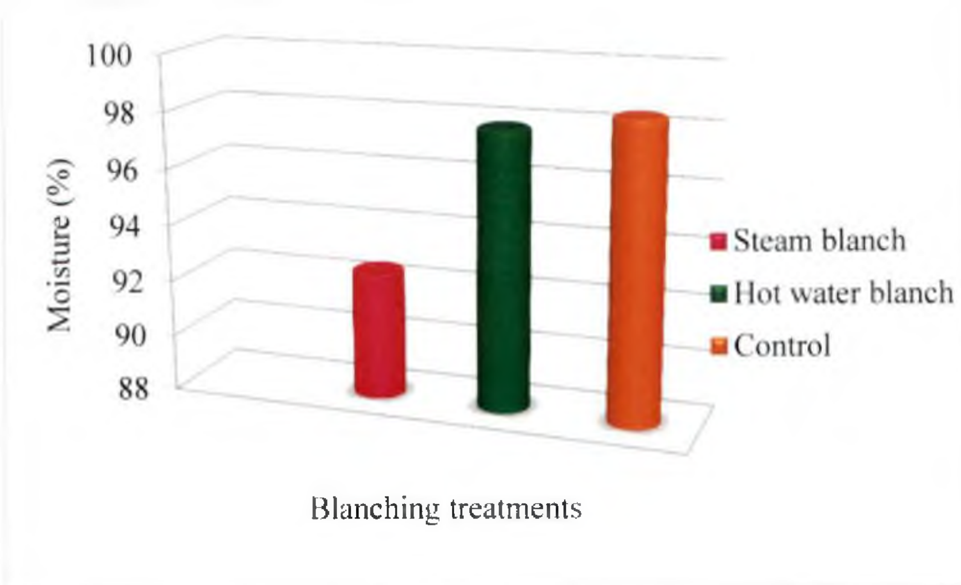


Figure 1. Effect of blanching on moisture content of aloe gel

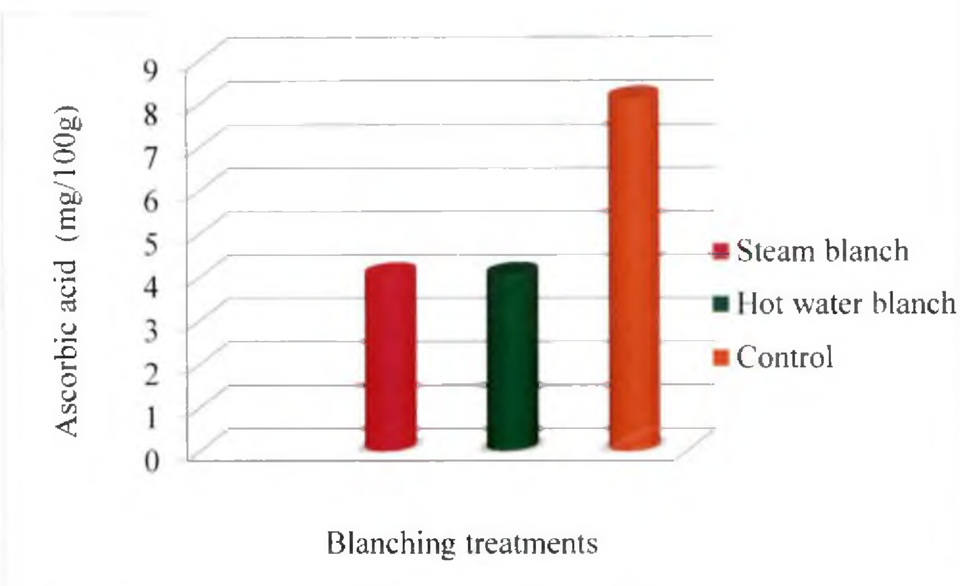


Figure 2. Effect of blanching on ascorbic acid aloe gel

gel was due to deposit of organic acids. Jabbar *et al.* (2014) reported that blanching had no considerable effect on titratable acidity of carrot juice.

Ascorbic acid had crucial role in determining the quality of food. Ascorbic acid of the aloe gel extracted after different treatments were found to be significant. Aloe gel extracted after steam blanching and hot water blanching recorded an ascorbic acid content of 4.06 mg /100g and aloe gel extracted without blanching recorded 8.12 mg/ 100g (Figure 2). Sasikumar *et al.* (2013), Sasikumar (2015a) reported ascorbic acid content of aloe gel extracted without blanching as 7 mg/100g and Kumar *et al.* (2012) observed it as 3.76 to 3.86 mg/100g. Ascorbic acid content of gel extracted without any blanching was higher than that of blanched aloe gel. These results were in line with the findings of Shubhra *et al.* (2014) who reported ascorbic acid content of gel without blanching as 1.9 mg/100g and 1.7 mg/100g for gel after blanching as and stated that lower ascorbic acid content of blanched aloe gel may be due to the oxidation of ascorbic acid during processing.

Sugar comprises of all monosaccharide and disaccharides present in food and is an important biochemical constituent determining the quality. Steam blanched aloe gel recorded the highest reducing sugar of 0.43 per cent. Hot water blanched aloe gel recorded 0.42 per cent and the lowest reducing sugar of 0.41per cent was recorded for aloe gel extracted without blanching (Figure 3). In case of total sugar, steam blanched aloe recorded the highest total sugar of 0.53 per cent and 0.52 per cent for hot water blanched aloe gel where as aloe gel extracted without any blanching recorded the lowest total sugar of 0.51 per cent (Figure 4). Hamid *et al.* (2014) observed reducing sugar and total sugar of aloe gel as 0.36 per cent and 0.65 per cent respectively. Talib *et al.* (2016) reported reducing sugar of aloe gel as 022± 0.6 per cent and total sugar as 070± 0.5 per cent. Reducing sugar and total sugar of aloe gel extracted after blanching was higher than that of aloe gel extracted without blanching. This was in line with the results of Shubhra *et al.* (2014) who had reported increased reducing and total sugar of aloe gel extracted after blanching. Wisal *et al.* (2013), Hamid *et al.* (2014) reported slight increase in

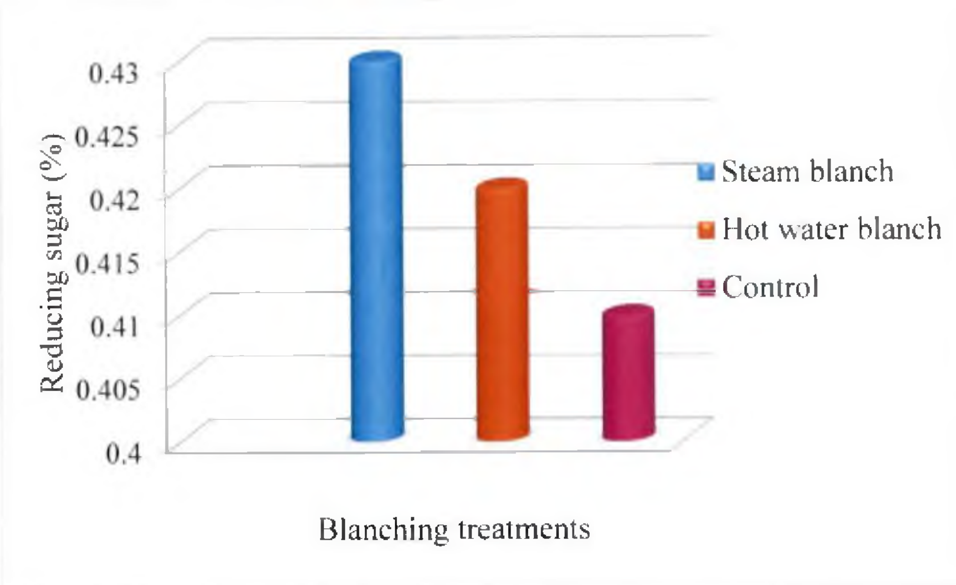


Figure 3. Effect of blanching on reducing sugar of aloe gel

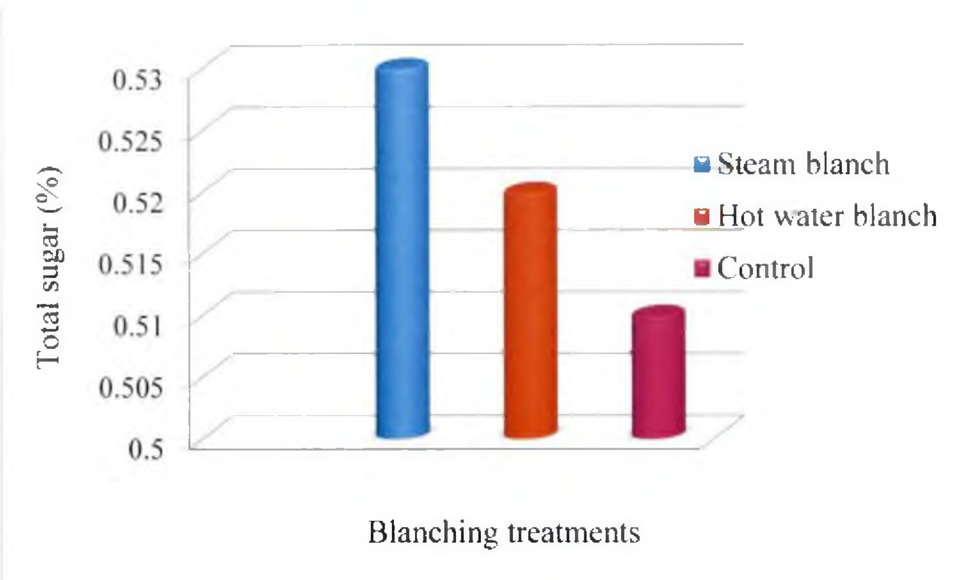


Figure 4. Effect of blanching on total sugar of aloe gel

reducing sugar and total sugar content during heat treatments could be attributed to the conversion of insoluble compounds to soluble compounds and inversion of non- reducing sugars to reducing sugars.

Antioxidant is any substance which prevents the oxidation of a substrate at its lower concentration (Kispotta *et al.*, 2012). Antioxidant activity expressed as DPPH radical scavenging activity of aloe gel extracted after steam blanching was 81.30 per cent. Aloe gel extracted after hot water blanching recorded an antioxidant activity of 72.88 per cent and it was 71.12 per cent for gel extracted without blanching (Figure 5). DPPH is an easy and accurate method to measure the antioxidant activity of fruit and vegetable juices or extracts (Katalinic *et al.*, 2004). Free radical scavenging effect of aloe gel extract depends on hydrogen atom donation by different phenolic and flavonoid compounds and hydrogen donor capacity accounts for the antioxidant activity and provides a base for the pharmacological and therapeutic applications of aloe gel extract (Ozsoy *et al.*, 2009). Saritha *et al.* (2010) who reported that antioxidant activity of methanol extract of aloe gel as 93.14 per cent. Padmanabhan and Jangle (2012) reported higher percentage of inhibition means higher is the antioxidant activity or scavenging effect. Nurhuda *et al.* (2013) reported steam blanching and hot water blanching for 5to 15 minutes had no significant effect on antioxidant activity of rambutan peel. Lopez *et al.* (2013) reported antioxidant activity will be more if the phenol content is higher.

Crude fibre content represents the insoluble residue on hydrolysis with acid and alkali and it includes indigestible cellulose, lignin and other components. Crude fibre content of aloe gel extracted by different treatments ranged between 0.198 to 0.2 per cent and recorded a stable value during heat treatments. This is in line with the results of Shubra *et al.* (2014) who reported that crude fibre content of aloe gel without blanching and after blanching was 0.26 per cent and stated that blanching had no significant effect on crude fibre content. Hamid *et al.* (2014) also reported crude fibre content of fresh aloe gel as 0.24 per cent.

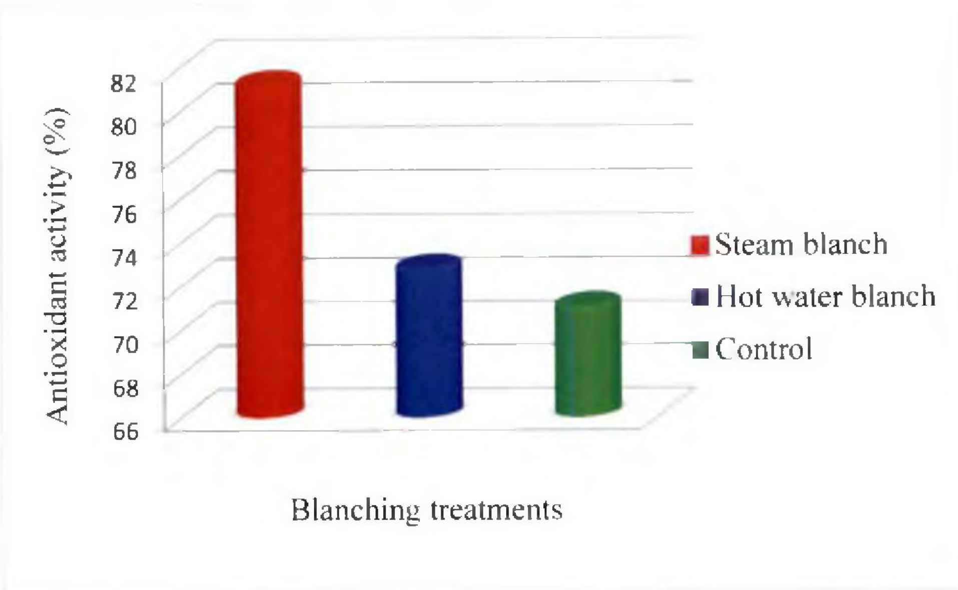


Figure 5. Effect of blanching on antioxidant activity of aloe gel

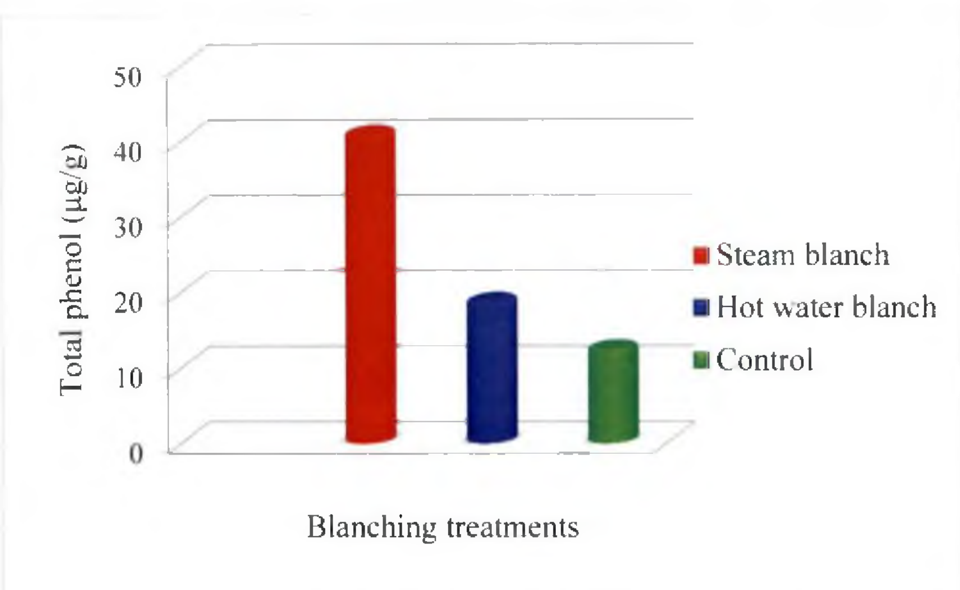


Figure 6. Effect of blanching on total phenol of aloe gel

Ash content represents the amount of minerals present in the food. Ash content of aloe gel extracted after different treatments ranged between 0.28 to 0.29 per cent and was found stable after heat treatments. This agrees with the findings of Shubhra *et al.* (2014) who reported that ash content of aloe gel extracted after blanching treatments was 0.26 per cent and aloe gel extracted without blanching was 0.25 per cent. In the present study, aloe gel extracted after steam blanching and hot water blanching recorded ash content of 0.29 per cent and aloe gel extracted without blanching recorded 0.28 per cent. Elbandy *et al.* (2014) reported ash content of fresh aloe gel as 0.242 per cent. Hamid *et al.* (2014) observed as 0.20 per cent and 0.23±0.01 per cent by Talib *et al.* (2016).

Fruits and vegetables are rich in phytochemicals which includes phenolic compounds, ascorbic acid, flavanoids and carotenoids. Most of the antioxidant properties of aloe gel are mainly due to the presence of phenolic compounds (Shubhra *et al.*, 2014). Blanching treatments influenced total phenolic content of aloe gel. Steam blanched aloe gel recorded the highest phenol content of 40.98 $\mu g\ g^{-1}$ where as hot water blanched aloe gel recorded 18.77 $\mu g\ g^{-1}$ and 12.49 $\mu g\ g^{-1}$ for aloe gel extracted without blanching (Figure 6). Blanching treatments increased total phenol content of aloe gel than aloe gel without blanching. This agrees with the findings of Morales – de la Pena *et al.* (2011) who reported increase in phenol content with heat treatments and stated that the increase could be attributed due to the formation of new phenolic compounds as a result of biochemical reactions during heat treatment or due to release of some free phenol acids or flavanoids as a result of some effect on cell membranes or in phenolic complexes with other compounds or due to inactivation of polyphenol oxidase enzyme (PPO) which prevents further loss of phenolic compounds or might be due to enhancement of phenolic concentration since heat treatment have induced favorable conditions to increase phenylanine ammonialyase (PAL) activity. Hamid *et al.* (2014) reported heat treatment could increase total phenols by 5-8 per cent. This was contradictory to the result reported by Shubhra *et al.* (2014) who found that total phenol content of gel without blanching was 23 mg/100g and phenol content of gel after blanching was 21mg/100 g and reported blanched aloe gel have lower phenol content than aloe gel without blanching might be due to high volatility and oxidation nature of phenolic compounds.

5.1.2. Physical Properties of Aloe Gel

In determining the quality of aloe gel, viscosity plays an important role. Viscosity of a fluid is a measure of its resistance to flow. Aloe gel extracted after steam blanching recorded the highest viscosity of 9.98 cP, 4.34 cP and 3.60 cP at 60 rpm, 120 rpm and 180 rpm respectively (Figure 7). The lowest viscosity of 3.76 cP, 2.16 cP and 1.48 cP was recorded for aloe gel extracted after hot water blanching at 60,120 and 180 rpm respectively and aloe gel extracted without any blanching recorded viscosity of 5.40 cP at 60 rpm, 3.36 cP at 120 rpm, and 2.26 cP at 180 rpm. Gowda *et al.* (1979) reported viscous nature of aloe gel was due to the presence of polysaccharides. Chiou (2003) reported that with the increase in heating time, viscosity of aloe gel decreases. Chandegara and Varshney (2013) found that viscous nature of aloe gel decreases with time. Chandegara and Varshney (2014) stated biological activity is more for aloe gel with high viscosity. Chandegara *et al.* (2015) reported that aloe gel with high viscosity has better quality.

Quality and purity of aloe gel can be determined by the physical property refractive index. Steam blanched aloe gel and hot water blanched aloe gel recorded refractive index of 1.3366 and refractive index of aloe gel extracted without any blanching was1.3364. Chandegara and Varshney (2013) reported that any treatment which give lower refractive index as the best method for aloe gel extraction and stated that refractive index of aloe gel ranged from 1.33789 to 1.34390. Chandegara *et al.* (2015) reported that higher impurities in extracted aloe gel contribute to higher refractive index and with the increase in extraction temperature refractive index and TSS of aloe gel increases. He also reported that refractive index of 1.33603 was obtained for gel with TSS 1.31^0B.

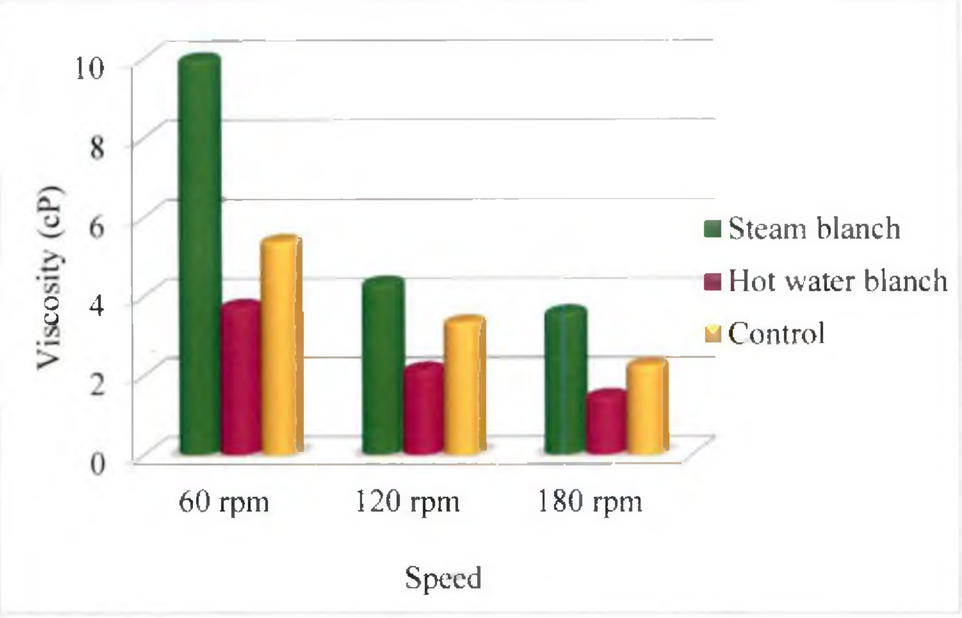


Figure 7. Effect of blanching on viscosity of aloe gel

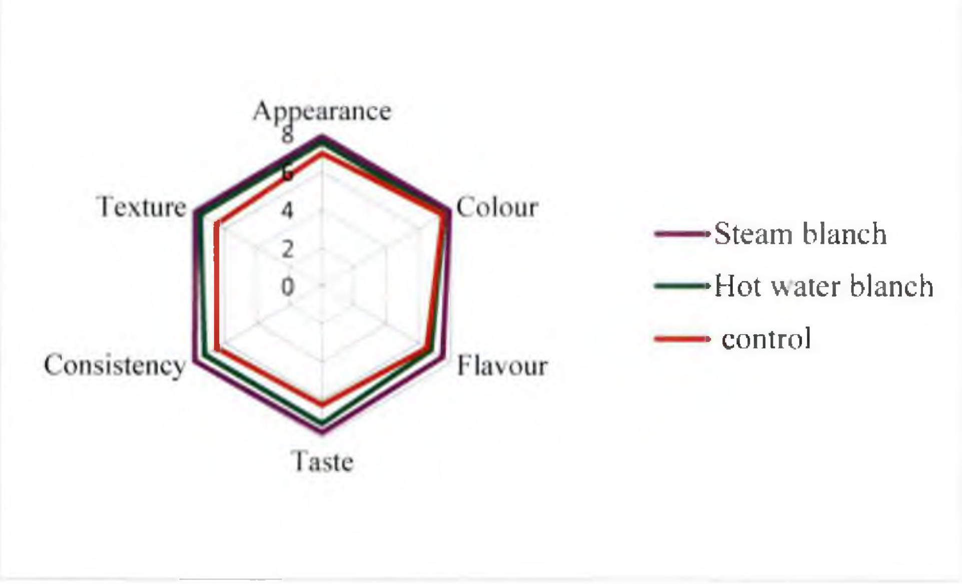


Figure8. Effect of blanching on organoleptic qualities of aloe gel

Purity of the aloe gel extracted is also indicated by the physical property optical density. Aloe gel extracted after steam blanching recorded the lowest optical density of 0.805 and hot water blanching recorded the highest optical density of 1.097. Aloe gel extracted without blanching recorded an optical density of 1.048. This was in conformity with the results of Wang and Strong (1993) who reported optical density of aloe gel ranges from 1.020 to 1.437. Chandegara and Varshney (2013) reported that the method of aloe gel extraction which could give lower optical density as the best method for extraction of aloe gel. Higher optical density of aloe gel contributed to higher impurity in the extracted aloe gel and increase in values of optical density can be attributed to the enzymatic degradation of aloe gel at higher extraction temperatures (Chandegara *et al.*, 2015).

Specific gravity is a dimensionless unit which is the ratio of density of a material to the density of water at a given temperature. The specific gravity of 1.0200 was recorded for steam blanched aloe gel and for hot water blanched aloe gel it was 1.0196 and aloe gel extracted without blanching recorded a specific gravity of 1.0169. Chandegara and Varshney (2013) reported that specific gravity of extracted aloe gel ranged from 1.0221 to 1.0339.

5.1.3. Sensory Evaluation of Aloe Gel

Aloe gel extracted after heat treatment and control were subjected to a sensory analysis and the extracted aloe gel showed significant difference in sensory quality parameters *viz.,* appearance, colour, flavour, taste, consistency and texture (Figure 8).

Aloe gel extracted after steam blanching recorded the highest mean score for appearance (7.91), colour (7.91), flavour (7.47), taste (7.71), consistency (7.88) and texture (7.78). Steam blanched aloe gel were supported with higher mean ranks too.

The lowest mean score for appearance (7.00), colour (7.50), flavour (6.50), taste (6.25), consistency (6.50) and texture (6.50) was recorded for aloe gel extracted without blanching. It was observed that the lowest sensory quality attributes were recorded by aloe gel extracted without any blanching. The slight bitter taste due to the presence of small amount of aloin content in the unblanched aloe gel and its hard texture might have affected all the sensory scores negatively. It was seen that the highest organoleptic score for appearance, colour, flavour, taste, consistency and texture was maintained by steam blanched aloe gel and biochemical and physical properties of aloe gel also support the high sensory acceptability of steam blanched aloe gel. Chandegara and Varshney, (2013) reported steaming could remove residual amount of aloin and reduce bitterness. Sasikumar *et al.* (2013), Elbandy *et al.* (2014), Sasikumar (2015a) and Sasikumar (2015b) reported that incorporation of *Aloe vera* gel in different fruit beverages were acceptable.

5.2 OSMODEHYDRATION OF ALOE GEL

Aloe as an industrial crop is used in the food industry for the preparation of health food drinks (Seoshin *et al.*, 1995). Pisalkar *et al.* (2014) stated that osmotic dehydration retains colour, aroma, nutritional constituents, and flavour compounds. In the present study 1cm^3 sized aloe gel cubes extracted after steam blanching were subjected to three levels of osmotic concentration (30, 40 and 50^{0}B) and two levels of immersion time (4 h and 6 h) and Mass transfer characters, biochemical and physical properties of osmo dehydrated aloe gel are discussed below.

5.2.1 Mass Transfer Characters

Solid gain is an indicator of movement of solute into the aloe cubes and it increased with increase in osmotic concentration. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded the highest solid gain of 10.68 per cent and it was 9.72 per cent for aloe gel in 50^0 B osmotic

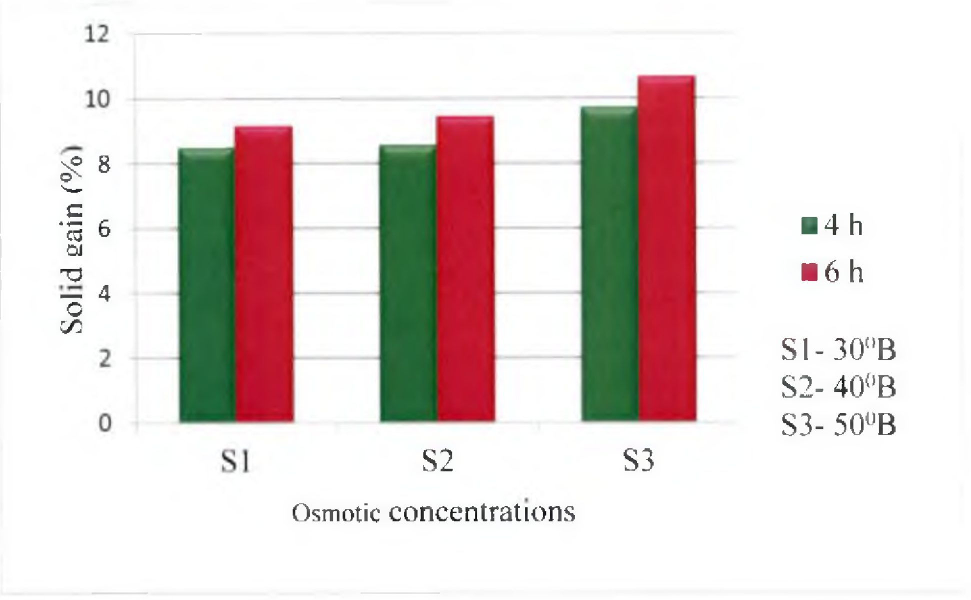


Figure. 9. Effect of osmotic concentration and immersion time on solid gain (%) of aloe gel

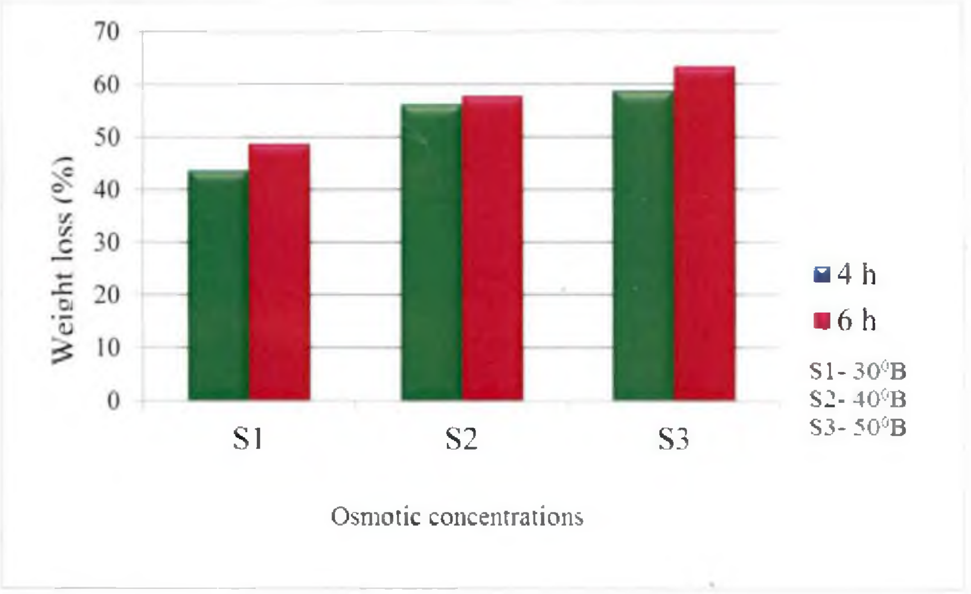


Figure 10. Effect of osmotic concentration and immersion time on weight loss (%) of aloe gel

concentration and 4 h immersion time and the lowest solid gain of 8.52 per cent was recorded for osmo dehydrated aloe gel in 30^0 B osmotic concentration and 4 h immersion time (Figure 9). Garcia-Segovia *et al.* (2010) reported highest sugar gain with 50^0 B osmotic treatment of aloe gel and microstructure especially porosity of aloe contributed to the change in solid gain velocity. He also reported that the phenomena of high loss in the turgor pressure, shrinkage and deformation in parenchymatic cells during osmotic dehydration decreased the mass transfer between the fruit and the osmotic solution in peeled aloe slices. Pisalkar *et al.* (2011) reported that solid gain of aloe gel cubes increased with the increase in sugar concentration and temperature. Chavan (2012) reported that solid gain and water loss increase with increased solute concentration was due to high rate of diffusion of solute and water exchange. Kumar and Devi (2011) reported higher concentration of osmotic solution and immersion time increased the solid gain on osmotic dehydration of pineapple. Pisalkar *et al.* (2014) reported that at the beginning of drying process drying rates were higher and later decreased with decrease in moisture content of aloe gel.

Simal *et al.* (2000) reported the effect of dehydration on functional properties of aloe. Vega *et al.* (2007) and Vega-Galveza *et al.* (2009) reported the kinetics of the hot-air drying of aloe gel and drying temperature on the kinetic parameters of aloe gel. Miranda *et al.* (2010) reported the applicability of the Weibull distribution model in predicting the moisture content of aloe gel dried by hot-air and also evaluated the effects of temperature on the kinetic parameters, structural properties and total polysaccharide content of aloe gel.

Weight loss of osmo dehydrated aloe gel increased with increase in osmotic concentration and immersion time (Figure 10). The highest weight loss of 63.45 per cent was recorded for osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time and 58.81 per cent for 50^0B osmotic concentration and 4 h immersion time. Osmo dehydrated aloe gel in 30^0B osmotic concentration and 4 h immersion time recorded the lowest weight loss of 43.63 per cent. Moisture loss during osmosis may be resulted in weight loss of aloe gel. These findings are supported by Beristain *et al.* (1990); Singh (2008); Sridevi and Genitha (2012); Fasogbon *et al.* (2013) in osmosed pineapple and Ponting *et al.* (1966); Hawkes and Flink (1978); Torreggiani (1993); Thippanna (2005); Mercali *et al.* (2010) in banana. Increase in osmotic duration, increased the solid gain, water loss and weight loss of banana (Saputra, 2001; Jalalli *et al.*, 2008; Renu, 2012), mango and pineapple slices (Pokharkar and Prasad, 1998; Tiwari and Jalali, 2004a and Tiwari and Jalali, 2004b), sapota (Patil *et al.*, 2013; Gupta *et al.*, 2014), and in orange (Pandharipande and Gaikar, 2015). Mass transfer characters depends on shapes and thickness of fruit slices was reported by Rastogi and Raghavarao (1997), Kumar and Devi (2011), Dhingra *et al.* (2013), Khanom (2014).

5.2.2 Biochemical Properties of Osmo Dehydrated Aloe Gel

Steam blanched aloe gel recorded a moisture content of 92.58 per cent and it reduced to 57.39 per cent for aloe gel osmosed in 50^0 B osmotic concentration and 6 h immersion time and 60.52 per cent for 50^0 B osmotic concentration with 4 h immersion time (Figure 11). Osmo dehydrated aloe gel in 30^0 B osmotic concentration and 4 h immersion time recorded the highest moisture content of 72.35 per cent. Moisture content of the aloe gel cubes decreased on osmosis and facilitates the sugar absorption by the gel cubes. These results are supported by the findings of Femenia *et al.* (1999) and Chang *et al.* (2006) who reported that on drying moisture content of aloe gel decreased and with the temperature and drying time percentage of decrease increased. Isurini *et al.* (2014) reported that moisture content of osmo dehydrated aloe gel cubes in 50^0B sugar at 40°C for 4 h as 72.3 per cent. Akbarian *et al.* (2014) reported about 30 to 70 per cent water was removed on osmotic dehydration of fruits. Sasikumar (2015a) reported that increase in moisture content of aloe gel increases the chance of spoilage. Hence osmotic dehydration is adopted as a method to decrease the moisture content of aloe gel. Aloe gel osmo dehydrated in 50 ^{0}B for 4 h recorded 32.06 per cent reduction of moisture with 58.81 per cent weight loss with a solid gain of 9.72 per cent.

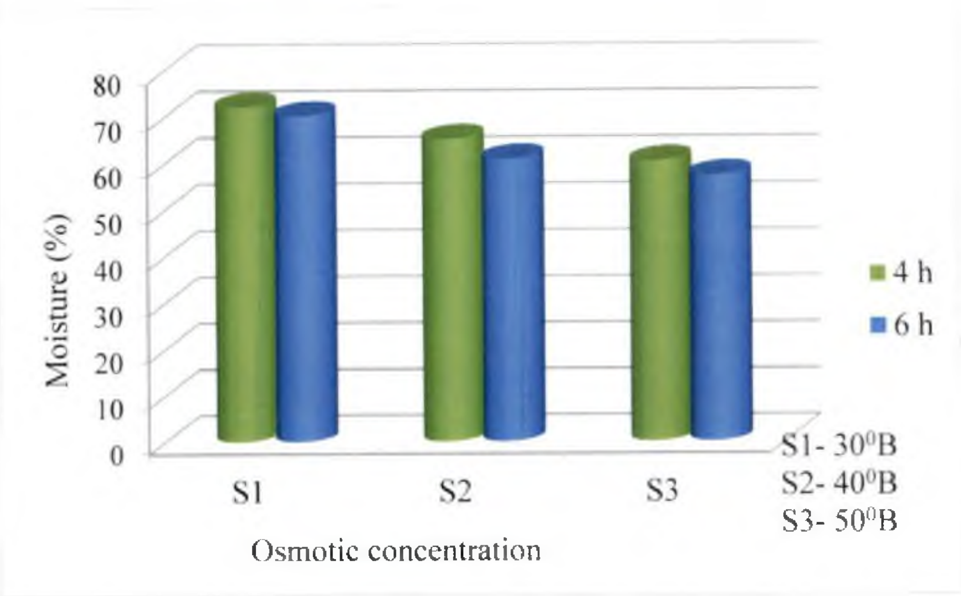


Figure 11. Effect of osmotic concentration and immersion time on moisture content (%) of aloe gel

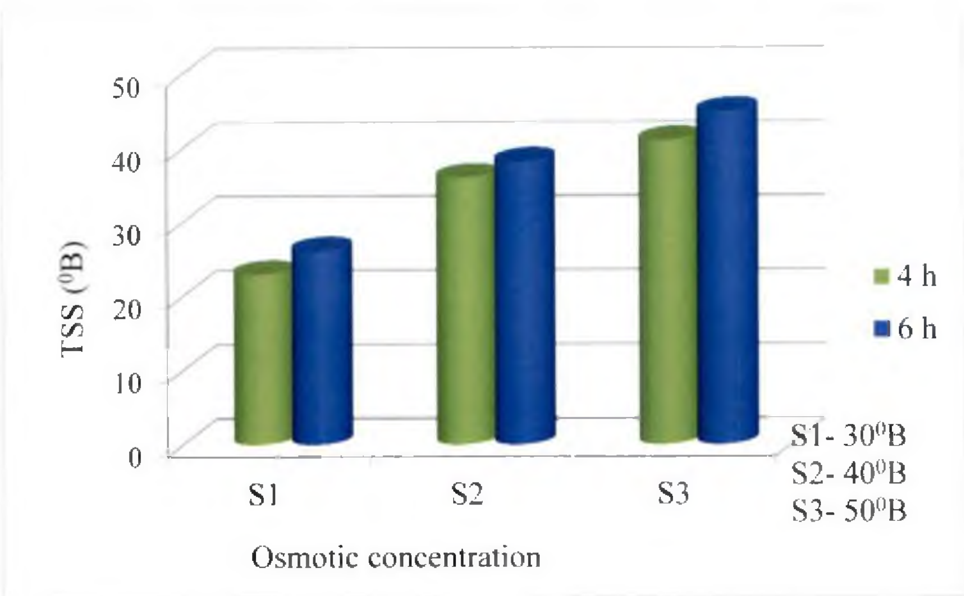


Figure 12. Effect of osmotic concentration and immersion time on TSS (^{0}B) of aloe gel

The highest TSS of 44.90^0 B was observed for aloe gel in 50^0 B osmotic concentration and 6 h immersion and 41.03^0 B for 50^0 B osmotic concentration and 4 h immersion time (Figure 12). The lowest TSS of 22.98^0 B was recorded for osmo dehydrated aloe gel in 30^0 B osmotic concentration with 4 h immersion time and TSS increased with osmotic concentration and immersion time. Decrease in moisture content during osmosis enhanced the absorption of sugar which in turn increases the TSS of aloe gel cubes. These results are in conformity with the results of Rashmi (2002) in OD of pineapple slices, Geetha *et al.* (2006) in aonla and Dionello *et al.* (2009) in pineapple. Isurini *et al.* (2014) reported that TSS of osmo dehydrated aloe gel cubes in 50^{0}B sugar at 40^{o}C for 4 h as 25.2^0 B.

Osmodehydration of aloe gel did not influence the pH of aloe gel. Eshun and He (2004) and Miranda *et al.* (2009) reported that on drying of aloe gel no variations in pH were observed. Negligible effect of osmotic dehydration on pH was observed by (Sapata *et al.*, 2009). But decrease in pH of osmo dehydrated pineapple slices was reported by Fasogbon *et al.* (2013).

Acidity of aloe gel extracted after steam blanching was 0.17 per cent and acidity of osmo dehydrated aloe gel in different osmotic concentrations and immersion time ranged from 0.115 per cent to 0.157 per cent and there was no influence of osmotic variables even though acidity showed slight decrease. Variation in percentage acidity during drying of aloe gel was reported by Hernandez *et al.* (2006) and Miranda *et al.* (2009). Many researchers reported that acidity decreased with increase in osmotic concentration and immersion time (Sharma and Kaushal, 1999; Sharma *et al.*, 2004; Devic *et al.*, 2010; Vijayakumari *et al.*, 2007; Phisut *et al.*, 2013a; Phisut *et al.*, 2013b). Reduction in acidity can be attributed to the leaching of acid from fruits to the osmotic solution through a semi permeable membrane (Sagar and Kumar, 2009). Phisut *et al.* (2013a) and Phisut *et al.* (2013b) reported total acidity of osmo dehydrated cantaloupes decreased due to leaching of acids into the medium during osmotic dehydration process.

Ascorbic acid of osmo dehydrated aloe gel in different osmotic concentrations and immersion time ranges from 6.09 to 9.46 mg/100g and showed no significant difference with osmotic variables. Osmotic treatment helped in reducing the degradation of ascorbic acid. Sagar and Kumar (2009) reported that the higher concentration of sugar syrup provided more protection to degradation of ascorbic acid. Several research workers reported that ascorbic acid losses during osmotic dehydration might be attributed to the leaching of the vitamin from the product to the osmotic solution during the osmotic process as reported by Chiralt and Talens (2005); Mandala *et al.* (2005); Rasheed (2005); Singh *et al.* (2007); Elbeltagy *et al.* (2008); Santos and Silva (2008); Shi and Xue (2009); Devic *et al.* (2010); Nadia *et al.* (2013); Phisut *et al.* (2013a); Phisut *et al.* (2013b).

Steam blanched aloe gel recorded reducing sugar of 0.43 per cent and total sugar of 0.53 per cent and it increased with osmotic treatment. This is supported by the solid gain and moisture loss of aloe gel during osmotic dehydration. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded highest reducing sugar of 3.11 per cent and 2.97 per cent for 50^0 B osmotic concentration and 4 h immersion time. The lowest reducing sugar of 1.65 per cent was observed for osmo dehydrated aloe gel in 30^0 B osmotic concentration and 4 h immersion time. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded highest total sugar of 17.39 per cent and 14.92 per cent for 50^0 B osmotic concentration and 4 h immersion time and the lowest total sugar of 7.59 per cent was recorded for 30^0 B osmotic concentration and 4 h immersion time. Reducing and total sugar increased with increase in concentration and immersion time of aloe gel cubes because of the increased sugar uptake and moisture removal. Raoult-wack *et al.* (1991), Torreggiani, (1993), Chavan *et al.*, (2010), Amin and Hossain (2012) and Patil *et al.* (2013) reported that uptake of solutes and a resultant increase in sugar content in fruit slices is characteristic phenomenon of the osmosis process.

Antioxidant activity of steam blanched aloe gel was 81.30 per cent and it reduced during osmotic treatment. The highest antioxidant activity of 75.95 per cent was recorded for osmo dehydrated aloe gel in 50^0 B osmotic concentration and 4 h immersion time (Figure 13). These results are in conformity with the findings of Miranda *et al.* (2009) who reported the effect of temperature on the physicochemical and nutritional properties and antioxidant capacity of aloe gel and higher drying temperature increased the loss per cent. Padmanabhan and Jangle (2012) reported antioxidant activity will be more if percentage of inhibition is higher. Giovanelli *et al.*, (2013) reported that significant loss in the antioxidant activity of osmo dehydrated blue berries was observed during osmotic treatment. Phisut *et al.* (2013a) and Phisut *et al.* (2013b) reported that antioxidant activity of osmo dehydrated cantaloupes decreased when compared with fresh sample and low antioxidant activity can be attributed to high leaching of soluble antioxidant components during osmotic dehydration process.

Phenol content of aloe gel before osmotic dehydration was 40.98 $\mu g\ g^{-1}$ and it reduced with the process. The highest phenol content of 7.59 $\mu g\ g^{-1}$ was observed for osmo dehydrated aloe gel in 50^0 B osmotic concentration and 4 h immersion time and 7.19 $\mu g\ g^{-1}$ for 40^0 B osmotic concentration and 4 h immersion time. Phenol content decreased with increase in immersion time of osmosis and it can be due to leaching of the phenolic compounds from aloe gel cubes into osmotic solution. This is in accordance with the findings of Vijayakumari *et al.* (2007) and Devic *et al.* (2010) who reported that higher loss of natural solutes might be induced by prolonged osmotic dehydration process. Giovanelli *et al.* (2013) reported that significant loss in the antioxidant components such as total phenolic content in osmo dehydrated blue berries during osmotic treatment at higher temperature. Phisut *et al.* (2013a) and Phisut *et al.* (2013b) reported that the phenolic content of osmo-dried cantaloupe was lower than fresh cantaloupe and it can be due to leaching of natural solutes such as acids, vitamins and small molecules of phenolic compound into the osmotic solution during osmotic dehydration process.

5.2.3 Physical Properties of Osmo Dehydrated Aloe Gel

Refractive index of aloe gel before osmotic dehydration was 1.3366 and refractive index increased with osmotic process. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded the highest refractive index of 1.4111 and 1.4033 for 50^0 B osmotic concentration and 4 h immersion time and lowest refractive index of 1.3702 was recorded for 30^0 B osmotic concentration and 4 h immersion time. The refractive index of aloe gel cubes increased with increase in osmotic concentration and immersion time. This might be due to the mass transfer phenomena occurred during the process of osmosis. Higher refractive index of the gel denotes the impurity of gel (Chandegara *et al.*, 2015).

Optical density of aloe gel increased during osmotic treatment. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded the highest optical density of 1.687 and 1.442 for 50^0 B osmotic concentration and 4 h immersion time. The lowest optical density of 0.917 was recorded for 30^0 B osmotic concentration and 4 h immersion time. The optical density of aloe gel cubes increased with increase in osmotic concentration and immersion time which might be due to mass transfer phenomena during osmosis process. Higher the impurities in the gel, higher will be the optical density (Chandegara *et al.*, 2015).

Specific gravity of aloe gel also increased during osmotic dehydration. Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 6 h immersion time recorded the highest specific gravity of 1.1051 and 1.1005 for aloe gel in 40^0 B osmotic concentration and 6 h immersion time. Increase in osmotic concentration and immersion time increased the specific gravity which might be due to the solid gain and moisture loss during osmotic dehydration.

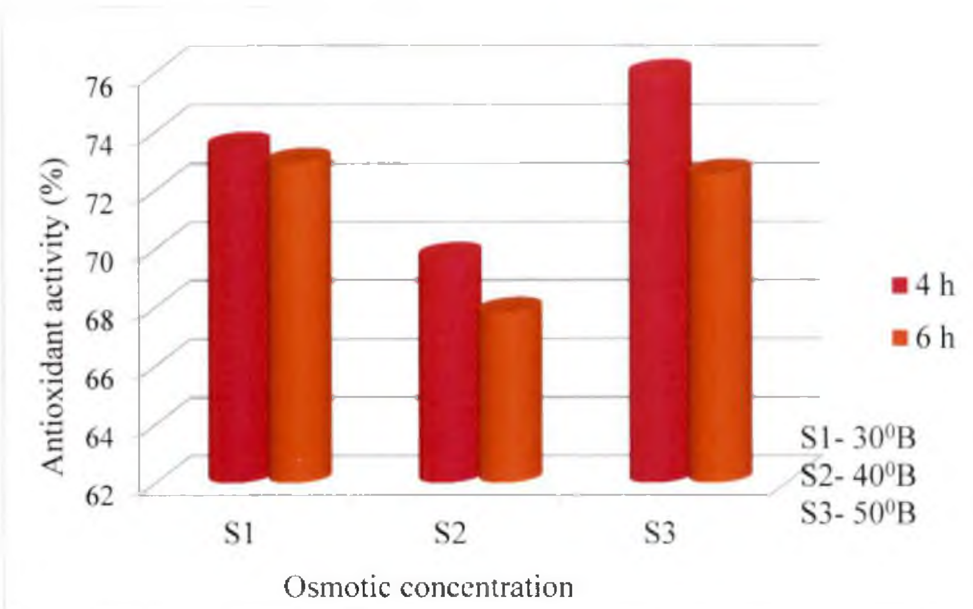


Figure13. Effect of osmotic concentration and immersion time on antioxidant activity (%) of aloe gel

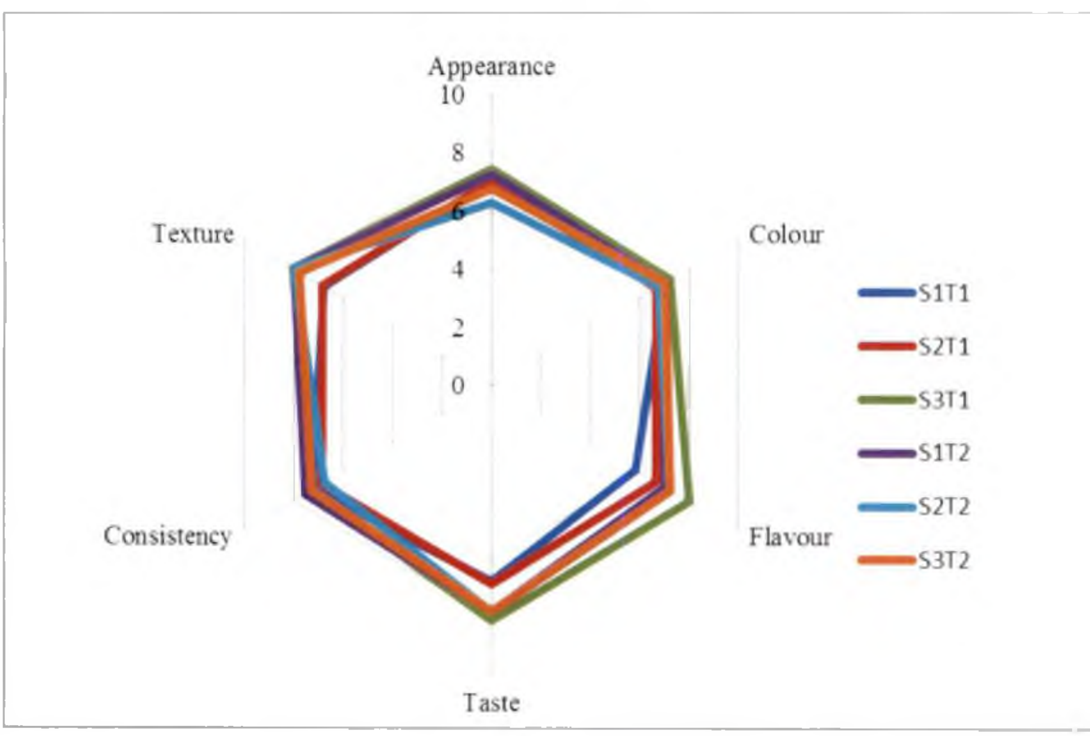


Figure14. Effect ofosmo dehydration on organoleptic qualities of aloe gel

5.2.4 Sensory Evaluation of Osmo Dehydrated Aloe Gel

Evaluation of organoleptic qualities of osmo dehydrated aloe gel in different osmotic concentration *viz*., 30^0B, 40^0B and 50^0B and in two levels of immersion time *viz*., 4 h and 6 h showed significant difference in sensory quality parameters of appearance, colour, flavour, taste, consistency and texture (Figure 14).

Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 4 h immersion time recorded the highest mean score for appearance (7.44), colour (7.25), flavour (8.03), taste (8.06), consistency (7.25) and texture (8.03) ~~(Fig-6)~~. Osmotically dehydrated product under process condition of low osmotic concentration and less time recorded the maximum acceptance. This is in accordance with the findings of Femenia *et al.* (2003); Hawlader *et al.* (2006); Miranda *et al.* (2009) who reported that during drying of aloe gel due to the effect of temperature on heat sensitive compounds present in aloe amount of colour variation increased with increase in drying temperature. Garcia-Segovia *et al.* (2010) reported that final composition, sensory quality and stability of aloe gel were affected by water loss and solid gain during osmotic dehydration.

Studies conducted by Gurumeenakshi *et al.* (2005) in osmo-air dehydrated papaya, Kumar and Sagar (2009) in pineapple, Chavan *et al.* (2010) in banana, Shafiq *et al.* (2010) in aonla, Kumar and Devi (2011) in pineapple slices, Nadia *et al.* (2013) in pear Kedarnath *et al.* (2014a) and Kedarnath *et al.* (2014a) in sapota slices reported the effect of osmtic dehydration on sensory qualities.

5.3 FORMULATION OF RTS BBEVERAGE AND STORAGE

5.3.1 Formulation of RTS Beverage

Biochemical and sensory parameters of RTS of pineapple, lime and cashew apple supplemented with 5 per cent and 10 per cent osmo dehydrated aloe gel, 5 per cent total aloe juice and without aloe are discussed below.

5.3.1.1 Biochemical Properties of RTS Formulation

RTS formulations supplemented with 10 per cent osmo dehydrated aloe gel recorded the highest TSS in all fruit beverages and it was 12.93^{0}B for pineapple RTS, 12.97^{0}B for lime RTS and 13.00^0 B for cashew apple RTS. TSS of RTS beverages without aloe gel supplementation was in the range of 12.07 to 12.13^0 B and TSS increased with percentage of aloe gel supplementation. These results are in accordance with the findings of Sunita and Ananya (2013) who reported increase in TSS content of blended RTS beverages on addition of aloe juice into bael juice. Elbandy *et al.* (2014) reported that TSS percentage increased in mango nectar with 25 per cent aloe gel supplementation. Hamid *et al.* (2014) reported TSS of orange-carrot blend nectar increased on supplementation of aloe gel. Shubhra *et al.* (2014) reported kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice recorded a TSS of 15^0 B. Increase of TSS from 12.30 to 16.37^0 B in blended beverage of aloe and bael fruit juice with 60 per cent aloe gel was reported by Sasikumar (2015b). Talib *et al.* (2016) reported TSS of aloe juice supplemented pear fruit RTS beverage increased with addition of 20 and 30 per cent aloe juice and showed a slight decrease with 10 per cent supplementation.

RTS formulations without aloe gel supplementation recorded the highest pH for pineapple, lime and cashew apple RTS and pH decreased with aloe gel supplementation but there were no significant difference between 5 per cent and 10 per cent aloe gel supplementation. Sunita and Ananya (2013) reported supplementation of aloe juice in bael juice decreased the pH of the RTS beverage compared to control. Elbandy *et al.* (2014) reported that slight decrease in pH was recorded on supplementation of 25 per cent aloe gel in mango nectar. Hamid *et al.* (2014) reported that slight decrease in pH of orange- carrot blend nectar on supplementation of aloe gel. Decrease in pH of blended beverage with 60 per cent aloe in bael fruit juice when compared with aloe juice was reported by Sasikumar (2015b).

Acidity of the RTS formulations increased on addition of 5 per cent aloe juice and 5 per cent and 10 per cent osmo dehydrated aloe gel in RTS formulations of pineapple, lime and cashew apple. Manoharan and Ramasamy (2013) reported that minor decrease in pH and increase in total acidity of aloe gel supplemented beverages might be due to the presence of uronic salicylic and phenolic acids in aloe gel. Elbandy *et al.* (2014) found that on addition of 25 per cent aloe gel in mango nectar total acidity slightly increased when compared with control. Hamid *et al.* (2014) reported total acidity of the orange-carrot blend nectar increased on supplementation of aloe gel. Sasikumar (2015b) reported increase in acidity in blended beverage with 60 per cent aloe and bael fruit juice as compared to aloe juice.

Pineapple RTS, lime RTS and cashew apple RTS with 10 per cent osmo dehydrated aloe gel recorded the highest reducing sugar of 4.96 per cent, 4.84 and 4.92 per cent respectively. Total sugar of 10 per cent osmo dehydrated aloe gel supplemented pineapple, lime and cashew apple RTS was recorded as 7.88, 8.02, 7.95 per cent respectively. Aloe juice as well as osmo dehydrated aloe gel 5 per cent and 10 per cent supplementation increased reducing sugar and total sugar of all three fruit RTS formulations. Reducing sugar and total sugar of RTS formulations supplemented 10 per cent osmo dehydrated aloe gel was higher than that of 5 per cent supplementation. Elbandy *et al.* (2014) reported increase of total sugar and reducing sugar on addition of 25 per cent aloe gel in mango nectar. Hamid *et al.* (2014) reported increase in reducing sugar and decrease in total sugar and non- reducing sugar on supplementation of aloe gel in orange-carrot blend nectar. Shubhra *et al.* (2014) reported increase in reducing sugar and total sugar content of kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice when compared to that without aloe juice. Sasikumar (2015b) reported increase in reducing sugar and total sugar of blended beverage with 60 per cent aloe juice supplementation in bael juice.

RTS formulations of pineapple, lime and cashew apple with 10 per cent osmo dehydrated aloe gel recorded the highest ascorbic acid of 18.06, 19.45 and 20.84 mg/100g respectively (Figure 15). Ascorbic acid content of RTS formulations increased with aloe gel supplementation. This is in accordance with the result of Elbandy *et al.* (2014) who reported increase in ascorbic acid content of 25 per cent aloe gel supplemented mango nectar in comparison to without aloe supplementation. Hamid *et al.* (2014) reported supplementation of aloe gel in orange-carrot blend nectar showed no noticeable change in ascorbic acid content. Shubhra *et al.* (2014) reported increase in ascorbic acid content of kinnow nectar supplemented with 4 per cent blanched and unblanched aloe juice than that of control (2.50 mg/100g). Sasikumar (2015b) reported ascorbic acid of blended RTS beverage increased with 60 per cent aloe gel supplementation in bael fruit juice.

RTS formulations supplemented with 10 per cent osmo dehydrated aloe gel recorded highest antioxidant activity. Pineapple, lime and cashew apple RTS supplemented with 10 per cent osmo dehydrated aloe gel recorded the highest antioxidant activity of 86.29, 81.22 and 80.72 per cent respectively (Figure 16). When compared with control, antioxidant activity of RTS formulations supplemented with 5 per cent aloe juice and 5 per cent and 10 per cent osmo dehydrated aloe gel was higher. These results are in accordance with Chauhan *et al.* (2012) who reported increase in antioxidant activity of RTS beverage with the addition of 6 herbal extracts. Srividya and Ramachandran (2012) reported that supplementation of spice extracts increased antioxidant activity which might be due to the presence of antioxidant compounds like vitamin C and polyphenols. Hamid *et al.* (2014) reported increase in antioxidant activity of orange- carrot blend nectars supplemented with aloe gel. Hridyani (2015) and Hridyani and Soni (2015) reported increase in antioxidant activity of juice blend increased with the addition of basil. Sukapriya and Krishnaprabha (2015) reported antioxidant activity of gooseberry juice incorporated watermelon RTS beverage increased than that of watermelon alone.

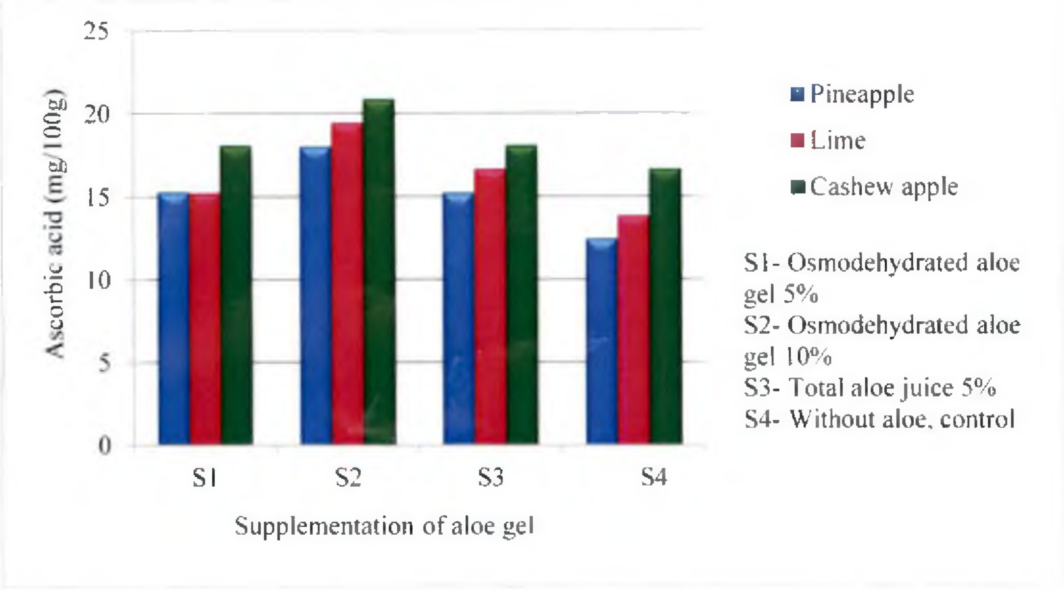


Figure 15. Effect of aloe gel supplementation on ascorbic acid of RTS beverages

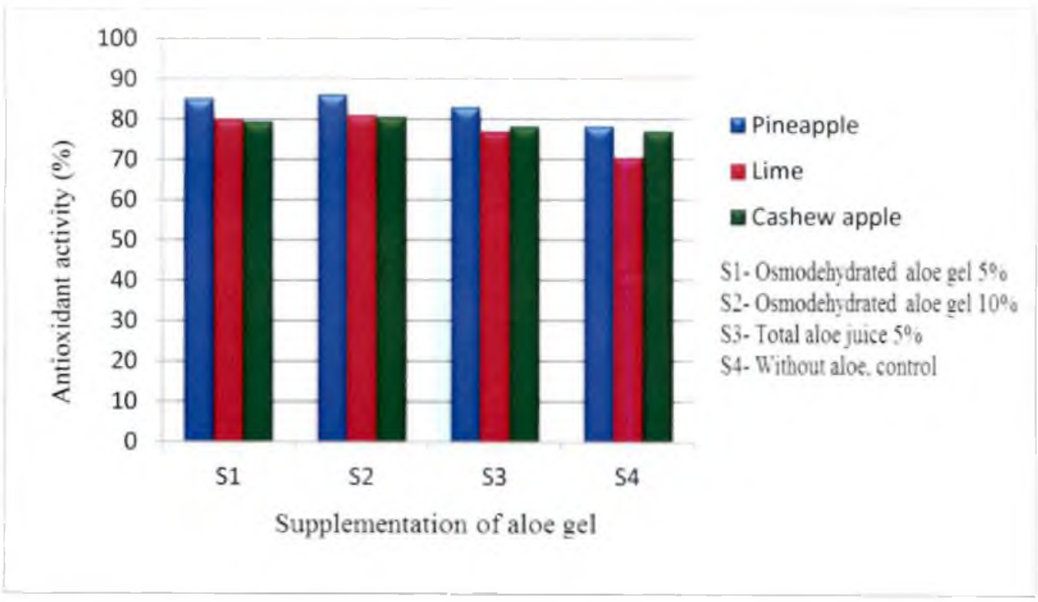


Figure 16. Effect of aloe gel supplementation on antioxidant activity (%) of RTS beverages

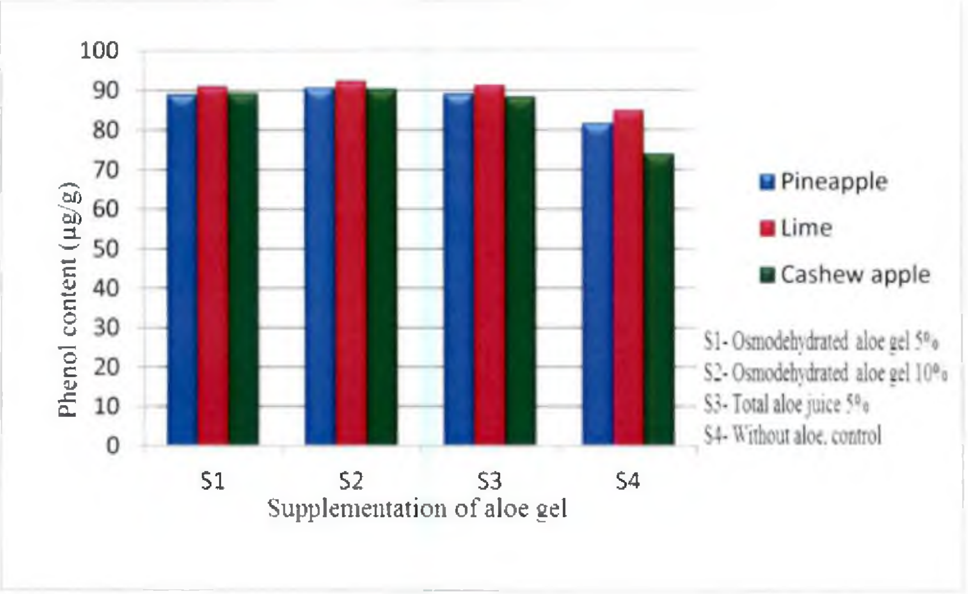


Figure 17. Effect of aloe gel supplementation on total phenols (µg g^{-1}) of RTS beverages

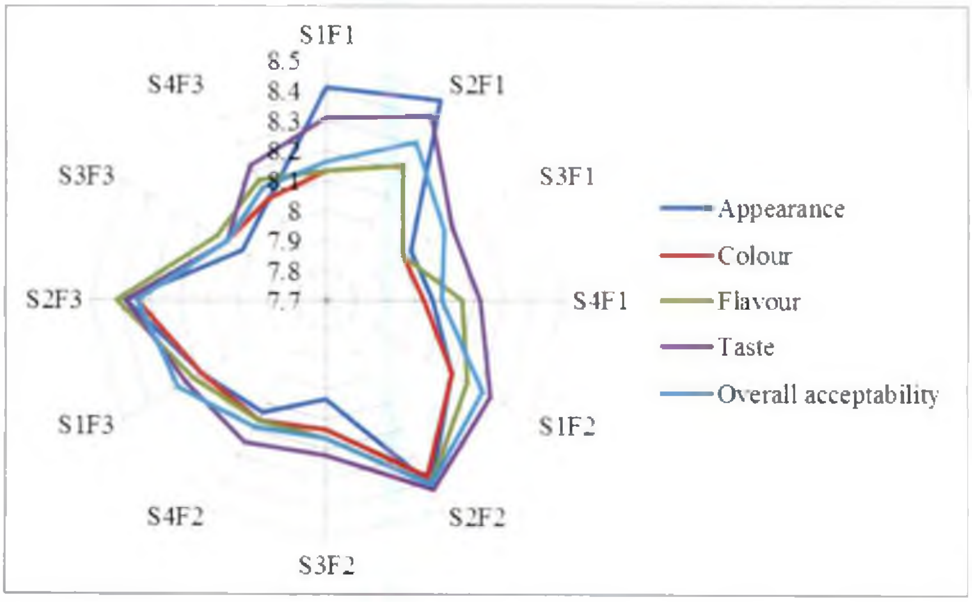


Figure 18. Effect of aloe gel supplementation on sensory qualities of RTS beverages

Aloe gel supplementation increased the phenolic content of formulated RTS beverages. Phenol content was higher for pineapple (90.89 μg g^{-1}), lime (92.52 μg g^{-1}) and cashew apple (90.51 μg g^{-1}) RTS formulations supplemented with 10 per cent osmo dehydrated aloe gel (Figure 17). Supplementation of 5 per cent aloe juice and 5 per cent and 10 per cent osmo dehydrated aloe gel in RTS formulations increased the total phenol content compared to RTS formulations without aloe supplentation. Shubhra *et al.* (2014) reported that total phenol content of blanched and unblanched aloe juice 4 per cent supplemented kinnow nectar was higher than control. Hamid *et al.* (2014) reported increase in phenol content of orange- carrot blend nectars supplemented with aloe gel when compared to control.

Crude fibre content of RTS beverages increased with aloe supplementation. Crude fibre content was higher for RTS formulations of pineapple (1.30 per cent), lime (1.37 per cent) and cashew apple (0.99 per cent) supplemented with 10 per cent osmo dehydrated aloe gel. Shubhra *et al.* (2014) reported considerable improvement in crude fibre content on supplementation of 4 per cent aloe juice in kinnow nectar. Hamid *et al.* (2014) reported with increase of amount of aloe gel supplementation crude fibre of orange-carrot nectar increased.

5.3.1.2 Sensory Evaluation of Formulated RTS Beverages

RTS of pineapple, lime and cashew apple supplemented with 5 per cent and 10 per cent osmo dehydrated aloe gel (50^0B for 4 h), 5 per cent total aloe juice and RTS without supplementation were analysed for various sensory attributes and showed significant difference in sensory quality parameters *viz.*, appearance, colour, flavour, taste, consistency and texture (Figure 18).

On sensory analysis of pineapple RTS formulations, RTS with osmo dehydrated aloe gel 10 per cent recorded the highest score for appearance (8.47), colour (8.22), flavour (8.22), taste (8.41) and overall acceptability (8.31). On analyzing lime RTS formulations, osmo dehydrated aloe gel 10 per cent supplemented RTS recorded the highest score for appearance (8.41), colour (8.38), flavour (8.41), taste (8.43) and overall acceptability (8.41). Similarly cashew apple RTS formulations with osmo dehydrated aloe gel 10 per cent recorded the highest score for appearance (8.38), colour (8.34), flavour (8.41), taste (8.38) and overall acceptability (8.34). Present study revealed that 10 per cent supplementation of osmo dehydrated aloe gel recorded highest sensory quality for pineapple, lime and cashew apple RTS. Boghani *et al.* (2012) reported that appearance, taste and overall acceptability of beverage improved with the increase in concentration of aloe juice up to the level of 10 per cent in papaya juice, while further increase reduced the appearance, taste and overall acceptability of the juice. They reported that with increase in concentration of aloe juice in papaya juice colour score decreased gradually and maximum score for colour was observed for control sample. They also reported that papaya juice with aloe juice 5 per cent and 10 per cent recorded the highest score for flavour due to improvement in mouth feel while further increase resulted in decrease of flavour.

Sasikumar (2015b) reported that appearance, colour, taste, flavour and overall acceptability score increased for blended beverages and 60 per cent aloe supplemented bael juice recorded the highest score for appearance, colour, taste flavour and overall acceptability.

Sasikumar *et al.* (2013) reported appearance, colour, taste, flavour and overall acceptability of aonla ginger RTS beverage improved with increase in concentration of aloe gel up to the level of 70 per cent. Hamid *et al.* (2014) reported that supplementation of aloe gel up to 40 per cent in orange-carrot blended nectar does not affect the overall acceptability. Shubhra *et al.* (2014) reported unblanched aloe juice (4 per cent) supplemented in kinnow nectar recorded the highest score for overall acceptability. Sasikumar (2015a) reported that with the decrease in concentration of aloe gel and increase of aonla fruit juice in aloe-aonla blended beverage appearance, colour, taste, flavour and overall acceptability of beverage scored highest.

Talib *et al.* (2016) reported that highest score for colour was recorded for pear juice without aloe supplementation. Talib *et al.* (2016) reported that pear juice with 20 per cent aloe supplementation recorded highest sensory scores for flavour, taste, appearance and overall acceptability.

5.3.2 Storage of RTS Formulation

Selected best RTS formulations of pineapple, lime and cashew apple RTS supplemented with 10 percent osmo dehydrated aloe gel were kept under room temperature and conducted storage stability study for three months and biochemical, sensory and microbial qualities were analysed at fortnight intervals.

5.3.2.1 Biochemical Properties of Stored RTS Formulations

TSS is considered as one of the most important quality attributes used as an indicator of quality of food (Elbandy *et al.*, 2014). TSS of RTS formulations of pineapple increased from 12.80^0B to 16.80^0 B during storage and for lime RTS it increased from 12.83^0 B to 17.57^0 B and it was 12.80^0B to 17.17^0 B for cashew apple RTS during storage. Singh and Kumar (1995); Jakhar and Pathak (2012); Boghani *et al.* (2012); Sasikumar *et al.* (2013); Sasikumar (2015a); Sasikumar (2015b); Tiwari and Deen (2015); Talib *et al.* (2016) reported that TSS of the stored beverage increased during storage and it was due to the conversion of polysaccharides into monosaccharide and oligosaccharides and other constituents of juice into sugar. Chauhan *et al.* (2012) reported negligible change in TSS throughout two months storage of functional herbal RTS beverage. Elbandy *et al.* (2014) reported conversion of non-soluble pectin into soluble phase was the reason for gradual increase in TSS of aloe gel added mango nectar. Hridyani (2015) and Hridyani and Soni (2016) reported increase in TSS of RTS beverage made from traditional medicinal plants during storage. Sasikumar (2015b) found minimum increase in TSS of aloe juice alone than that of aloe and bael blended beverage. Tiwari and Deen (2015) reported that gradual increase of TSS from 12.00 ^{0}B to 12.60 °B was observed in 25 per cent aloe juice supplemented bael fruit RTS beverage.

Pineapple, lime and cashew apple formulation exhibited a decrease in pH during storage. pH of RTS formulation of pineapple decreased from 3.97 to 1.77, for lime RTS from 3.97 to 1.57 and 3.97 to 1.73 for cashew apple RTS during three months of storage. pH had an inverse correlation with acidity and pH of beverage decrease with increase of storage days and variations in pH during storage can be attributed to the change in chemical properties that are affected by storage conditions (Girdharilal, 1988; Pawar *et al.*, 2011; Yadav *et al.*, (2010); Boghani *et al.*, 2012; Sasikumar *et al.*, 2013; Sasikumar, 2015a; Sasikumar, 2015b).

Acidity is an important factor in food quality attributes as it reveals the spoilage and fermentation of food (Elbandy *et al.*, 2014). Acidity of RTS formulations of pineapple increased from 0.26 to 0.54 per cent, 0.26 to 0.65 per cent for lime RTS and 0.25 to 0.58 per cent for cashew apple RTS during three months of storage. Pawar *et al.* (2011); Boghani *et al.* (2012); Sasikumar *et al.* (2013); Sasikumar (2015a); Sasikumar (2015b); Tiwari and Deen (2015); Talib *et al.* (2016) reported that increase in acidity of beverages was observed with the increase in storage period.

Hamid *et al.* (2014) reported acidity of aloe gel supplemented orange-carrot blend nectar increased during three months storage. Elbandy *et al.* (2014) reported that as a result of fermentation in nectars acidity of aloe gel incorporated mango nectar during storage slightly increased which might be due to fermentation. Sasikumar (2015b) found that increase in acidity during storage was due to the addition of citric acid into the functional beverages and observed minimum increase in acidity in aloe juice beverage while maximum acidity was recorded for aloe-bael blended beverage. Tiwari and Deen (2015) observed increase in acidity of 25 per cent aloe gel supplemented bael RTS beverage from

0.25 per cent to 0.30 per cent during storage. Talib *et al.* (2016) reported that acidity will be comparatively more in soft drinks with high level of aloe and also due to partial contribution of acid formers during bacterial spoilage.

Sugar content is the most important quality attributes as it affects flavour of RTS beverage (Elbandy *et al.*, 2014). Reducing sugar of pineapple RTS, lime RTS and cashew apple RTS increased from 4.84 per cent to 13.33, 14.29 and 13.97 per cent respectively during 90 days of storage (Figure 19). Total sugar of RTS formulations of pineapple increased from 7.74 to 22.07 per cent, 7.81 to 25.18 per cent for lime and 7.74 to 23.84 per cent for cashew apple during storage. Elbandy *et al.* (2014) reported that increase in sugar content of mango nectar during storage was due to inversion of sucrose into glucose and fructose under acidic condition of nectar. Sasikumar (2015b) reported that reducing sugar of functional beverage of 60 per cent aloe supplemented bael fruit increased from 11.21 per cent to 15.8 per cent during the storage period and increase in reducing sugar was due to conversion of sucrose into glucose and fructose by the acid in the beverage and increase in total sugar was due to hydrolysis of polysaccharides in to monosaccharide and oligosaccharides. Tiwari and Deen (2015) reported reducing sugar and total sugar of bael- aloe blended beverage increased during storage and the increase in sugars can be attributed to hydrolysis of carbohydrates into sugars and conversion of non- reducing sugar into reducing sugar.

Ascorbic acid reflects the nutritional characteristic of the food (Elbandy *et al.*, 2014). Ascorbic acid of all RTS formulations decreased with storage. Ascorbic acid of pineapple RTS formulation decreased from 18.06 mg/100g to 5.56 mg/100g, for lime RTS 19.45 mg/100g to 8.33 mg/100g and 20.84 mg/100g to 9.72 mg/100g for cashew apple RTS during storage period (Figure 20). Nagpal and Rajalakshi (2009) reported ascorbic acid content of fruit juice decreased during storage due to oxidation as ascorbic acid is sensitive to oxygen, light and heat by both enzymatic and non-enzymatic catalyst. Elbandy *et al.* (2014) reported that gradual reduction in ascorbic acid content of mango nectar during storage was due to oxidation effect of oxygen present in nectar. Shubhra *et*

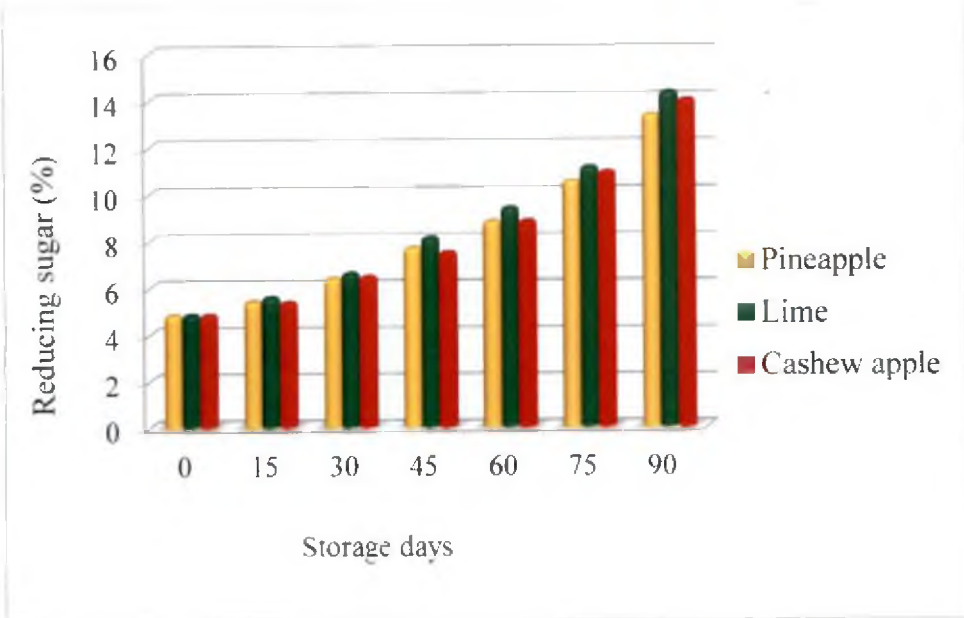


Figure19. Effect of storage on reducing sugar (%) of RTS formulations

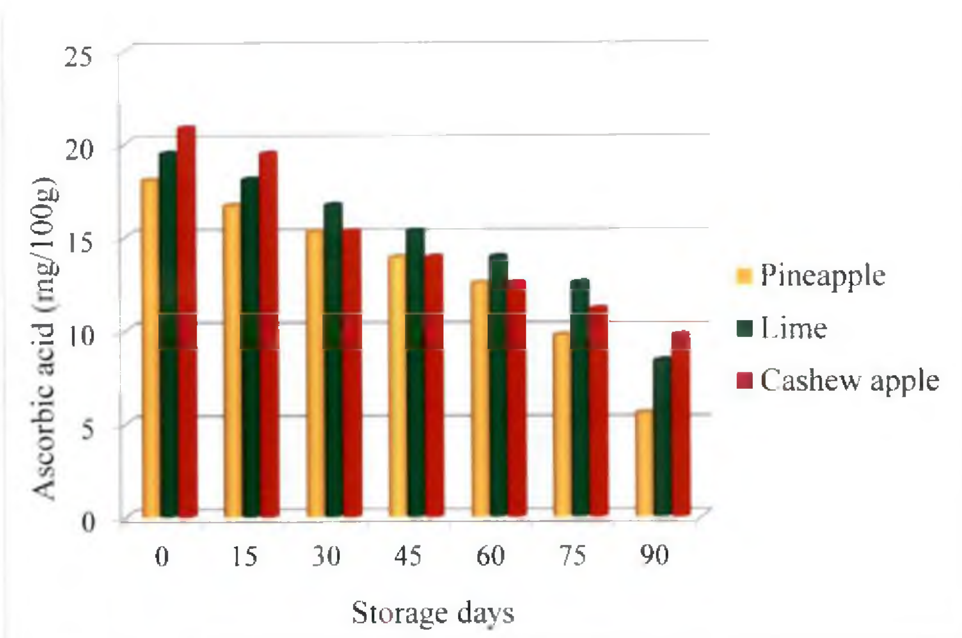


Figure20. Effect of storage on ascorbic acid (mg/100g) of RTS formulations

al. (2014) found that vitamin loss during storage of aloe supplemented kinnow nectar can be attributed to the effect of light, interaction with metallic ions and high room temperature conditions and also reported that ascorbic acid content. Tiwari and Deen (2015) reported that vitamin C content decreased during storage for bael-aloe gel blend beverage which might be due to direct influence of temperature and light exposure on ascorbic acid which lead to oxidation of ascorbic acid to dehydroascorbic acid. Talib *et al.* (2016) reported that during storage of aloe based RTS ascorbic acid decreased and percentage of decrease was high with aloe juice supplemented beverage.

Antioxidant activity of the stored RTS formulations decreased during storage. Antioxidant activity of pineapple RTS formulations decreased from 86.12 to 73.43 per cent and for lime RTS it was 80.88 to 68.36 per cent and 81.12 to 58.64 per cent for cashew apple RTS during three months of storage. These results are in accordance with the findings of Gao and Rupasinghe (2012) who reported decrease in antioxidant activity of apple carrot juice blends during storage. Chauhan *et al.* (2012) found antioxidant activity of the functional herbal RTS beverages decreased during storage. Hridyani (2015) and Hridyani and Soni (2015) reported decrease in antioxidant activity of juice blend with holy basil during storage. The results are contradictory to the findings of Klimczak *et al.* (2007) who reported that due to Maillard's reaction antioxidant activity increased during storage of orange juices. Morales-de la Pena *et al.* (2011) reported that due to polymerization reactions of polyphenols antioxidant activity increased during storage. Saberian *et al.* (2013) reported that that during storage of aloe juice DPPH inhibition percent increased significantly for 30 days at 25^0C compared to storage at 4^0C. Hamid *et al.* (2014) reported increase in antioxidant activity of orange- carrot blend nectars supplemented with aloe gel.

During storage of RTS formulation phenol content decreased. Total phenol content of RTS formulations of pineapple decreased from 90.99 μg g^{-1} to 82.77 μg g^{-1}, for lime RTS from 92.22 μg g^{-1} to 80.53 μg g^{-1} and from 90.83 μg g^{-1} to 79.26 μg g^{-1} for cashew apple RTS during 90 days storage. Decrease in total phenolic content with the advancement in storage period can be attributed to the oxidation of volatile phenolic compounds (Ranganna, 1986). Nejatzadeh-Barandozi (2013) reported that the non-flavonoid group of polyphenols are the major polyphenol compounds found in aloe leaf gel and it contributes to 93% of the total polyphenols. Shubhra *et al.* (2014) reported that decrease in phenolic content was observed in kinnow nectar supplemented with unblanched aloe juice, blanched aloe juice and without supplementation after a storage period of 6 months. Hamid *et al.* (2014) reported that unsteady phenomena of phenol content during storage period were due to polymerization reactions and synthesis of new compounds during storage and found that phenol content of orange- carrot blend nectars supplemented with aloe gel increased during storage at room temperature which was contradictory to the result obtained.

RTS formulations exhibited stability in crude fibre content for pineapple, lime and cashew apple RTS during storage ranged from0.98 per cent to 1.38 per cent. Shubhra *et al.* (2014) reported crude fibre content of the aloe juice supplemented kinnow nectar recorded a stable value till the end of storage period.

5.3.2.2 Sensory Evaluation of Stored RTS Beverages

Sensory analysis of stored pineapple, lime and cashew apple RTS supplemented with 10 per cent osmo dehydrated aloe gel conducted at fortnight intervals revealed that mean score pertaining to appearance, colour, flavour, taste and overall acceptability showed slight reduction towards the end of three months storage.

The sensory quality profile of beverage is a prime factor to consider the marketability of product (Boghani *et al.*, 2012). Mean score for appearance decreased from 8.41 to 8.09 for pineapple RTS formulations, 8.56 to 8.28 for lime RTS and 8.47 to 8.13 for cashew apple RTS during storage period. Mean score for colour decreased from 8.50 to 8.19 for pineapple RTS formulations, 8.59 to 8.31 for lime RTS and 8.56 to 8.25 for cashew apple RTS during storage. With the advancement in storage, the mean score for flavour decreased from 8.59 to 8.28 for pineapple RTS formulation, 8.69 to 8.41 for lime RTS and 8.44 to 8.13 for cashew apple RTS formulation. The mean score for taste decreased from 8.62 to 8.31 for pineapple RTS formulation, 8.69 to 8.41 for lime and 8.59 to 8.19 for cashew apple RTS formulation during storage. Mean score for overall acceptability decreased from 8.75 to 8.44 for pineapple RTS formulations, 8.84 to 8.56 for lime RTS and 8.72 to 8.38 for cashew apple RTS during storage. The findings are in conformity with various research reports. Overall sensorial quality profile of papaya- aloe RTS beverage slightly decreased during storage of three months (Boghani *et al.*, 2012). Shubhra *et al.* (2014) reported overall acceptability of aloe juice supplemented kinnow nectar decreased with the advancement of storage period due to loss of flavor and colour during storage. Sasikumar *et al.* (2013) reported slight decrease in overall sensorial quality profile of blended aloe, aonla and ginger therapeutic RTS during storage of four months. Several other researchers reported that sensorial profile of blended therapeutic RTS beverage decreased during storage (Larmond, 1985; Dachiya and Dhawan, 2001; Gomez *et al.*, 2005; Yadav *et al.*, 2010; Balaswamy *et al.*, 2011; Unde *et al.*, 2011; Jakhar and Pathak, 2012; Gaikwad *et al.*, 2013; Sasikumar, 2015a; Sasikumar, 2015b).

Elbandy *et al.* (2014) reported that color and consistency scores for mango nectar with aloe gel was stable during storage period while without aloe supplemented nectar decreased due to its antioxidant property. Colour and consistency scores were best for treatments with 20 per cent and 25 per cent aloe gel supplementation in mango nectar. But taste and odour scores decreased for all treatments during storage period and mango nectar without aloe and 5 per cent aloe gel recorded best taste scores and without aloe gel addition recorded the best score for odour. Sasikumar (2015b) reported that with the progression of storage period flavour, colour and organoleptic taste scores of juice blends decreased and juice blend with 60 per cent aloe juice in bael fruit juice recorded the highest score for appearance, colour, taste, flavour and overall acceptability at the end of storage of 6 months.

5.3.2.3 Enumeration of Microbial Load during Storage

Stored RTS formulations of pineapple, lime and cashew apple RTS were microbiologically safe for 3 months storage at room temperature and no bacterial and fungal colony forming units were detected during three months storage. Chauhan *et al.* (2012) reported that during storage total colony count of functional herbal RTS beverage increased slightly but was not increased significantly during storage. Elbandy *et al.* (2014) reported that reduced level of bacterial counts were found in high concentrations of aloe gel supplemented mango nectar and during storage total bacterial count at room temperature was negligible to count which revealed the anti bacterial property of aloe gel. Sasikumar, (2015b) reported that total viable count population was within the acceptable for all blended formulation and the lowest range was recorded 60 per cent aloe juice supplemented bael fruit beverage at the end of six months storage. Hridyani (2015) and Hridyani and Soni (2016) reported that during storage microbial load of RTS beverage from traditional medicinal plants increase but was not significantly increased.

Summary

6. SUMMARY

The present study entitled "Development of *Aloe vera* gel supplemented Ready To Serve fruit beverages" was carried out in the Department of Processing Technology of College of Agriculture, Vellayani during the period 2014-2016, with the objective to optimize the process variables for osmotic dehydration of aloe gel and supplementation of aloe gel in RTS fruit beverages and to evaluate the quality of the product during storage. The study was carried out as three parts.

1. Aloe gel extraction
2. Osmo dehydration of aloe gel
3. Formulation of RTS beverage and storage

Major findings are summarized as follows

Aloe vera leaves were subjected to blanching treatments *viz.*, steam blanch, hot water blanch and without any blanching and gel extracted by hand filleting was analyzed for biochemical, physical and sensory qualities.

Biochemical analysis of aloe gel extracted after steam blanching recorded the lowest moisture content of 92.58 per cent with highest acidity (0.17 per cent), antioxidant activity (81.30 per cent), total phenol (40.98 $\mu g\ g^{-1}$), reducing sugar (0.43 per cent) and total sugar (0.53 per cent). Blanching treatments did not influence TSS, pH, crude fibre and ash content of aloe gel.

Physical properties of aloe gel play an important role in determining the quality and purity of extracted gel. On analyzing the physical properties, the highest viscosity of 9.98cP, 4.34 cP and 3.60 cP was observed for aloe gel extracted with steam blanch at 60 rpm, 120 rpm and 180 rpm respectively. The lowest optical density of 0.805 with refractive index 1.3366 and specific gravity 1.0200 was recorded for aloe gel extracted after steam blanching.

Aloe gel with highest chemical and physical quality attributes were supported with high sensory scores too. Sensory evaluation of aloe gel revealed that steam blanched aloe gel recorded the highest mean score for appearance (7.91), colour (7.91), flavour (7.47), taste (7.71), consistency (7.88) and texture (7.78). Based on superior chemical, physical and sensory quality parameters aloe gel extracted after steam blanching was selected as the best treatment for conducting osmo dehydration studies.

Steam blanched aloe gel of $1 cm^3$ size were osmosed in 30, 40 and 50^0B syrup concentrations with an immersion time of 4 h and 6 h. The osmo dehydrated aloe gel was analyzed for mass transfer, chemical, physical and sensory qualities. Mass transfer characters *viz.*, solid gain and weight reduction increased with increase in osmotic concentration and immersion time. Biochemical properties such as total soluble solids, reducing sugar and total sugar increase and moisture content decreases with increase in concentration of osmotic solution and duration of immersion time. Osmotic dehydration of aloe gel did not influence pH, acidity and ascorbic acid of the aloe gel.

Osmo dehydrated aloe gel in 50^0 B osmotic concentration and 4 h immersion time recorded solid gain of 9.72 per cent, weight loss of 58.81 per cent, moisture content of 60.52 per cent, 41.03^0 B TSS, reducing sugar of 2.97 per total sugar of 14.92 per cent, antioxidant activity of 75.95 per cent, phenol content of 7.59 $\mu g\ g^{-1}$, refractive index of 1.4033, optical density of 1.442 and specific gravity of 1.0848. Sensory evaluation of osmo dehydrated aloe gel revealed that gel in 50^0 B osmotic concentration and 4 h immersion time recorded the highest score for appearance (7.44), colour (7.25), flavour (8.03), taste (8.06), consistency (7.25) and texture (8.03). Mass transfer characters, biochemical, physical and sensory parameters of osmo dehydrated aloe gel revealed that osmotic treatment of aloe gel at 50^0 B for 4 h recorded the highest acceptability with good retention of nutritional properties. Hence the osmo dehydrated aloe gel in 50^0B osmotic concentration and 4h immersion time was selected for the formulation of RTS beverage.

Osmo dehydrated aloe gel in 50^0B osmotic concentration for 4 h at 5 per cent and 10per cent level and total aloe juice 5 per cent were supplemented into Ready To Serve beverages of pineapple, lime and cashew apple. Formulated beverages were analyzed for biochemical and sensory properties of aloe gel supplemented RTS and compared with RTS without aloe gel supplementation.

Pineapple RTS formulation supplemented with 10 per cent osmo dehydrated aloe gel recorded 12.93^0B TSS, pH of 3.77, 0.27per cent acidity, 4.96per cent reducing sugar, 7.88per cent total sugar, 1.30per cent crude fibre, 18.06 mg/100g ascorbic acid, 86.29per cent antioxidant activity and 90.89 μg g^{-1} phenol and also recorded highest sensory score for appearance (8.47), colour (8.22), flavour (8.22), taste (8.41) and overall acceptability (8.31).

Lime RTS formulation supplemented with 10 per cent osmo dehydrated aloe gel recorded 12.97^0B TSS, pH of 3.77, 0.27per cent acidity, 4.84per cent reducing sugar, 8.02 per cent total sugar, 1.37per cent crude fibre, 19.45 mg/100g ascorbic acid, 81.22per cent antioxidant activity and 92.52 μg g^{-1} phenol and recorded highest score for appearance (8.41), colour (8.38), flavour (8.41), taste (8.43) and overall acceptability (8.41) on sensory evaluation.

On analyzing the cashew apple RTS formulations, 10 per cent osmo dehydrated aloe gel supplemented RTS recorded 13.00 ^{0}B TSS, pH of 3.77, 0.27per cent acidity, 4.92per cent reducing sugar, 7.95 per cent total sugar, 0.99per cent crude fibre, 20.84 mg/100g ascorbic acid, 80.72per cent antioxidant activity and 90.51 μg g^{-1} phenol and recorded highest sensory score for appearance (8.38), colour (8.34), flavour (8.41), taste (8.38) and overall acceptability (8.34).

Biochemical and sensory properties of aloe gel supplemented RTS beverages revealed that 10per cent osmo dehydrated aloe gel supplemented pineapple, lime and cashew apple RTS were found superior and were taken for further storage stability studies for three months at room temperature.

The stored RTS formulations were analyzed for biochemical, sensory and microbial qualities at fortnight intervals. Chemical quality parameters *viz.*, TSS, acidity, reducing sugar and total sugar increased with storage period while pH, ascorbic acid antioxidant activity and phenol content decreased.

Pineapple RTS formulation recorded increase in TSS (12.80 to 16.80^0 B), acidity (0.26 to 0.54per cent), reducing sugar (4.84 to 13.33per cent), total sugar (7.74 to 22.07 per cent) and decrease in pH (3.97 to 1.77), ascorbic acid (18.06 to 5.56mg/100g), antioxidant activity (86.12 to 73.43 per cent) and total phenol (90.99 to 82.77 $\mu g\ g^{-1}$) and crude fibre content showed a stable value after 90 days of storage.

Lime RTS formulation recorded increase in TSS (12.83 to 17.57^0 B), acidity (0.26 to 0.65 per cent), reducing sugar (4.84 to14.29 per cent), total sugar (7.81 to 25.18 per cent) and decrease in pH (3.97 to 1.57), ascorbic acid (19.45 to 8.33 mg/100g), antioxidant activity (80.88 to 68.36 per cent) and total phenol (92.22 to 80.53 $\mu g\ g^{-1}$) after 90 days of storage and storage did not influence crude fibre content.

Cashew apple RTS formulation recorded increase in TSS (12.80 to 17.17 ^{0}B), acidity (0.25 to 0.58 per cent), reducing sugar (4.84 to 13.97 per cent), total sugar (7.74 to 23.84 per cent) and decrease in pH (3.97 to 1.73), ascorbic acid (20.84 to 9.72 mg/100g), antioxidant activity (81.12 to 58.64 per cent) and total phenol (90.83 to 79.26 $\mu g\ g^{-1}$) and crude fibre content showed a stable value after 90 days of storage.

Sensory evaluation of the stored RTS beverages revealed that sensory profile of pineapple, lime and cashew apple RTS slightly decreased during storage of three months and were acceptable. No bacterial and fungal colony forming units were observed during three months storage of RTS formulations and were microbiologically safe up to three months.

Osmo dehydration of aloe gel extracted after steam blanching in 50^0 B osmotic solution for 4 h and supplementation of 10 per cent osmo dehydrated aloe gel in pineapple, lime and cashew apple RTS had higher acceptability up to three months storage.

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DEVELOPMENT OF *Aloe vera* GEL SUPPLEMENTED READY TO SERVE FRUIT BEVERAGES

by

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ABSTRACT

The present study entitled "Development of *Aloe vera* gel supplemented Ready To Serve fruit beverages" was carried out in the Department of Processing Technology, College of Agriculture, Vellayani during 2014-2016 with the objective to optimize the process variables for osmotic dehydration of aloe gel, supplementation of aloe gel in Ready To Serve (RTS) fruit beverages and to evaluate the quality of the product during storage.

Aloe vera leaves of uniform size, free from pests, diseases and mechanical damages were subjected to blanching treatments *viz.*, steam blanch, hot water blanch and without any blanching. Aloe gel extracted by traditional hand filleting method was analyzed for biochemical, physical and sensory quality parameters.

Blanching treatments did not influence TSS, pH, crude fibre and ash content of aloe gel. Aloe gel extracted after steam blanching recorded the lowest moisture content (92.58%), highest acidity (0.17%), antioxidant activity (81.30%), total phenol (40.98 $\mu g\ g^{-1}$), reducing sugar (0.43%) and total sugar (0.53%). On analyzing the physical properties, highest viscosity (9.98cP at 60 rpm) and lowest optical density (0.805) were recorded for steam blanched aloe gel in addition to highest mean score for sensory attributes. Steam blanched aloe gel had a refractive index of 1.3366 and specific gravity of 1.0200 and was selected for osmo dehydration studies.

Aloe gel of 1cm^3 cube size taken after steam blanching was osmosed in sugar syrup of 30, 40 and 50^0B concentrations with an immersion time of four and six hour. The osmo dehydrated aloe gel was analyzed for mass transfer, biochemical, physical and sensory qualities. Mass transfer characters *viz.*, solid gain and weight loss and biochemical parameters such as total soluble solids, reducing sugar and total sugar increased with increase in osmotic concentration and immersion time and it did not influence pH, acidity and ascorbic acid of aloe gel. Osmotic treatment of aloe gel at 50^0B for four hour immersion time recorded

9.72% solid gain with 58.81% weight loss, 60.52% moisture, 41.03^{0}B TSS, 7.59 μg g^{-1} phenol, 75.95% antioxidant activity, 2.97% reducing sugar, 14.92% total sugar, 1.4033 refractive index, specific gravity of 1.0848, optical density of 1.442 with highest sensory score for flavour, taste and texture and hence selected to formulate aloe gel supplemented RTS fruit beverages.

Osmo dehydrated aloe gel (in 50^{0}B syrup concentration for four hour) at 5 % and 10 % level and total aloe juice (5%) were supplemented into Ready To Serve beverages of pineapple, lime and cashew apple. Formulated beverages were analyzed for biochemical and sensory properties and compared with respective fruit RTS without aloe gel supplementation. Analyses revealed that 10% supplementation resulted in RTS beverages with superior biochemical and sensory qualities and hence pineapple, lime and cashew apple RTS supplemented with 10% osmo dehydrated aloe gel were subjected to storage stability studies under room temperature for three months.

The stored RTS formulations were analyzed for biochemical, sensory and microbial qualities at fortnight intervals. During storage, total soluble solids, reducing sugar, total sugar and acidity of all aloe gel supplemented RTS beverages increased while pH, ascorbic acid, antioxidant activity and total phenol content decreased. Sensory profile of stored aloe gel supplemented RTS beverages revealed that they were acceptable during storage of three months with slight reduction in sensory scores. All RTS beverages were found microbiologically safe during storage and aloe gel supplemented lime RTS formulation recorded the highest acceptability.

Appendices

APPENDIX I

COLLEGE OF AGRICULTURE, VELLAYANI

Dept. of Processing Technology

Title: Development of *Aloe vera* gel supplemented ready to serve fruit beverages

Score card for assessing the organoleptic qualities of *Aloe vera* gel

Sample : Aloe gel

Instructions : Your are given 3 aloe gel samples. Evaluate them and give scores for each criteria

Criteria	Samples		
	1	2	3
Appearance			
Colour			
Flavour			
Taste			
Consistency			
Texture (hard/firm/soft)			
Any other remarks			

Score

Like extremely -9

Like very much -8

Like moderately -7

Like slightly -6

Neither like or dislike -5

Dislike slightly -4

Dislike moderately -3

Dislike very much -2

Dislike extremely -1

Date :

Name :

Signature :

APPENDIX II

COLLEGE OF AGRICULTURE, VELLAYANI

Dept. of Processing Technology

Title: Development of *Aloe vera* gel supplemented ready to serve fruit beverages

Score card for assessing the organoleptic qualities of osmo dehydrated aloe gel

Sample : Osmo dehydrated aloe gel

Instructions : Your are given 6 osmo dehydrated aloe gel samples. Evaluate them and give scores for each criteria

Criteria	Samples					
	1	2	3	4	5	6
Appearance						
Colour						
Flavour						
Taste						
Consistency						
Texture (hard/firm/soft)						
Any other remarks						

Score

Like extremely -9

Like very much -8

Like moderately -7

Like slightly -6

Neither like or dislike -5

Dislike slightly -4

Dislike moderately -3

Dislike very much -2

Dislike extremely -1

Date :

Name :

Signature :

APPENDIX III

COLLEGE OF AGRICULTURE, VELLAYANI

Dept. of Processing Technology

Title: Development of *Aloe vera* gel supplemented ready to serve fruit beverages

Score card for assessing the organoleptic qualities of formulated RTS beverages

Sample : Aloe gel supplemented RTS beverages

Instructions : Your are given 12 samples. Evaluate them and give scores for each criteria

Criteria	Samples											
	1	2	3	4	5	6	7	8	9	10	11	12
Appearance												
Colour												
Flavour												
Taste												
Overall accepatability												

<u>Score</u>

Like extremely -9

Like very much -8

Like moderately -7

Like slightly -6

Neither like or dislike -5

Dislike slightly -4

Dislike moderately -3

Dislike very much -2

Dislike extremely -1

Date :

Name :

Signature :

APPENDIX IV

COLLEGE OF AGRICULTURE, VELLAYANI

Dept. of Processing Technology

Title: Development of *Aloe vera* gel supplemented ready to serve fruit beverages

Score card for assessing the organoleptic qualities of stored RTS formulations

Sample : RTS formulations

Instructions : Your are given 3 samples. Evaluate them and give scores for each criteria

Criteria	Samples		
	1	2	3
Appearance			
Colour			
Flavour			
Taste			
Overall accepatability			

Score

Like extremely -9

Like very much -8

Like moderately -7

Like slightly -6

Neither like or dislike -5

Dislike slightly -4

Dislike moderately -3

Dislike very much -2

Dislike extremely -1

Date :

Name :

Signature :