STUDIES ON STANDARDIZATION OF RECIPE AND STORAGE BEHAVIOUR OF FLAVOURED CUSTARD APPLE (*Annona squamosal* L.) SHAKE

M.Sc. (Hort.) Thesis

by

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INDIRA GANDHI KRISHI VISHWAVIDYALYA RAIPUR (C.G.)

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STUDIES ON STANDARDIZATION OF RECIPE AND STORAGE BEHAVIOUR OF FLAVOURED CUSTARD APPLE (*Annona squamosa* L.) SHAKE

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Chetna Kashyap

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CERTIFICATE - I

This is to certify that the thesis entitled **"STUDIES ON STANDARDIZATION OF RECIPE AND STORAGE BEHAVIOUR OF FLAVOURED CUSTARD APPLE (*Annona squamosal* L.) SHAKE"** submitted in partial fulfillment of the requirements for the degree of **"Master of Science in Horticulture"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur is a record of the bonafide research work carried out by **Chetna Kashyap** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or certificate course. All the assistance and help received during the course of the investigation and have been duly acknowledged by her.

Chairman

Date: 05/10/2021

THESIS APPROVED BY THE STUDENT'S ADISORY COMMITEE

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Member (Dr. Vijay Kumar) _____

Member (Dr. Annu Verma) _____

Member (Dr. R.R. Saxena) _____

CERTIFICATE – II

This is to certify that the thesis entitled **"STUDIES ON STANDARDIZATION OF RECIPE AND STORAGE BEHAVIOUR OF FLAVOURED CUSTARD APPLE (*Annona squamosal* L.) SHAKE"** submitted by **Chetna Kashyap** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **"Master of Science in Horticulture"** in the **Department of Fruit Science** has been approved by External Examiner and Student's Advisory Committee after oral examination, under the chairmanship of head of the Department.

Date: 23/08/2022

Signature of Head of the Department

Name:_____

Major Advisor _____

Faculty Dean _____

Approved/Not Approved

Directorate of Instruction _____

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Chetna

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LIST OF ABBREVATIONS

ABBREVATION	DESCRIPTION
ANOVA	Analysis of Variance
&	And
et al.	and other / Co-workers
etc.	and so on; and other people
@	at the rate
Cm	Centimeter
CD	Critical difference
°Brix	Degree Brix
ºC	Degree Celsius
Fig.	Figure
G	Gram
Ha	Hectare
Mg	Milligram
Ml	Milliliter
Mm	Millimeter
m ha	Million hectare
Mt	Million ton
viz.	Namely
No./no.	Number
%	Per cent
SEm±	Standard error of mean
i.e.	That is
TSS	Total Soluble Solids

THESIS ABSTRACT

a)	Title of Thesis	"Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosal* L.) Shake"
b)	Full name of Student	Chetna Kashyap
c)	Major Subject	Fruit Science
d)	Name and Address of the Major Advisor	Dr. Deepti Patel, Scientist, Department of Fruit Science, College of Agriculture, IGKV, Raipur
e)	Degree to be Awarded	M.Sc. (Hort.) Fruit Science

Signature of Student

Signature of Major Advisor

Date: 05/10/2021

Signature of Head of Department

ABSTRACT

The present investigation entitled **"Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosal* L.) shake"** was carried out at Processing Laboratory, Department of Fruit Science, College of Agriculture, IGKV, Raipur (C.G.) during the year 2020–21. The experiment was conduct in a completely randomized design with 07 treatments in three replications. The treatment consisted seven different concentration of custard apple pulp and milk viz. T_0:100 per cent milk (Control), T_1: 70 per cent milk + 30 per cent Custard Apple pulp + 5 per cent Honey, T_2: 65 per cent milk + 35 per cent custard apple pulp + 5 per cent Honey, T_3: 60 per cent milk + 40 per cent custard apple pulp+5 per cent Honey, T_4:70 per cent milk + 30 per cent custard apple pulp + 5 per cent Jaggery, T_5: 65 per cent milk + 35 per cent custard apple pulp +5 per cent Jaggery, T_6: 60 per cent milk + 40 per cent custard apple pulp + 5 per cent Jaggery.

Custard apple fruits were procured from local market and were analyzed for physico-chemical characteristics. Processed product, shake was prepared by using

pulp of custard apple which was tested regularly at 15 days intervals for their chemical and sensorial constituents. Custard apple shake was organoleptically assessed by implementing a 9 point hedonic rating scale and findings were noted during storage over a span of 45 days.

The observations regarding on physical compositions of custard apple fruit were noted as average fruit weight (170.16g), average fruit volume (200 cc), average fruit diameter (22.6 cm), average fruit length (6.83 cm), the average fruit seed weight (42.59 g) average fruit pulp weight (11.14 g) and pulp-to-seed ratio (3.63). Similarly the chemical parameter of custard apple fruits were analysed and recorded, total soluble solids (20.43 ^{0}Brix), total sugar (17.15%), reducing sugar(13.65%), non-reducing sugar content (3.5%), total titrable acidity (0.20 %) and total ascorbic acid (15.65mg/100g) before processing into shake.

The results revealed that the chemical parameters of the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) was found to be significantly superior with respect to TSS (24.77 ^{0}Brix), total sugar (14.59 %), reducing sugar (11.35 %), non-reducing sugar (3.16 %), acidity (0.18 %) and pH (6.03). The maximum protein content (3.11%) was recorded under T_0 -100 % milk (Control), whereas maximum ascorbic acid content (23.67 mg / 100 g) was recorded under the treatment T_5 (65% milk + 35 % custard apple pulp + 5 % jaggery).

As regard with the different sensory parameters of custard apple shake the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) recorded the maximum value of colour and appearance (8.55), flavour (8.54), taste (8.81) and overall acceptability (8.42) whereas, the score of texture (7.48) was observed maximum under the treatment T_1 (70 % milk + 30 % custard apple pulp + 5 % honey).

On the basis of present finding it can be concluded that the milk shake recipe prepared from 70% milk + 30 % custard apple pulp + 5 % Jaggery (T_4)has found to be best with respect to different quality parameter and sensory evaluation and can be recommended for commercial preparation of custard apple shake.

शोधग्रंथसारांश

शोध शीर्षक	:	सुवासित सीताफल शेक रेसिपि का मानकीकरण एवं भंडारण व्यवहार का अध्ययन
छात्रा का नाम	:	चेतना कश्यप
प्रमुख विषय	:	फल विज्ञान
मुख्य सलाहकार का नाम और पता	:	डॉ. दीप्ति पटेल (वैज्ञानिक) फल विज्ञान विभाग, कृषि महाविद्यालय, इन्दिरा गाँधी कृषि विश्वविद्यालय, रायपुर (छत्तीसगढ़)
प्रदान की जाने वाली उपाधि	:	एम. एस. सी. (उद्यानिकी) फल विज्ञान

Patel

मुख्य सलाहकार काहस्ताक्षर

Chetna

छात्रा का हस्ताक्षर

दिनांक 05/10/2021

विभागाध्यक्ष का हस्ताक्षर

सारांश

वर्तमानअनुसंधान शीर्षक "सुवासित सीताफल (*एनोना स्क्वामोसा* एल.) शेक के रेसिपी के मानकीकरण और भंडारण व्यवहार पर अध्ययन" प्रसंस्करण प्रयोगशाला, फल विज्ञान विभाग, कृषि महाविद्यालय, रायपुर (छ.ग.) में वर्ष 2020-21 के दौरान की गयी थी। तीन पुनरावृत्तियों में 07 उपचारों के साथ पूरी तरह से यादृच्छिक डिजाइन का उपयोग किया गया है। उपचार में सीताफल के गूदे और दूध के सात अलग-अलग सांद्रण शामिल थे। T_0: 100 प्रतिशत दूध (नियंत्रण), T_1: 70 प्रतिशत दूध + 30 प्रतिशत सीताफलका गूदा + 5 प्रतिशत शहद, T_2: 65 प्रतिशत दूध + 35 प्रतिशत सीताफलका गूदा + 5 प्रतिशत शहद, T_3: 60 प्रतिशत दूध + 40 प्रतिशत सीताफलका गूदा + 5 प्रतिशत शहद, T_4:70 प्रतिशत दूध + 30 प्रतिशत सीताफलका गूदा + 5 प्रतिशत गुड़, T_5: 65 प्रतिशत दूध + 35 प्रतिशत सीताफलका गूदा + 5 प्रतिशत गुड़, T_6: 60 प्रतिशत दूध + 40 प्रतिशत सीताफलका गूदा + 5 प्रतिशत गुड़।

सीताफलके फल स्थानीय बाजार से खरीदे गए और भौतिक-रासायनिक विशेषताओं के लिए उनका विश्लेषण किया गया। सीताफल के गूदे का उपयोग करके प्रसंस्कृत उत्पाद, शेक तैयार किया गया था, जिसे नियमित रूप से 15 दिनों के अंतराल पर उनके रासायनिक और संवेदी घटकों के लिए परीक्षण किया गया था। सीताफल शेक को 9 बिंदु हेडोनिक रेटिंग स्केल लागू करके इंद्रियग्राही मूल्यांकन किया गया था और 45 दिनों की अवधि में भंडारण के दौरान निष्कर्षों का विश्लेषण किया गया।

सीताफल की भौतिक संरचना का विश्लेषण करने पर औसत फल वजन (170.16 ग्राम), औसत फल आयतन (200 सीसी), औसत फल व्यास (22.6 सेमी), औसत फल लंबाई (6.83 सेमी), औसत फल बीज वजन(42.59 ग्राम) फलों के गूदे का औसत वजन (11.14 ग्राम) और गूदे से बीज का अनुपात (3.63) प्राप्त किया गया। इसी तरह, सीताफलों के रासायनिक विशेषताओं का विश्लेषण किया गया, जिसमे कुल घुलनशील ठोस (20.43^0ब्रिक्स), कुल चीनी (17.15%), अपचायक शर्करा (13.65%) अनअपचायी शर्करा (3.5%), कुल अम्लता (0.20%) और कुल एस्कॉर्बिक एसिड (15.65मिलीग्राम/100 ग्रा.) प्रसंस्करण से पहले प्राप्त हुआ।

परिणामों से पता चला कि रासायनिक विशेषताओंमें उपचार T_4 (70% दूध + 30% सीताफलका गूदा + 5%गुड़) के कुल घुलनशील विलय (24.77 डिग्री ब्रिक्स), कुल चीनी (14.59%), उपचायी शर्करा (11.35%), अनपचायक शर्करा (3.16%), अम्लता (0.18%) और पीएच (6.03)। अधिकतम प्रोटीन (3.11%) T_0 -100% दूध (नियंत्रण) के तहत दर्ज की गई थी, जबकि अधिकतम एस्कॉर्बिक एसिड (23.67 मिलीग्राम / 100 ग्राम) उपचार T_5 (65% दूध + 35% सीताफलका गूदा + 5% गुड़) के तहत दर्ज की गई थी।

सीताफल शेक के विभिन्न संवेदी मानकों के संबंध में उपचार T_4 (70% दूध + 30% सीताफलका गूदा + 5% गुड़) ने रंग और उपस्थिति (8.55), सुवास (8.54), स्वाद

(8.81) और समग्र स्वीकार्यता (8.42)का अधिकतम मूल्य दर्ज किया। जबकि, T_1 (70% दूध + 30% सीताफलका गूदा + 5% शहद) के उपचार के तहत बनावट का स्कोर (7.48) अधिकतम देखा गया।

वर्तमान खोज के आधार पर यह निष्कर्ष निकाला जा सकता है कि 70% दूध + 30% सीताफलका गूदा + 5% गुड़ (T_4) से तैयार मिल्क शेक रेसिपी को विभिन्न गुणवत्ता मापदंडों और संवेदी मूल्यांकन के संबंध में सबसे अच्छा पाया गया है और सीताफलशेक की व्यावसायिक तैयारी एवं विक्रय के लिए अनुशंसितहो सकता है ।

CHAPTER –I
INTRODUCTION

Custard apple (*Annona squamosal* L.) a member of Annonaceae family, popularly known as “sugar apple” or “sweet sop” or “fruit of poor people” is native to Tropical America, and is well distributed in the tropical, subtropical and arid zones of the world. In India it is called with different vernacular name like Sitaphal, Saripha etc. Custard apple has a oval or heart-shaped fruit with polygonal indentations on the top. Out of 100 species of annona, only 5 species, *viz*., Custard apple, cherimoya, Sour sop, bullock’s heart and atemoya are of commercial importance (Jain *et al*. 2019). The Custard apple has a scratchy outer shell, individual arils are cream-white sheaths that encase solitary, lustrous, deep brown seeds.

Custard apple contains more calories (101 calories/ 100g). Simple carbohydrates account for the majority of the calories. On the other hand, it is free from saturated fats and cholesterol. Custard apple has higher vitamin-C content (19.2 mg/100 g) than cherimoya. Custard apple is a good source of B-complex vitamins, particularly vitamin B_6 (17 % pyridoxine per 100 g). Fruit also contain several polyphenolic antioxidants. Among them, the most prominent are Annonaceous acetogenins. Acetogenin compounds such as asimicin and annonacin are potent cytotoxins. These compounds have anti-cancer, anti-malarial, and de-worming properties (Custard apple Nutrition facts, n.d.).

Custard apple is cultivated in India over an area of 46 thousand hectares with an annual output of 401 thousand MT, (Anon., 2020). In Chhattisgarh, custard apple is being grown in area of 9.541 thousand hectares with a production of 53.016 thousand MT and productivity of 5.55 MT/ha (Anon., 2020-21). The favourable agro-climatic condition for this crop in Chhattisgarh makes it available in nearly every district of this state. Generally tribal people and farmers of Chhattisgarh harvest sugar apple fruits from the forest area and sell it at a very low price at either on the road side or nearby markets. Since they have no idea about the market demand of this fruit, they harvest fruit either when the fruits have

attained improper maturity, or when the fruits are over ripened thus leading to considerable post harvest loses.

Custard apple is one of the most delightful and delicate fruit. Despite it's delightful flavour and high nutritive value, it fetches a low price due to market glut. Browning during the storage of fruits or it's pulp, is an obstacles in its post – harvest life. Therefore processing is the only option for increasing its shelf life. This technique not only extends the life of perishable goods, but it also generates a better market than fresh fruit. It aids in the removal of surplus product from the market during the post-harvest season, price stabilization, and the maintenance of a store of fruits to fulfill consumption during off-seasons.

Milk shake is a cold beverage prepared from milk and ice. It is considered as perfect health diet drink having low fat and sugar percentage andhigher MSNF(milk solids not fat)composition than ice cream (Sharma and Gupta, 1978). Fruit pulp can be added to make it more tasty and healthful. Fruit juice outlets in various regions of India sell milk shakes throughout the year (Sharma and Gupta, 1978). Blending milk with other fruits to create sweet and appealing products is becoming more popular. Custard apple pulp having pleasant aroma and flavor,sweet with moderate acidity could be anexcellent source for dessert, milkshakes and ice-creams.

Keeping the above facts in view the present investigation entitled: **"Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosal* L.) shake"** was carried out at Processing Laboratory, Department of Fruit Science, College of Agriculture, IGKV, Raipur with the following objectives:

1. To find out best proportion of custard apple and milk for preparation of custard apple shake
2. To analyze the quality parameters of custard apple shake during storage
3. To analyze sensory qualities of custard apple shake during storage

CHAPTER –II

REVIEW OF LITERATURE

Custard apple among one of the important fruit crop cultivated in tropical and sub-tropical region of the globe. The fruit is perishable and has very short storage life at ambient temperature which imparts serious post harvest losses. So as to extend the availability period of custard apple, the only way is value addition. Milk shake, blends with different fruit is recent concept and is gaining importance in Asian countries and abroad. The vital review of literature relevant to investigation entitled **"Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosa* L.) shake"** is given under this chapter that helps to correlate the findings of the experiment and is deal within the following sub heads:

2.1 Best proportion of custard apple and milk for custard apple shake

2.2 Quality parameters of custard apple shake during storage

2.3 Sensory qualities of custard apple shake during storage

2.1 Best proportion of custard apple and milk for custard apple shake

Varpe (1992) prepared fruit-flavored milk shake fortified with mango, sapota, apple and orange pulp at 5, 10 and 15% levels, respectively. He concluded that a milk shake with 15 to 10 % mango pulp and 10 % orange squash was superior and more acceptable than others.

Kshirsagar (1996) prepared fruit flavoured milk shake and concluded that the milk shakes made with 12 per cent mango fruit pulp had superior sensory parameter and acceptability as compared to other milk shakes.

Kashid *et al*. (2007) prepared golden milk shake from different proportions of safflower milk and cow milk *i.e.* 30:70 (T_1), 40:60 (T_2), 50:50 (T_3) and 100 per cent cow milk (T_0). Their result showed that a golden milk shake made with 70 parts cow milk with 30 parts safflower milk was closer to control (T_0) in acceptability. It was also permissible to make a golden milk shake using 50 parts cow milk and 50 parts safflower milk.

Pakalwad *et al.* (2010) found that the papaya milk shake, made with 90 parts buffalo milk and 10 parts papaya pulp was the most popular, with a rating of like very much to like extremely.

Poul *et al*. (2009) found that the milk shake made from blends of buffalo milk and custard apple pulp (90:10) was best among all treatments.

Alizadeh *et al*. (2014) conducted a research trial to develop a novel fruit-based milkshake by partially substituting sucrose with stevia and utilizing a blend of Kiwi, apple and banana concentrates. Five different fruit milk shake treatments were analysed using various ratios of sucrose and stevia; (1) 100:0 (TA : solely 36 g sucrose), (2) 75:25 (TB: 27 g sucrose and 40 mg Stevia), (3) 50:50 (TC : 18 g sucrose and 90 mg stevia), (4) 25:75 (TD: 9 g sucrose and 100 mg stevia) and (5) 0:100 (TE: solely 180 mg stevia). They concluded from their trial that the fruit based milk shake prepared by using sucrose / stevia (25:75) has the highest consumer acceptance.

Ubale *et al*. (2014) prepared milk shake by using three ratio of sapota (7, 8 and 9%) with three ratio of jaggery (7, 8 and 9 per cent) to investigate the sensory and chemical properties of sapota milkshake Based on sensory examination, it was determined that the sapota milk shake produced with 7% jaggery and 8% pulp was highly accepted by consumers

Mule *et al.* (2014) studied the fortified milk shake and buffalo milk shake and mixed with dried fig prepared in various proportions, such as 5%, 7.5, and 10%. The buffalo milk shakes with a 5% fig (*Ficus carica*) mix was much more consumer friendly having superior sensory appeal and nutritional value, as well as more cost-effective than control.

Karki *et al*. (2015) studied the sensory and chemical contents of sapota milkshakes by using three levels of sapota pulp (7%, 8%, and 9%). as well as three levels of jiggery (7%, 8%, and 9%). Based on sensory evaluation, it was determined that the sapota milk shake made with 7% jiggery and 8% pulp was approved by all judges, since this treatment had the maximum mark among the others.

Bakane *et al*. (2016) concluded that the various proportions of milk and custard apple pulp i.e 100:0, 90:10, 80:20, 75:25, 70:30, 65:35, and 60:40. were used to make custard apple milk shakes, According to the study, custard apple pulp (35%) in combination with cow milk (65%) produced the most acceptable milk shake, ranked between like very much to like very extremely.

Hingane *et al.* (2016) observed the sensory assessment of different amounts of cow milk and papaya pulp *i.e.* 95:05, 90:10, 85:15 and 80:20. were used to make milk shakes. The average rating of papaya milk shake (9 point hedonic scale) prepared with addition of 15% papaya pulp was found preferable and approved remarkably by the panelist. The treatment papaya pulp (85:15) was found best amongst all the treatments and further they concluded that the cost of production of 1 litre papaya milk shake increased with increased in the level of papaya pulp.

Prakash *et al*. (2016) prepared the skim milk mango shake incorporating mango pulp into the skim milk in the ratios, *i.e.*2:3, 1:1, 3:2. Safeda mango pulp showed higher acceptance than Dasheri mango pulp for manufacturing of mango shake. Fuzzy study suggests that the treatment S_4 produced with Safeda mango and skim milk in the ratio of 2:3 had greater acceptance, whereas the treatment S_3 prepared with Dasheri and skim milk in a ratio (3:2) received the least preference.

Jadhav *et al.* (2017) studied that sensory features of ginger (*Zingibe rofficinale* L.) milk shake by adding ginger juice, 2.5%, 5%, 7.5% and 10% of milk in volume basis. Their results revealed that milkshake prepared by adding 5% ginger juice was most effective and accepted milkshake.

Awhad *et al.* (2017) observed that the treatment consisted of 90 parts soya milk and 10 parts custard apple pulp, was found to be more palatable than the other treatments, with a rating of like very much to detest very much.

Shinde *et al.*(2018) conducted a trial on physicochemical analysis of milk shake blending with date pulp . The result revealed that the milk shake prepared with 7.5 % date pulp was found best treatment on the basis of physicochemical analysis of milkshake the most acceptable quality flavoured milkshake could prepared by using date pulp at the rate of 7.5 per cent of the buffalo skim milk.

Surve *et al*. (2018) conducted an experiment and results revealed that the treatment J_1D_2 (4 per cent jaggery and 10 per cent date pulp) was found to be the best among the other treatments.

Kuchekar *et al.* (2019) conducted a trial prepared milk shake by using that different amounts of buffalo milk mixed with crushed almond (5%, 10% and 15%). A product made with almond milk would be more pleasant and nutritious. All amounts of crushed almond in milk shakes were acceptable, including 5%, 10% and 15%, but the optimal level of almond that could be integrated in the blend up to 5% was the most acceptable and cost-effective. The larger amount of crushed almond in the mix received a lower score by the panel of judges.

Patil *et al*. (2019) prepared the blended carrot milkshake based on one factor variation. In this case optimization, the amount of carrot puree to be added was followed on the basis of 9 point hedonic scale. The mean score of overall acceptability was found to be highest for the treatment T_4 (8.2) followed by T_3 (7.9), T_5 (7.5), T_2 (6.3), T_1 (6.3) and lowest was under T_0 (6.1). The Sample containing 60% milk and 40% carrot puree gave good characteristics drink. It is further observed that milkshake is a good source of minerals contain calcium (230 mg /100 ml) and iron (24.03 mg / 100 ml).

Chauhan *et al*. (2019)concluded that the quality attributes of avocado milkshake powder was maintained by using standard protocol. The avocado milk shake powder was compared with avocado pulp powder. They resulted that

avocado milk shake powder is rich in phyto-nutrient like carotenoid (500 mg/100g), phenol (246 mg/100g) and flavonoids (24 mg/100g). Flow properties such as compressibility, permeability and aeration of avocado milk shake powder was higher than avocado pulp powder. Further they concluded that the prepared powder is easily reconstituted in water. Chocolate was also prepared in ratio of 30:70, 70:30 and 50:50 (cocoa powder and avocado milk shake powder) respectively. The final product of chocolate was standardized in the ratio of 30:70 of cocoa powder and avocado milk shakepowder.

2.2 Quality parameters of custard apple shake during storage

2.2.1 Total solublesolids (^{o} Brix)

Poul *et al*. (2009) concluded that the total soluble solids content of treatment T_0 (control), T_1 (90 % part of buffalo milk + 10 part of custard apple pulp), T_2 (85 part of buffalo milk + 15 parts of custard apple pulp) and T_3 (80% part of buffalo milk + 20 parts of custard apple pulp) were 22.57, 23.49, 23.76 and 24.26 per cent, respectively. The total soluble solid of custard apple milk shake was maximum (24.26) in T_3 and minimum in T_0 (22.57). When the amount of custard apple pulp was increased, the total soluble solids of the custard apple milk shakewas found increased.

Repate *et al*. (2010) prepared flavoured milk shake from different proportions of cow milk blended with safflower milk and they found that the total soluble solids content in T_0 (100:0) was maximum (15.21%) and maximum (13.10) was registered under T_4 (60:40). There was decrease in total soluble solids in flavoured milk with increased level of safflower milk. There were significant differences in total soluble solids content of flavoured milk.

Bakane *et al*. (2016) observed gradual increase in TSS of milk shake from 17.4 to 24.2° Brix with increase in level of custard apple pulp from 0 to 40 %.

Shinde *et al*. (2018) studied that the total soluble solids content of milkshake decreased with an increase in the level of date pulp. The maximum total soluble solid (21.35%) was noticed in milkshake without date pulp (T_0), whereas the lowest TSS (29.55%) was recorded in milkshake with 10% date pulp (T_4).

2.2.2 pH:

Paul *et al*. (2009) studied the pH of custard apple milk shake in different treatment T_0, T_1, T_2 and T_3. The pH of custard apple milk shake was recorded highest (6.56) in T_1: 90 parts of buffalo milk + 10 part custard apple pulp and lowest (6.41) in T_3: 80 parts of buffalo milk + 20 part custard apple pulp. The pH of custard apple milk shakes was shown to drop as the percentage of custard apple pulp in the milkshake increased.

Bakane *et al*. (2016) concluded that the pH of custard apple milkshake was found to be lower than expected (6.62 to 6.33) with increase in percentage of custard apple pulp in prepared milkshake.

2.2.3 Acidity (%):

Paul *et al*. (2009) concluded that the mean acidity of custard apple milk shake for treatment T_0, T_1, T_2 and T_3 was 0.13, 0.14, 0.15 and 0.15 per cent, respectively. There was a substantial difference between the treatment T_0 and T_1. With the addition of custard apple pulp to the mix, the acidity of the custard apple milk shake was found to be enhanced.

Mule *et al.* (2014) observed that the highest acidity content 0.14 % under the treatment T_4 (10 % of fig milk shake) and lowest acidity content (0.06%) recorded was in control (T_1).

Bakane*et al*. (2016) observed that the acidity was found to be increased from 0.12 to 0.14 % with increase in percentage of custard apple pulp in the blend.

Shinde*et al*. (2018) observed that the mean value of acidity negligibly decreased with increase in the level of date pulp. The lowest acidity (0.18%) was observed in milkshake prepared without date pulp (T_0), whereas the highest acidity (0.32%) was recorded in milkshake with 10 % date pulp (T_4).

Kuchekar *et al.* (2019) observed that the treatment T_1: 5 parts crushed almond + 95 part buffalo milk recorded highest acidity (0.16), however the treatment T_3: 15 parts crushed almond + 85 part buffalo milk showed lowest acidity percentage (0.14). There were non-significant differences in all treatments of almond milkshake.

2.2.4 Total sugar (%):

Poul *et al*. (2009) observed the total sugar content of custard apple milk shake and registered treatments were 14.03, 15.73, 16.45 & 17.38 per cent total sugar under T_0, T_1, T_2 and T_3, respectively. The total sugar content was lowest (14.03%) in treatment T_0: 100 % parts of buffalo milk (control), and highest (17.38%) under the treatment T_3.It was observed that the proportion of custard apple pulp when increased in blend there was significant increase in the total sugar content of custard apple milk shake, this might be due to more total sugar content present in custard apple pulp.

Mule *et al*. (2014) concluded that total sugar was significantly ($P \leq 0.05$) higher (12.78%) in 10% fig sample as compared to other two samples. The lowest total sugar 12.58 % was noted in fig milk shake prepared from buffalo milk.

Bakane *et al*. (2016) studied that the increase in the amount of custard apple pulp in the milk shake, the overall sugar level gradually increased. This is due to the fact that pulp contains higher sugar than milk.

2.2.5 Protein (%):

Poul *et al*. (2009) conducted an experiment and custard apple milk shake and found 3.84, 3.40, 3.54 and 2.92 % of protein under T_0 (100:0), T_1 (90:10), T_2 (85:15) and T_3 (80:20) respectively. The treatment 100:0 (T_0) was considerably better than the other treatments in respect to protein concentration. The protein content of the mix decreased as the amount of custard apple pulp in the blend increased. This might be attributed due to the lower protein content of custard apple pulp comparison to buffalo milk.

Repate *et al*. (2010) studied the flavoured milk shake blended with cow milk and safflower milk and stated that decreasing level of cow milk in milkshake decreased the protein content in product as cow milk content more protein than safflower milk.

Mule *et al.* (2014) reported that protein percentage of milk shake increased when the quantity of fig pulp is increased in the milk shake. The maximum protein

(4.52%) was recorded under the treatment T_4 with 10% fig pulp and lowest content was noticed in T_0 (4.22%).

Kuchekar *et al.* (2019) concluded that the protein content of almond milk shake was recorded highest (4.44%) under the treatment T_3. However, the lowest protein per cent (4.02%) was found under control. The non-significant differences were observed in respect to protein per cent in all the treatments. Under the trial asthe proportion of buffalo milk increased, the protein content in the finished product was also increased due almonds contain less protein (4.02%) as compared to buffalo milk.

Shinde *et al*. (2018) studied significant increase in protein content of milkshake with decrease in the level of date pulp. The highest protein content (4.19%) was observed in milkshake prepared without date pulp (T_0), whereas the lowest protein content (3.66%) was observed in milkshake prepared with 10% date pulp (T_4).

2.3 Sensory qualities of custard apple shake during storage

2.3.1 Colour and appearance

Repate *et al*. (2010) observed that treatment T_0 (control) scored the highest hedonic score for colour and appearance followed by T_1 (8.91), T_2 (8.30), T_3 (7.26) and T_4 (6.65). This indicated that increase in proportion of safflower milk in the blend decreased the score of colour and appearance of flavoured milk.

Pakalwad *et al*. (2010) studied that the mean score of colour and appearance for different treatments of papaya milk shake ranged from 8.07 to 8.33. The treatment T_1 (8.33) was found to be significantly superior over the rest of the treatments. It was observed that increased level of papaya pulp in papaya milk shake decreased the score of colour and appearance slightly.

Mule *et al.* (2014) recorded the maximum score (8.38) for appearance under treatment Crushed fig @ 7.5 % of buffalo milk.

Ubale *et al*. (2014) concluded that the colour and appearance score for different concentrations of jaggery on milkshake ranged from 6.12 to 7.71. The data showed that product prepared with 7 per cent jaggery scored the highest score followed by 8 and 9 per cent. It was observed that addition of jaggery up to 7 per cent increases the colour and appearance score of milk shake; however, addition of jaggery beyond 7 per cent decreased the colour and appearance score of milk shake.

More *et al.* (2017) recorded the maximum score for color and appearance (8.0) with milkshake prepared from 4% *Aloe vera* pulp, 12% custard apple pulp and 10 % sugar (T_2). The average scores for colour and appearance attribute of milk shake under different treatments ranged from 7.50 (T_0) to 8.00 (T_2).

Hingane *et al.* (2016) concluded that the mean score for colour and appearance of milk shake were 16.04, 17.16, 18.72 and 15.36 under the treatments T_1, T_2, T_3 and T_4, respectively. The significantly highest score was (18.72) received by milk shake prepared with addition of 15 per cent papaya pulp (T_3) while lowest score (15.36) was received by milk shake blended with addition of 20 per cent papaya pulp (T_4).

Bakane *et al*. (2016) concluded that the average rating for colour and appearance of various custard apple milk shake treatments was in the range of 5.87 to 7.73. It was found that increasing the amount of custard apple pulp in a milkshake marginally improves the colour and appearance value. Significant differences between treatments were obtained. Treatment T_5 has the best colour and appearance score.

Kuchekar *et al*. (2019) concluded that the average hedonic rating for colour and appearance of different treatments of almond milk shake ranges from 7.95 to 8.33. The treatment T_1 (8.33) was obtained to be significantly better than the other treatments. It was discovered that increase in the amount of the almond milk shake improved the colour and appearance score.

Patil *et al*. (2019) concluded that the average colour and appearance value for carrot milk shake combinations was determined to be in the range of 6.4 to 8. It

was concluded that increasing in the amount of carrot puree in milkshake somewhat improves the colour and appearance of the score. Treatment T_4 (60 % buffalo milk + 40 % carrot puree) received the highest colour and appearance ratings.

Chauhan *et al*. (2020) in their experiment found that as avocado is naturally green in color, so the value of a* is negative after the addition of milk and malto dextrin in pulp of avocado which gives the color value of (L*=77.62, a*= -2.22, b*=19.63) in butter fruit milk shake powder.

2.3.2 Flavour

Pakalwad *et al*. (2010) observed that the average flavour grade of papaya milk shake for treatments T_0, T_1, T_2 and T_3 was 8.15, 8.52, 8.24 and 8.48, respectively. The treatment T_1 (90% buffalo milk and 10% papaya pulp) was significantly superior over T_0 (100% buffalo milk by weight (control)) and T_2 (85% buffalo milk and 15% papaya pulp) treatments which concludes that a milk shake made with 90% buffalo milk and 10% papaya pulp had a deliciousflavour.

Repate *et al*. (2010) conducted a trial on preparation of flavoured milk from cow milk blended with safflower milk with five treatments viz., 100: 0 (T_0), 80: 20 (T_1), 70:30 (T_2), 60:40 (T_3) and 50:50 (T_4). Their results revealed that the score of flavour ranged between 6.41 (T_4)to 8.94 (T_0).

Ubale *et al*. (2014) conducted an experiment and found that mean score for flavour of ranged from 6.00 to 7.10. The score of flavour for product prepared with 8 per cent jaggery scored the highest score. The product prepared with 9 per cent jaggery scored lowest score followed by 7 and 8 per cent.

Mule *et al.* (2014) conducted an experiment and observed that the fig milk shake prepared from buffalo milk reported that the score for flavour on 9 point hedonic rating scale and ranged from 8.04 to 8.29. The highest score of 8.29 was obtained under fig milkshake prepared from 7.5% fig (T_3) which was significantly followed by control (flavour score of 8.09).

More *et al.* (2015) reported that the milk shake sample prepared from (T_2)has highest score (7.75) for flavour. Sample T_2 (4% *Aloe vera*pulp, 12% custard apple pulp and 10 % sugar)give mild and pleasant smell of Aloevera, which is identifiable. The flavour score for different treatments ranged between 6.87 and 7.75.

Research done by Bakane *et al*. (2016) revealed that the milk shake made with 65 per cent cow milk and 35 per cent custard apple pulp has a delicious flavour.

Hingane *et al.* (2016) observed that the flavour of milk shake was significantly ($P<0.05$) affected due to addition of different levels of papaya pulp. Highest score for flavor (39.68) was obtained in milk shake prepared with 15 per cent papaya pulp, while the lowest score (33.20) was obtained in milk shake prepared with addition of 5 per cent papaya pulp (T_1).

Jadhav *et al*. (2017) conducted an experiment and revealed that the maximum score (7.72) was recorded under T_2 (milkshake with 5 per cent ginger juice) and lowest score (7.35) was obtained in control (milk shake without addition of ginger).

Patil *et al.* (2019) registered that 60% buffalo milk blended with 40% carrot puree gave good flavour to milk shake.

Kuchekar *et al*. (2019) observed that the mean score for flavour of almond milkshake for treatments T_0, T_1, T_2 and T_3 was 8.03, 8.52, 8.47 and 8.22, respectively. The treatment $T_1$was significantly superior over T_0 and T_3 treatments. However, the flavour score of treatment T_2 was at par with treatment T_1. It has been concluded that 95% buffalo milk blend with 5 % almond provided milkshake a delicious flavor.

2.3.3 Texture

Pakalwad *et al*. (2010) prepared papaya milk shake and reported that the score for body and texture exhibited increasing trend with increasing levels of papaya pulp.

Mule *et al*. (2014) reported from their experiment that highest score for texture of fig milk shake (8.29) prepared from buffalo milk was observed and lowest score (8.16) was recorded under T_4.

Ubale *et al*. (2014) concluded that the mean score for texture ranged from 6.20 to 7.28. Under different treatment the score of texture for sapota milk shake product prepared with 7 per cent jaggery scored the highest score. The product prepared with 9 per cent jaggery scored lowest score followed by 7 and 8 per cent.

Hingane *et al*. (2016) found that the average scores for texture of milk shake were 27.28, 28.24, 32.16 and 26.32 for treatments T_1, T_2, T_3 and T_4, respectively. The significantly highest score 32.16 was accorded for milk shake prepared with 15 per cent papaya pulp (T_3),while the lowest score 26.32 was noticed in milk shake blended with addition of 20 per cent papaya pulp (T_4).

More *et al*. (2017) concluded that the milk shake prepared with T_2 (12% custard apple pulp + 4% *Aloe vera* pulp 10 % sugar) has highest average score (8.12) for texture, while sample T_3 (12 % custard apple + 5% aloe vera) has lowest average score (7.62) for body and texture.

Kuchekar *et al.* (2019) concluded that the average score for almond milk shake's texture characteristics was between 8.22 and 8.18. The best score (8.49) was obtained under the treatment T_1 and lowest (8.18) was found in T_3.

Patil *et al*. (2019) concluded that the average scores for texture attributes of milk shake were 27.28, 28.24, 32.16 and 26.32 for treatments T_1, T_2, T_3 and T_4 respectively. The significantly highest score was (32.16) assigned to milk shake prepared with 15 per cent papaya pulp (T_3),while the lowest score (26.32) was accorded to milk shake blended with addition of 20 per cent papaya pulp (T_4).

2.3.4 Taste

Ubale *et al*. (2014) found that the sapota milk shake registered the mean score for taste ranges between 6.11 to 7.00. The milk shake prepared with **7%**jaggery was significantly superior over all other treatment.

More *et al.* (2015) observed that among all the samples, the milk shake prepared(with12% custard apple pulp + 4% *Aloe vera*pulp 10 % sugar)had the

highest average taste score (8.00), while the sample (T_3)had the lowest taste score (7.00).

Repate *et al*. (2010) found that the mean score for test ranged from 6.31 to 8.98. It was lowest in (T_4)and highest in T_0. There were significant differences in the taste score of treatment T_2, T_3 and T_4.

Pakalwad *et al.* (2010) found that the highest score (8.74) for taste was under the treatment (10 % papaya pulp + 90 % buffalo milk by weight) followed by 15 % papaya pulp + 85 % buffalo milk by weight (8.20), 100% buffalo milk by weight (8.18) and 20 % papaya pulp + 80 % buffalo milk by weight (7.60). Increasing the percentage of papaya pulp in the mix was also ratyed below average among the panelist. The 10 per cent papaya pulp combination wasaccepted by the panelist in general.

Bakane *et al.* (2016) conducted an experiment and recorded that the highest mouth feel score (8.51) for under the treatment 65% cow milk and 35 % custard apple pulp by weight followed by 60 % cow milk and 40 % custard apple pulp by weight (7.90), 70 % cow milk and 30 % custard apple pulp by weight(7.54), 75 % cow milk and 25 % custard apple pulp by weight(7.17), 80% cow milk and 20 % custard apple pulp by weight(6.18), 90 % cow milk and 10 % custard apple pulp by weight (5.39) and lowest was noted under 100 % cow milk by weight(4.43). The 35 per cent blending of custard apple pulp 65% cow milk and 35 % custard apple pulp by weight was determined to be the most popular. The custard apple milk shake, made with 40% pulp and 60% milk, was difficult to consume as,-it received a worse mouth feel rating.

CHAPTER – III

MATERIALS AND METHODS

The present investigation entitled “Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosa*L.) shake” was undertaken at processing Laboratory, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the year 2020–2021. Details concerning the material used and the techniques adopted throughout the course of investigation are mentioned in this chapter under the following sub-heads:

3.1 Geographical Situation

Raipur is located in east central part of Chhattisgarh state bordered by the Mahanadi River and the geographical coordinate are 21.25ºN latitude, 81.63ºE longitudes and altitude of 298.15 meters above mean sea level.

3.2 Climatic Condition of Raipur

The region receives an average annual rainfall of 1307.5 mm, of which the major amount (around 87%) is received from June to mid- September Rainfall patterns however, vary greatly from year to year, particularly from June to September. May is the hottest month of the year with an average temperature of 35.4^{o} C. During summer, the maximum temperature reaches 42.7^{o}C. The average minimum temperature is 20.2^{o}C.

3.3 Weather condition during storage period

The meteorological data on various parameters *i.e* temperature, relative humidity, during the experiment periods are depicted in appendices-B and Fig 3.1.

3.4 Materials

3.4.1 Fruits

The experiment material *i.e* custard apple fruits were procured from the local market of Kanker district of Chhattisgarh. Uniform sized fruit having optimum maturity were selected and brought to the laboratory for preparation of product and further studies.

3.4.2 Tools and Equipment's used

Different tools and equipment such as Burette, Mixer Grinder, gloves and Trays were used during preparation of processed product. All the material were properly washed and sanitized before using. Electronic weighing balance was used for weighing product during experiment

3.5 Experimental Details:

- Crop : Custard apple (*Annona squamosal* L.)
- Design of experiment : Completely Randomized Design (CRD)
- Number of Treatments : 07
- Number of Replications : 03
- Experiment conducted in the month : October 2020 - November 2020

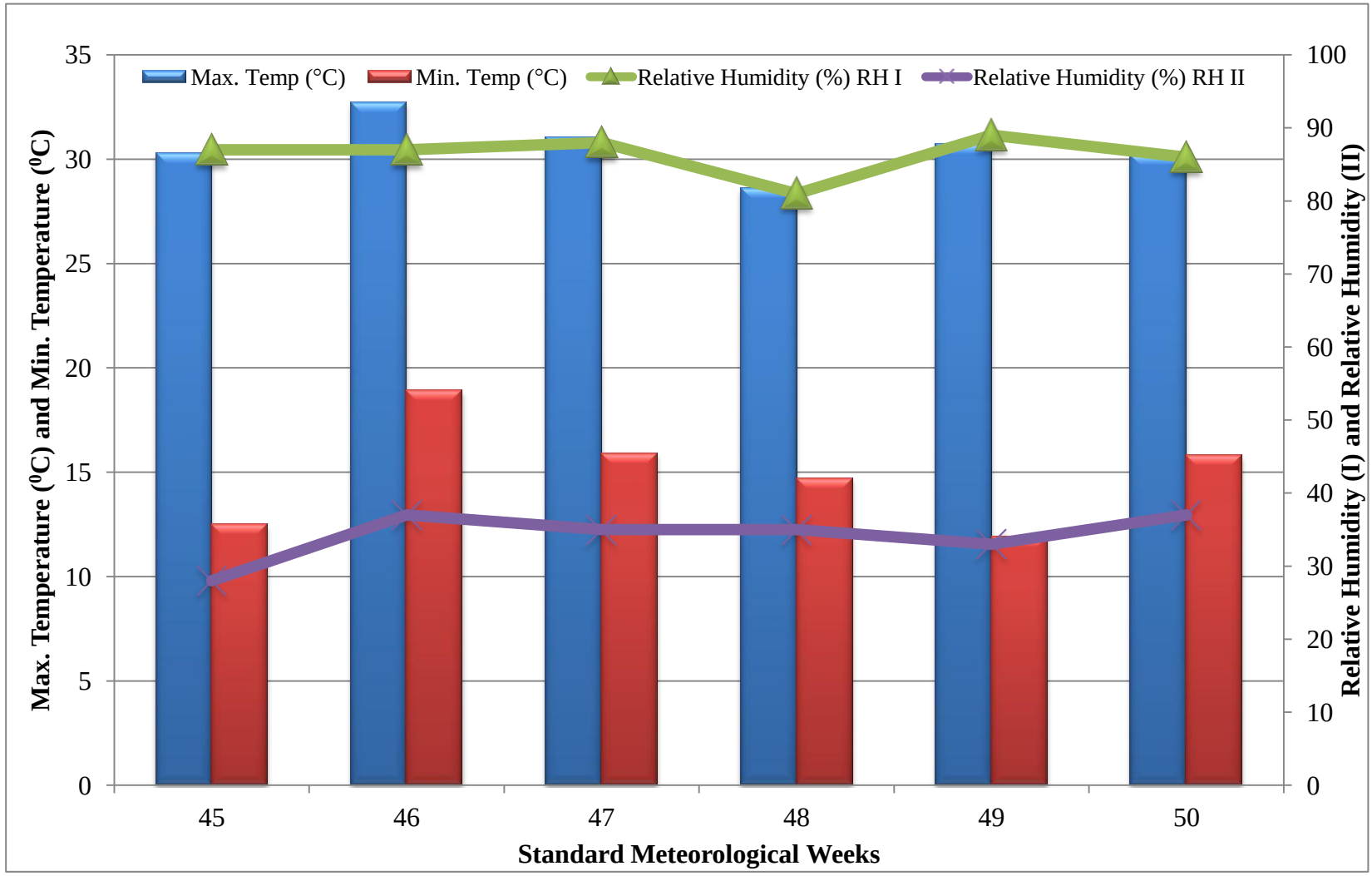


Fig. 3.1: Weekly Meteorological data during experimental period from November 05 - December 16, 2020

3.6 Treatment Details:

The Experiment was laid out in Completely Randomized Block Design (CRD) with three replications. The treatment details of the experiment are depicted in following table:

Table 3.1: Treatment details

S. No.	Treatment details	Notations used
1.	100 % Milk (Control)	T_0
2.	70 % milk + 30 % Custard apple pulp + 5 % Honey	T_1
3.	65 % milk + 35 % Custard apple pulp + 5 % Honey	T_2
4.	60 % milk + 40 % Custard apple pulp + 5 % Honey	T_3
5.	70 % milk + 30 % Custard apple pulp + 5 % Jaggery	T_4
6.	65 % milk + 35 % Custard apple pulp + 5 % Jaggery	T_5
7.	60 % milk + 40 % Custard apple pulp +5 % Jaggery	T_6

3.7 Preparation of Custard apple shake

3.7.1 Selection of fruit

Fully ripe fruit were selected to prepare custard apple milk shake, before processing the fruits were washed in running tap water to remove the dust particles.

3.7.2 Extraction of pulp

The pulp was extracted manually and the seeds were removed from pulp by rubbing it on steel mesh. After removal of seed the pulp was filtered through muslin cloth.

3.7.3 Addition of Fruit pulp, Milk, Honey /Jaggery

After pulp extraction, the measured quantity of all the ingredients *viz*., pulp, milk and honey or jaggery were taken as per treatments in mixer grinder and then blending was done for 1 to 2minutes.

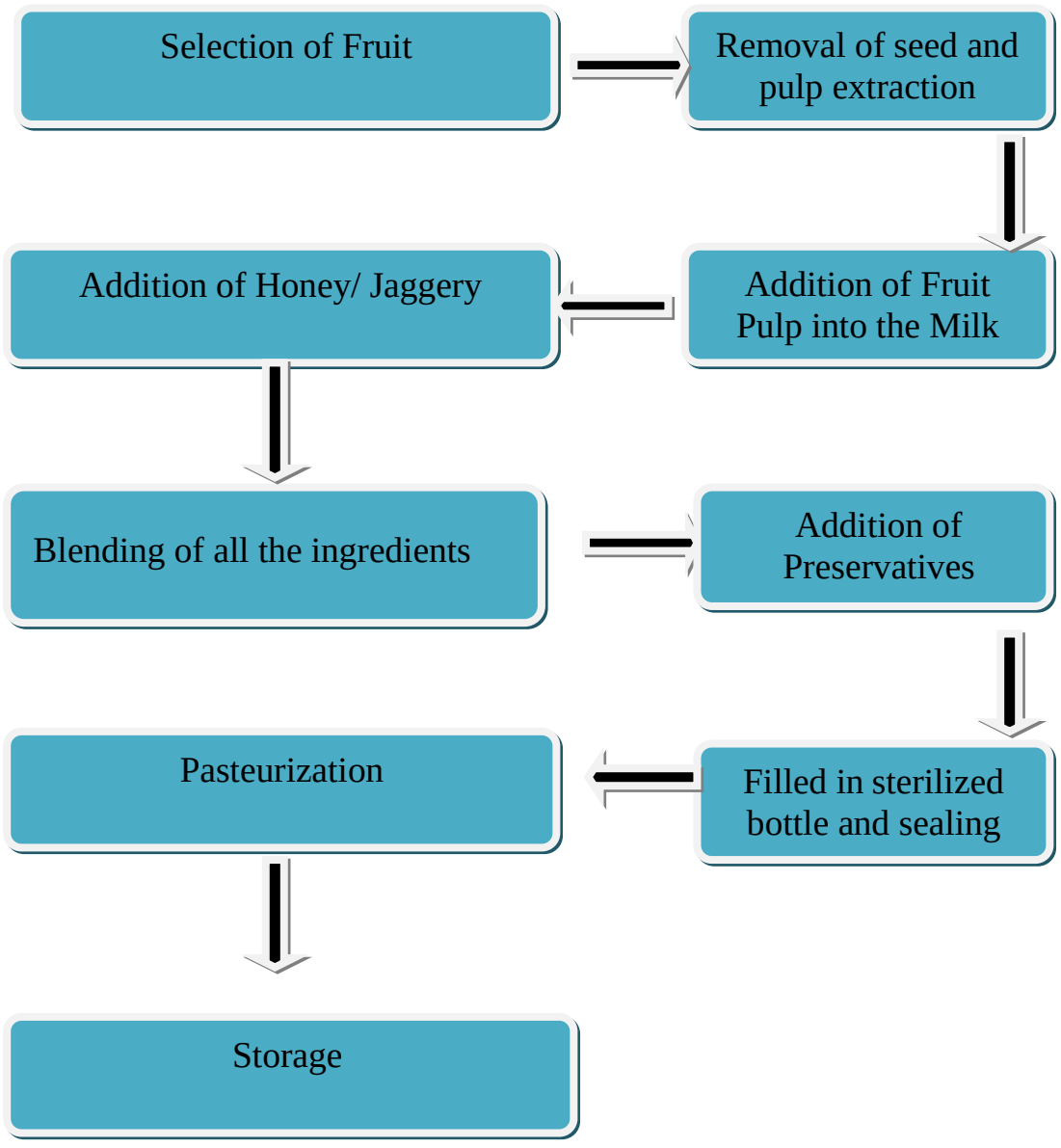
3.7.4 Addition of preservative

Sodium benzoate was used 0.1 % as preservative to preserve the custard apple shake to enhance the shelf life of processed product.

3.7.5 Filling and Sealing of bottles

The prepared product *i.e.* Custard apple shake is filled in hot into sterilized bottles and was sealed by crown corking machine.

Flow chart for preparation of Custard Apple Milk Shake



3.8 Observations recorded

The following observations were recorded during storage

3.8.1 Physical Composition of fruit

3.8.1.1 Weight of custard apple fruit (g)

3.8.1.2 Volume of custard apple fruit (cc)

3.8.1.3 Length of custard apple fruit (cm)

3.8.1.4 Diameter of custard apple fruit (g)

3.8.1.5 Weight of custard apple seed (g)

3.8.1.6 Pulp weight (g)

3.8.1.7 Pulp /Seed ratio

3.8.2 Chemical processed composition of fruit and custard apple shake

3.8.2.1 Total soluble solids (^{o}B)

3.8.2.2 Acidity (%)

3.8.2.3 pH

3.8.2.4 Ascorbic acid (mg/100g)

3.8.2.5 Sugar

3.8.2.5.1 Total Sugar(%)

3.8.2.5.2 Reducing sugar (%)

3.8.2.5.3 Non-reducing Sugar (%)

3.8.2.6 Protein (%)

3.8.3 Sensory evaluation of processed product

1. Appearance
2. Colour
3. Flavour
4. Taste
5. Texture

3.8.1 Physical composition of Custard apple fruits

Three randomly selected mature fruit of custard apple fruit was selected to observe the physical parameter. Fruits were taken to record observations on the following characters.

3.8.1.1 Weight of Custard apple fruit (g)

Randomly three fruits of custard apple were selected and the weight was measured using electrical balance. The observation was recorded in grams (g)

3.8.1.2 Volume of custard apple Fruit (cc)

The volumes of selected fruits were recorded by water displacement method using measuring cylinder and average volume was calculated and expressed in cc.

3.8.1.3 Length of custard apple fruits (cm)

The length of custard apple fruits were measured by Vernier caliper and the reading is noted in centimeter (cm).

3.8.1.4 Diameter custard apple of fruits (cm)

The fruit diameters were measured with a Vernier caliper and the reading expressed in cm.

3.8.1.5 Weight of custard appleseeds (g)

The pulp-free seeds of individual fruit were weighed separately and average seed weight of three fruits was recorded and expressed in grams.

3.8.1.6 Pulp weight (g)

The weight of pulp after discarding seed and rind of the selected fruits were measured by electronic weighing balance and expressed in grams.

3.8.1.6 Pulp: Seed ratio

The pulp: seed ratio was calculated by dividing the weight of pulp by weight of seed.

3.8.2 Chemical composition of fruits and custard apple shake

Chemical composition of fresh fruit was analyzed prior to preparation of custard apple shake, whereas the chemical composition of custard apple shake was

done initially just after preparation and up to acceptability of the product (45 days) at 15 days interval during storage period.

3.8.2.1 Total Soluble Solids (^{o}Brix)

Total Soluble Solids of Custards apple fruit and shake was determined by using hand refracto meter. The values are expressed in the units of ^{o}Brix.

3.8.2.2 Acidity (%)

The acidity was determined by titrating 10 ml of fruit juice/ pulp sample against 0.1 sodium hydroxide using phenolphthalein as an indicator. The end point appeared as light pink colour. The acidity was expressed in percent.

$$\text{Acidity (\%)} = \frac{\text{Titre of alkali} \times \text{Normality made up} \times \text{Volume wt. of acid} \times \text{Equivalent} \times 100}{\text{Number of sample taken for estimation} \times \text{Weight or volume of sample taken} \times 1000}$$

3.8.2.3pH

The pH of custard apple fruit pulp was determined by using digital pH meter.

3.8.2.4 Ascorbic acid (mg/100g)

The ascorbic acid of pulp was determined by the procedure given by Rangnna (1986).

Reagents used:

1. 3% Metaphosphoric acid (HPO_3)
2. Standard ascorbic acid: 1% L-ascorbic acid in Metaphosphoric acid solution.
3. Dye solution: 2, 6 – Dichlorophenol – indophenol in alkaline solution.

Estimation

5 ml L-ascorbic acid solution with same amount of HPO_3 was titrated against 2, 6– Dichlorophenols – indophenol. The end point was judged by light pink colour. The dye factor was determined as follow:

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Standard ascorbic acid solution with HPO_3 solution was titrated against the dye solution till the pink colour appears. This method was repeated for fruit pulp. The ascorbic acid was expressed as mg /100 g or ml.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{weight or volume of sample for estimation}}$$

3.8.2.5 Sugar (%)

Sugars were determined by the method as outline by Ranganna (1986).

Reagents

- Fehling's solution A: Copper Sulphate 69.28gm and volume made up to 1litre.
- Fehling's solution B: Potassium sodium tartrate 346 gm and sodium hydroxide(NaOH) 100 g and volume made up to 1 liter.
- Methylene blue indicator:1%aqueous.
- Neutral lead acetate (45%) solution.
- Potassium oxalate (45%) solution.
- Standard invert sugar solution: AR sucrose 9.5 gm and concentration HCl volume made up to 100ml.

The solution was allowed to stand for 3 to 5 days at 20-25ºC for inversion to take place so that it could be used for analysis for several months. 25 ml of invert sugar solution was taken in a flask and 50 ml distilled water was added to it and. It was then neutralized with 20% NaOH in the presence of phenolphthalein as an indicator until the solution turned into pink colour. It was then acidified with 1N HCl till the disappearance of pink colour. The volume was made up to mark with distilled water (1 ml = 2.5 ml of invert sugar).

3.8.2.5.1 Total Sugar (%)

Estimation

Fifty ml clarified sugar solution was added to 5 g of citric acid with 50 ml distilled water. It was boiled slowly for 10 minutes, cooled and transferred into a

250 ml volumetric flask and neutralized with phenolphthalein indicator and made up the volume. Titrate value was expressed as per cent reducing sugars. The total sugar was expressed in per cent and calculated using following formula:

Total Sugar (%) = Reducing sugar % (in which the titer is obtained after inversion) + percent sucrose

3.8.2.5.2Reducing sugar (%)

Estimation

A fixed amount of filtered juice (25ml) was transferred in to volumetric flask and adding and neutralizing the same amount of distilled water with this alkali solution. In this solution a fixed amount of lead acetate solution was added, shaked and allowed to stand for some time and essential amount of potassium oxalate solution was added to it. This procedure was followed to get clarified solution.

Five ml Fehling's solution A and Fehling's solution B was taken in a conical flask. Burette was filled with sugar solution. Conical flask was heated in an open flame. Two or four ml sugar solution was poured and 1-2 drop of methylene blue indicator was added. Now this solution was kept for heating and sugar solution was added to it. The end point appeared with brick-red colour. The reducing sugar was expressed in per cent.

$$\text{Reducing sugars (\%)} = \frac{\text{mg of inverted sugar} \times 250 \times 100}{\text{Reading of burette} \times 25 \times 1000}$$

3.8.2.5.3 Non- reducing sugar (%)

The quantity of non – reducing sugar in percentage is obtained by subtracting the value of reducing sugar from value of total sugar.

Non- reducing sugar (%) = Total sugar (%) – Reducing sugar (%)

3.8.2.6 Protein (%)

Protein content of custard apple milk shake was determined by the method described in Lane and Eyon (1923). The Kjedahl method, which basically

evaluates total nitrogen is the standard method for measuring the percent protein concentration in milk.

Sample Preparation

- 5 ml custard apple shake
- 10 ml H_2SO_4
- 2 gm salt mixture

Few blanks by adding all of the chemicals except custard apple shake was prepared and the sample was kept for 24 hours for further observation.

Protein analysis involve 3 steps:

1. Digestion – In the initial digestion stage, a mixture of potassium sulfate, copper sulfate, sulfuric acid and sample custard apple shake are added to a digestion flask containing a pre-weighed, pre-heated (38^o) sample of milk. The digested solution was is heated and kept at a rolling boil for approximately 1.5 to 2 hours. The digest is then transferred to a distillation flask, where sodium hydroxide (NaoH) and distilled water is added to neutralize the solution and ultimately convert ammonium sulfate to ammonia gas.

2. Distillation – In this distillation stage, the solution is again heated until the ammonia gas is liberated and captured in boric acid solution. For a single test, the distillation analysis takes 9 minutes.

3. Titration – The sample containing distillate is first titrate with a 0.2% sulfamic acid solution, and then a blank sample containing only digested reagents is titrated

$$\% \text{ Nitrogen sample} = \frac{(\text{Sample} - \text{Blank}) \times 0.014 \times 100 \times 0.02}{5}$$

% Protein = % of Nitrogen in milk shake sample x 6.25

3.8.3 Sensory evaluation of processed product

The organoleptic evaluation of custard apple shake was done by a panel of 6 members and the scoring was done on the basis 9 point hedonic scale as described by Ranganna (1986).

The different parameter for organoleptic evaluation were colour and appearance, taste, flavour, texture and over all acceptability.

The character with mean score of 5 or more out of 9 marks were considered acceptable. The overall acceptability of product was based upon the mean scores obtained from all these character studied under the test. The product with an overall mean score 15 or above was considered acceptable. The mean score obtained by different products were calculated (Appendices A).

3.9 Statisticalanalysis

Data recorded on various aspects in the laboratory were subjected to statistical analysis of variance technique as given in Gomez and Gomez (1985). The data obtained was analysed by using software "OPSTAT". The significant differences between treatments were compared with the critical difference at 5 per cent level of significance. The statistical analysis of the data was determined by using the Completely Randomized Experimental Design.

Table 3.2: Skeleton of analysis of variance (ANOVA)

Source of variation	**Degree of freedom**	**Sum of square**	**Mean sum of square**	**Fcal.**	**Ftab.**
Treatment	**(**t-1)	TrSS	TrMS = $\frac{\text{TrSS}}{\text{Df}}$	$\frac{\text{TrMS}}{\text{EMS}}$	
Error	(rt-t)	ESS	EMS = $\frac{\text{ESS}}{\text{Df}}$		
Total	rt-1	TSS			

t = number of treatment

r = number of replication

The F test was applied to judge the overall significance of various treatments in general and comparison of individual treatment was made with the help of critical difference at 5 per cent level of significance.

This was calculated as given below:

$$\text{SEm}\pm = \frac{\sqrt{\text{EMS}}}{\text{No of replication}}$$

C.D. for treatment = SEd × t value at 5% error degree of freedom

Where,

SEm = Standard Error of means

SEd = Standard Error of difference

C.D. = Critical difference

Selection of Fruits

Removal of seed and pulp

Addition of fruit pulp into the milk

Blending of all the ingredients

Addition of Preservatives

Filled in to sterilized bottle and sealing

Storage

Plate1: Flow chart for preparation for Custard Apple Milk Shake

Plate 2: Chemical analysis of Product (custard apple milk shake)

CHAPTER –IV
RESULT AND DISCUSSION

The data obtained on different aspects of Studies on "Standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosal* L.) shake during the course of investigation have been presented in appropriate tables and figures, along with statistical interpretations. Some facts and arguments have also been highlighted, which are briefly explained under the headings as follows:

4.1 Physico-chemical composition of custard apple fruits

4.2 Bio-chemical changes in blended custard apple shake during storage

4.3 Organoleptic evaluation of blended custard apple shake during storage

4.1 Physico-chemical composition of custard apple fruits

4.1.1. Physical composition

The Physico-chemical composition of custard apple fruits was investigated, and the results are depicted in Table 4.1.

A preview of data gathered in Table 4.1 should that the custard apple selected for preparation of custard apple shake record average fruit weight (170.16g) , average fruit volume (200 cc), average fruit diameter (22.6cm), average fruit length (6.83cm), average seed weight (11.14 g.) averagefruit pulp weight (42.59g) and pulp-to-seed ratio (3.63).

4.1.2. Chemical composition

The chemical composition of mature custard apple fruit were analysed and the data furnished in Table 4.1.

The data related to chemical composition of custard apple fruits revealed that the fruit content total soluble solids (20.43^{o}brix), total sugar (17.15 %), reducing sugar (13.65%) and non-reducing sugar content (3.5%). The ascorbic acid content in fruit was 15.65 mg/100g while acidity was registered 0.21% in the fruit sample.

Table 4.1: Physico - chemical composition of custard apple fruits

S. No.	Characters	Mean Value
(A)	**Physical composition**	
	Weight of fruit (g)	170.16
	Volume of fruit (cc)	200
	Length of fruit (cm)	6.83
	Diameter of fruit (cm)	22.6
	Weight of seed (g)	11.7
	Pulp weight (g)	42.59
	Pulp /Seed ratio	3.63
(B)	**Chemical composition**	
	Acidity (%)	0.21
	Total soluble solids (^{o}Brix)	20.43
	Total sugar (%)	17.15
	Reducing sugar (%)	13.65
	Non-reducing sugar (%)	3.5
	Ascorbic acid (mg/100g)	15.65

4.2 Bio-chemical changes in blended custard apple fruit shake during storage.

4.2.1 Total soluble solids (^{o}Brix)

The data presented in table 4.2.1 clearly indicates that the total soluble solids (^{o}Brix) of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the total soluble solids of custard apple shake was found significantly superior and recorded highest (23.78^{o}Brix) under the treatment T_4 (70 % milk + 30 % Custard Apple pulp + 5 % Jaggery) from rest of the other treatments under the present investigation. The total soluble solids in the treatments T_1 and T_2, $T_2$and T_3 was recorded 20.79 and 20.56, 20.56 and 20.09^{o}Brix respectively and did not show any statistical variation at 5% level of significance. However the treatments T_5 and T_6 with total soluble solids of 23.21 ^{o}Brix and 23.01^{o}Brix registered significant differences with each other and from the rest of the other treatment under present study. The minimum total soluble solids (17.21 ^{o}Brix was noticed under the treatment T_0 (control).

At 15 days of storage, the total soluble solids content was found to be highest (24.67^{o}Brix) under the treatment T_4(70 % milk + 30 % custard apple pulp + 5 % jaggery) which was significantly superior over rest of the other treatment . All the treatments under the present study showed significant differences in respect to total soluble solids observed at 15 DAS. The treatments T_1 T_2 T_3, T_5 and T_6 having respectively total soluble solids of 22.89, 22.78, 22.56, 24.47 and 24.32 ^{o}Brix showed significantly different with each other at 5 % level of significance. The minimum total soluble solids (19.22 ^{o}Brix) were confirmed under the treatments T_0 (control).

At 30 DAS, similar increasing trend with respect to total soluble solids was recorded under the various treatments. The data showed the superiority of treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) thereby recording the maximum total soluble solids of 24.89 ^{o}Brix, and maintained ststistical parity with the treatment T_6 having total soluble solids content of 24.60 ^{o}Brix 5 % level of significance. Similarly the treatments T_5 and T_6 with respective total soluble solids of 24.57 and 24.60 ^{o}Brix were also statistically at par under the present experiment however the treatments T_1,T_2,and T_5 having the total soluble solids of 23.47, 23.67 and 24.57, respectively were showed significant differences with each other. The minimum total soluble solid (20.28 ^{o}Brix) was registered under control (T_0).

At 45 day of storage, significant differences were seen among the treatment means witrh respect to total soluble solids. Data presented in table 4.2.1 recorded that the treatments T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher total soluble solids (25.76 ^{o}Brix), which was found superior from rest of the other treatments. The treatments T_1,T_2, T_3,T_5, and T_6 having the respective total soluble solids of 23.67,24.34, 24.56, 25.43 and 25.54 ^{o}Brix exhibited significant differences with each other at 5 % level of significance. The treatment T_0 (control) recorded the minimum total soluble solids (21.38^{o} Brix).

The increased TSS in the custard apple shake after storage was most likely due to conversion of reserved starch and other polysaccharides to soluble form of sugar with the advancement of storage period. The current findings are consistent with the report, in that the total soluble solids in the custard apple shake grew steadily over time. Similar findings were reported by Poul *et al*. (2009) and Bakane *et al*. (2016), who found that total soluble solids increased with time.

Table 4.2.1: Effect of different recipe treatments on TSS (^{o} Brix) of Custard apple shake during storage

Treatments	Total Soluble Solids (^{0}Brix)				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 : 100 % Milk (Control)	17.21^{a}	19.22^{a}	20.28^{a}	21.38^{a}	19.52
T_1: 70 % milk + 30 % Custard Apple pulp + 5 % Honey	20.79^{c}	22.89^{d}	23.47^{c}	23.67^{d}	22.70
T_2: 65 % milk + 35 % Custard Apple pulp + 5% Honey	20.56^{bc}	22.78^{c}	23.67^{d}	24.34^{b}	22.83
T_3: 60 % milk + 40 % Custard Apple pulp + 5 % Honey	20.09^{b}	22.56^{b}	23.34^{b}	24.56^{c}	22.63
T_4: 70 % milk + 30 % Custard Apple pulp + 5 % Jaggery	23.78^{f}	24.67^{g}	24.89^{f}	25.76^{g}	24.77
T_5: 65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	23.21^{e}	24.47^{f}	24.57^{e}	25.43^{e}	24.42
T_6: 60 % milk + 40 % Custard Apple pulp + 5 % Jaggery	23.01^{d}	24.32^{e}	24.60^{ef}	25.54^{f}	24.33
SEm±	**0.049**	**0.019**	**0.014**	**0.010**	
CD (P=0.05)	**0.147**	**0.060**	**0.044**	**0.029**	

1. TSS: Total Soluble Solid
2. DAS: Days after storage
3. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. These letters have been affixed based on CD- value comparison of treatment means.

4.2.2. Acidity (%)

The data presented in table 4.2.2 clearly indicates that the acidity of custard apple milk shake decreased with the advancement of storage period.

At 0 DAS the acidity of custard apple shake was found significant superior and record highest (022 %) under the treatment. The treatment $T_{1,}$ T_2 and T_5 having the respective acidity of 0.21 % each were found non- significant with each other at 5% level of significance. The minimum (0.19 %) was noticed under the treatment T_0 (control).

At 15 days of storage, the acidity content was found to be highest (0.20 %) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was statistically at par with the treatments $T_{1,}$ T_2 and T_5 having 0.19 % acidity in each treatment at 5 % level of significance. The minimum acidity (0.17%) was confirmed under the treatment T_0 (control).

At 30 DAS, similar decreasing trend with respect to acidity was observed under the various treatments. The data showed that the treatments T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) and T_6 (60 % milk + 40 % Custard apple pulp + 5 % Jaggery) recorded the maximum acidity of 0.17% and 0.17%, respectively. Similarly, the treatments T_1 and T_3 and T_2 and T_5 with respective acidity of 0.16% and 0.16% and 0.15 % and 0.15% were also recorded statistically at par with each other under the present experiment. The minimum acidity (0.14%) was registered under control (T_0).

At 45 day of storage, significant differences were recorded among the treatment means with respect to acidity. As per the table 4.2.2, the treatment T_2 (65 % Milk + 35% custard apple pulp + 5% Jaggery) achieved significantly higher acidity (0.17%), which was found superior from other treatments but was statistically at par with treatment T_6 with acidity content of 0.16% under the present trial. The treatments T_1,T_3, T_4 and T_5 having the respective acidity of 0.15% each were noticed non-significant differences with each other at 5% level of significance. The treatment T_0 (control) recorded the minimum (0.14%) which was at par with treatment T_4 (0.14%).

decrease in acidity may be due to conversion of acids to sugars (Pool *et al*., 1972) and utilization of organic acid during respiration (Singh and Mathur,1954 and Srivastava *et al.*, 1961)

Table 4.2.2: Effect of different recipe treatments on Acidity (%) of custard apple shake during storage

Treatments	Acidity (%)				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 :100 % Milk (Control)	0.19^{a}	0.18^{ab}	0.14^{a}	0.14^{a}	0.16
T_1 :70 % milk + 30 % Custard apple pulp + 5 % Honey	0.21^{b}	0.19^{bc}	0.16^{b}	0.15^{a}	0.18
T_2 :65 % milk + 35 % Custard apple pulp + 5 % Honey	0.21^{b}	0.19^{bc}	0.15^{a}	0.17^{c}	0.18
T_3 : 60 % milk + 40 % Custard apple pulp + 5 % Honey	0.19^{a}	0.17^{a}	0.16^{bc}	0.15^{a}	0.16
T_4 :70 % milk + 30 % Custard apple pulp + 5 % Jaggery	0.22^{b}	0.20^{c}	0.17^{c}	0.14^{a}	0.18
T_5 :65 % milk + 35 % Custard apple pulp + 5 % Jaggery	0.21^{b}	0.19^{bc}	0.15^{ab}	0.15^{ab}	0.17
T_6 : 60 % milk + 40 % Custard apple pulp +5 % Jaggery	0.19^{a}	0.18^{ab}	0.17^{c}	0.16^{bc}	0.17
SEm±	**0.004**	**0.005**	**0.006**	**0.005**	
CD (P=0.05)	**0.012**	**0.015**	**0.018**	**0.016**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means.

4.2.3 pH

The data presented in table 4.2.3 clearly indicates that the pH of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the pH of custard apple shake was found significantly higher (5.80) under treatment T_4. The treatments T_1 and T_2 and T_2 and T_5 having the respective pH of 5.70 and 5.70 and 5.70 and 5.71 were found non- significant at 5%level of significant. However the treatments T_3 and T_6 with pHof 4.43 and 5.31 registered significant differences with each other and from the rest of the other treatment under present study. The minimum pH (4.38) was noticed under the treatment T_0(control).

At 15 days of storage, the pH content was found to be highest (6.20) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) and as compared to rest of the other treatment. All the treatments under the present study showed significant differences in respect to pH observed at 15 DAS. The treatments T_1, T_6 and T_0 having respective pH of 5.56, 5.11 and 4.81 showed significantly different with each other at 5 % level of significance. Whereas, the treatments T_2 and T_5having pH value of 6.00 and 6.01 showed non-significant difference with each other. The minimum pH (4.61) was T_0 (control).

At 30 DAS, similar increasing trend with respect to pH was recorded under the various treatments. The data showed that the superiority of treatment T_6 (60 % Milk + 40 % custard apple pulp + 5 % Jaggery) with maximum pH (6.11) and maintained statistical partity with the treatment T_4 having pH of 6.09 at 5 % level of significance. Similarly the treatments T_1 and T_4, T_5 andT_3 and T_2 and T_0 with respective pH of 6.09 and 6.09, 6.02 and 6.05 and 5.28 and 5.26 did not differ statistically. However the treatments T_2 and T_5 having the pH value of 5.28 and 6.02 showed significant differences with each other. The minimum pH (5.26) was registered under control (T_0).

At 45 day of storage, significant differences were soon among the difference treatment means in respect to pH. As per the table 4.2.3 revealed that the treatment T_2 (6.36) achieved significantly higher pH, which was found superior from rest of the other treatments. The treatments T_6, T_3, T_1 and T_4 having the

respective pH values of 6.22, 6.16, 6.11 and 6.03 revealed significant differences with each other at 5 % level of significance while no significant differences were observed between T_5 and T_1. The minimum pH 5.83 was recorded under treatment T_0 (control).

Under the present investigation the maximum pH values of was observed under the treatments T_2 and minimum values was noticed under control T_0. The retention of pH values during storage periods might be due to increased hydrogen ion concentration, bearing of moisture evaporation from the custard apple shake. The reduction in pH values is also due to retention of higher percentage of acidity to the pure milk was more than custard apple pulp during storage period. The present findings are close agreement with the findings recorded by the Pareek *et al.* (2011) and Sahu *et al.* (2016) in custard apple shake.

Table 4.2.3: Effect of different recipe treatments on pH of custard apple shake during storage

Treatments	pH				
	0 DAS	**15 DAS**	**30 DAS**	**45 DAS**	**Mean**
T_0 :100 % Milk (Control)	4.38^{a}	4.81^{b}	5.26^{a}	5.83^{a}	5.07
T_1 :70 % milk + 30 % Custard Apple pulp + 5 % Honey	5.70^{de}	5.56^{d}	6.09^{de}	6.11^{d}	5.86
T_2 :65 % milk + 35 % Custard Apple pulp+ 5 % Honey	5.70^{ef}	6^{ef}	5.28^{a}	6.36^{g}	5.83
T_3 :60 % milk + 40 % Custard Apple pulp + 5 % Honey	4.43^{b}	4.61^{a}	6.05^{c}	6.16^{e}	5.31
T_4 70 % milk + 30 % Custard Apple pulp + 5 % Jaggery	5.8^{g}	6.20^{g}	6.09^{ef}	6.03^{b}	6.03
T_5 :65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	5.71^{f}	6.01^{f}	6.02^{b}	6.09^{cd}	5.95
T_6 :60 % milk + 40 % Custard Apple pulp +5 % Jaggery	5.31^{c}	5.11^{c}	6.11^{f}	6.22^{f}	5.68
SEm±	**0.008**	**0.008**	**0.009**	**0.008**	
CD (P=0.05)	**0.026**	**0.024**	**0.028**	**0.023**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means.

4.2.4 Ascorbic acid (mg / 100 g)

The data presented in table 4.2.4 clearly indicates that the Ascorbic acid of custard apple milk shake increase with the advancement of storage period.

At 0 DAS the ascorbic acid of custard apple shake was found significant superior and record highest under the treatment T_4 (21.89 mg/100g) from rest of the other treatments under the present investigation. The treatment T_6 and T_5 having the respectiveascorbic acid content of 21.32 mg/100g and 21.38 mg/100g were found non- significant at 5% level of significance. However the treatments T_2, T_3 and T_1 with an ascorbic acid contentof 20.39 mg/100g, 20.75 mg/100g and 20.89 mg/100g, respectively registered significant differences with each other. The minimum ascorbic acid (20.22 mg/100g) was noticed under the treatment T_0 (control).

At 15 days of storage, the ascorbic acid content was found to be highest (22.01 mg/100g) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was superior rest of the treatments.Similar values were recorded in T_6 having 22.00mg/100g ascorbic acid content. All the treatments in the present observation showed significant differences with respect to ascorbic acid at 15 DAS. The treatments T_5 and T_6, T_1 and T_2 having respective ascorbic acid values of 22.00 mg/100g and 22.00 mg/100g, 21.03 mg/100g and 21.03 mg/100g however maintained statistical parity with each other at 5 % level of significance. Treatments T_5 and T_2 and T_1 and T_3 with respective ascorbic acid values of 22.00 mg/100g and 21.03 mg/100g and 21.03 mg/100g and 20.88 mg/100g showed significant difference with each other at 5 % level of significance. The minimum ascorbic acid (20.69 mg/100g) were confirmed under the treatment T_0 (control).

At 30 DAS, similar increasing trend with respect to ascorbic acid was recorded under the various treatments. The data showed the superiority of treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) and recorded the maximum ascorbic acid (24.69 mg/100g). The treatments T_5, T_6, T_2, T_1 and T_3 having the ascorbic acid of 24.44 mg/100g, 24.39 mg/100g, 24.32 mg/100g, 24.21 and 23.27 mg/100g respectively showed significant differences with each other. The minimum ascorbic acid (22.33 mg/100g) was registered under control (T_0).

At 45 day of storage, significant differences were seen among the different treatment means in respect to ascorbic acid. As per the table 4.2.4 recorded that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher ascorbic acid (27.03mg/100g), which was found superior from rest of the other treatments under the present trial. The treatments T_5, T_6, T_2, T_1 and T_6 having the respective ascorbic acid 26.87 mg/100g, 26.79 mg/100g, 26.41 mg/100g, 26.13 mg/100g and 26.03 mg/100g were observed significant differences with each other at 5 % level of significance.

The ascorbic acid content increased over the storage period. With increasing concentration of cow milk, irrespective of additional sweetener, the ascorbic acid content increased among the treatments. However, treatment containing 100% cow milk observed to have minimum ascorbic acid, suggesting that custard apple pulp in other treatments playing a vital role in retaining ascorbic acid. in custard apple.due to the oxidation of ascorbic acid to dehydroascorbic acid and then further degraded to 2,3-diketo-gluconic acid by the action of ascorbic acid oxidase enzyme.This might be attributed to low temperature and high relative humidity in storage, which inhibited the rate of oxidation and metholic activity Kumhar *et al.*(2014).

Table 4.2.4: Effect of different recipe treatments on ascorbic acid (mg/100g) of stored custard apple shake during storage

Treatments	Ascorbic acid (mg/ 100g)				
	0 DAS	**15 DAS**	**30 DAS**	**45 DAS**	**Mean**
T_0 :100 % Cow Milk (Control)	20.22^{a}	20.69^{a}	22.33^{a}	24.04^{a}	21.82
T_1 :70 % Cow milk + 30 % Custard Apple pulp + 5 % Honey	20.89^{d}	21.03^{c}	24.21^{c}	26.13^{c}	23.06
T_2 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey	20.75^{b}	21.03^{c}	24.32^{d}	26.41^{d}	23.12
T_3 :60 % Cow milk + 40 % Custard Apple pulp + 5 % Honey	20.39^{c}	20.88^{b}	23.27^{b}	26.03^{b}	22.42
T_4:70 % Cow milk + 30 % Custard Apple pulp + 5 % Jaggery	21.89^{f}	22.01^{e}	24.69^{g}	27.03^{g}	23.3
T_5 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Jaggery	21.38^{e}	22.00^{d}	24.44^{f}	26.87^{f}	23.67
T_6 :60 % Cow milk + 40 % Custard Apple pulp +5 % Jaggery	21.32^{e}	22.00^{de}	24.39^{e}	26.79^{e}	23.62
SEm ±	**0.031**	**0.006**	**0.008**	**0.01**	
CD at 5%	**0.095**	**0.018**	**0.024**	**0.03**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD-value comparison of treatment means

4.2.5 Total Sugar (%)

The data presented in table 4.2.5 clearly indicates total sugar of custard apple milk shake increased with the advantage of storage period.

At 0 DAS the total sugar of custard apple shake was found significantly superior and recorded highest under the treatment T_4 (12.89%) from rest of the other treatments. The treatments $T_{3,}T_{5,}T_2$ and T_6 having the respective total sugar of 12.7, 12.69, 12.67 and 12.65 were found non-significant with each other at 5% level of significance. However the treatments T_6 and T_1 with total sugar of 12 .65 and 12.32 registered significant differences with each other. The minimum total sugar (12.25%) was noticed under the treatment T_0 (control).

At 15 days of storage, the total sugar content was found to be highest (13.91%) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was noted superior from rest of the treatments. All the treatments under the present study showed significant differences in respect to total sugar observed at 15 DAS. The treatments $T_{3,}$ $T_{2,}$ T_0 and T_1having respective total sugar of 13.88%, 13.78%, 13.67% and 13.43% showed significant difference with each other at 5% level of significance. The minimum total sugar (13.41 %) were confirmed under the treatment T_6(60% milk + 40 % custard apple pulp + 5 % jaggery).

At 30 DAS, similar increasing trend with respect to total sugar was recorded under the various treatments. The data showed that the superiority of treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) recorded the maximum value in total sugar (15.76%), which was found significant over the treatment T_0 having total sugar content of 15.25 % at 5 % level of significance. Similarly the treatments $T_{0,}$ $T_{3,}$ $T_{6,}$ T_2 and T_5 and T_6 with respective total sugar of 15.25%, 15.23%, 15.21%, 15.19% and 15.16% were also statistically at par. The minimum total sugar (15.21%) was registered under T_6 (60% milk + 40 % custard apple pulp + 5 % jaggery).

At 45 day of storage, significant differences were seen among the treatment means in respect to total sugar. As per the table 4.2.5 recorded that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher total sugar (15.81%), which was found superior from rest of the other treatments under the

present trial. The treatments T_0 and T_5, T_3 and T_2 and T_2 and T_6 having the respective total sugar of 15.43% and 15.39%, 15.31% and 15.20% and 15.20% and 15.27% were statistically at par with each other at 5 % level of significance. The minimum total sugar of 15.11% was recorded under treatment T_1.

The total sugar per cent of shake showed an increasing trend up to 45 days of storage. Increase in total sugar might be due to partial hydrolysis of complex carbohydrate. Similar results have also been reported by Jadhav *et al.* (2017).

Table 4.2.5: Effect of different recipe treatments on total sugar (%) of custard apple shake during storage

Treatments	Total sugar %				
	0 Day	15DAS	30 DAS	45 DAS	Mean
T_0:100 % Cow Milk (Control)	12.25^{a}	13.67^{b}	15.25^{e}	15.43^{d}	14.15
T_1 :70 % Cow milk + 30 % Custard Apple pulp + 5 % Honey	12.32^{b}	13.43^{a}	15.05^{a}	15.11^{a}	13.97
T_2 :65% Cow milk + 35% Custard Apple pulp + 5% Honey	12.67^{cd}	13.78^{c}	15.19^{bc}	15.28^{bc}	14.23
T_3 :60% Cow milk + 40% Custard Apple pulp+5 % Honey	12.71^{e}	13.88^{d}	15.23^{de}	15.31^{c}	14.28
T_4 :70 % Cow milk + 30% Custard Apple pulp + 5 % Jaggery	12.89^{f}	13.91^{e}	15.76^{f}	15.81^{e}	14.59
T_5 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Jaggery	12.69^{de}	13.76^{c}	15.16^{b}	15.39^{d}	14.25
T_6:60 % Cow milk + 40 % Custard Apple pulp +5 % Jaggery	12.65^{c}	13.41^{a}	15.21^{cd}	15.27^{b}	14.13
SEm±	**0.014**	**0.008**	**0.011**	**0.014**	
CD at 5%	**0.014**	**0.024**	**0.034**	**0.043**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letters have been affixed based on CD- value comparison of treatment mean.

4.2.6 Reducing sugar (%)

The data presented in table 4.2.6 clearly indicates that the reducing sugar of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the reducing sugar of custard apple shake was found highest (9.35%) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was statistically superior from the treatment T_5 and T_3 having the reducing sugar content of 9.30 % and 9.21%, respectively. The treatment T_3 and T_6 and T_2 and T_1 having the respective reducing sugar of 9.21% and 9.19% and 9.11% and 9.11% were found non-significant with each other at 5% level of significance. However, the treatments T_5 and T_3 and T_6 and T_2 with reducing sugar of 9.30% and 9.21% and 9.19% and 9.11% registered significant differences with each other under present study. The minimum reducing sugar (9.01%) was noticed under the treatment T_0 (control).

At 15 days of storage, the reducing sugar content was found to be highest (10.83%) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was noted superior from rest of treatment . The treatments T_3, T_5 and T_2 having respective reducing sugar of 10 .72 %, 10.65% and 10.62 showed non-significant difference with each other at 5 % level of significance. The minimum reducing sugar (10.36%) were confirmed under the treatment T_6(60% milk + 40 % custard apple pulp + 5 % jaggery).

At 30 DAS, similar increasing trend with respect to reducing sugar was recorded under the various treatments. The data showed that the superiority of treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) recorded the maximum reducing sugar (12.42%), which was found statistically superior over the treatment T_0 having reducing sugar content of 12.15 % at 5 % level of significance. Similarly the treatments T_0, T_6 and T_3 with respective reducing sugar of 12.15%, 12.14% and 12.12 % were also recorded statistically at par under the present experiment. However the treatments T_2 and T_5 having the reducing sugar of 12.07% and 12.04%, respectively were statistically significant with each other. The

minimum reducing sugar (12.01%) was registered under T_1 (70 % Milk + 30 % custard apple pulp + 5 % Honey).

At 45 day of storage, the data revealed that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher reducing sugar (12.83%), which was found superior from rest of the other treatments and significantly followed by the treatment T_6 having reducing sugar of 12.62%. The treatments T_6, T_3, T_2, T_5, and T_0 having the respective reducing sugar of 12.62%, 12.62%, 12.57%, 12.55% and 12.50% exhibited non-significant difference.

The change in different sugar fraction could be due to hydrolysis of polysaccharides such as starch, pectin and the inversion of non-reducing sugar into reducing sugar as increase in reducing sugar was correlated with the decrease in non- reducing sugar. The increase in reducing sugar corresponded to the increase in total soluble solids and ultimate decrease in non-reducing sugar in the storage period. Similar findings were also reported by the Sharma and Singh (2005), Singh *et al.* (2011) in custard apple.

Table 4.2.6: Effect of different recipe treatments on reducing sugar (%) of custard apple shake during storage

Treatments	Reducing sugar (%)				
	0 DAS	**15 DAS**	**30 DAS**	**45 DAS**	**Mean**
T_0:100 % Cow Milk (Control)	9.01^{a}	10.50^{b}	12.15^{e}	12.50^{bc}	11.04
T_1 :70 % Cow milk + 30 % Custard Apple pulp + 5 % Honey	9.11^{bc}	10.39^{a}	12.01^{a}	12.40^{a}	10.97
T_2 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey	9.11^{c}	10.62^{cd}	12.07^{b}	12.57^{de}	11.01
T_3 :60 % Cow milk + 40 % Custard Apple pulp + 5 % Honey	9.21^{e}	10.72^{e}	12.12^{cd}	12.62^{ef}	11.16
T_4 :70 % Cow milk + 30 % Custard Apple pulp + 5 % Jaggery	9.35^{g}	10.83^{f}	12.42^{f}	12.83^{g}	11.35
T_5 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Jaggery	9.30^{f}	10.65^{de}	12.04^{a}	12.55^{cd}	11.13
T_6 :60 % Cow milk + 40 % Custard Apple pulp +5 % Jaggery	9.19^{de}	10.36^{a}	12.14^{de}	12.62^{f}	11.07
SEm±	**0.012**	**0.023**	**0.008**	**0.024**	
CD at 5%	**0.037**	**0.072**	**0.025**	**0.072**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment mean.

4.2.7 Non-Reducing sugar (%)

The data presented in table 4.2.7 clearly indicates that the non-reducing of custard apple milk shake decreased with the advancement of storage period.

At 0 DAS the non-reducing sugar of custard apple shake was found significant superior and recorded highest (3.56%) under the treatment T_2 (65% cow milk+ 35 % custard apple pulp + 5% jaggery) and did not differ significantly with the observation recorded in the treatment T_4 (3.54%). The treatments T_6 and T_3 having the respective non-reducing sugar of 3.46% and 3.46% were found non-significant with each other at 5% level of significant. However the treatmentsT_3, T_5, T_0 and T_1 with non-reducing sugar of 3.46%, 3.34%, 3.24% and 3.19% exhibited significant differences. The minimum non-reducing sugar (3.19%) was noticed under the treatment T_1(70 % milk + 30 % custard apple pulp + 5 % honey).

At 15 days of storage, the non-reducing content was found to be highest (3.40%) under the treatment T_6 (60 % milk + 40 % custard apple pulp + 5 % jaggery) which was noted superior from rest of the other treatments. The treatments T_3, T_2 T_0, T_5 and T_4 having respective non-reducing sugar of 3.16%, 3.16%, 3.16%, 3.11% and 3.08% showed non-significant difference with each other at 5 % level of significance. The minimum non-reducing sugar (3.04%) were confirmed under the treatment T_1(70 % milk + 30 % custard apple pulp + 5 % honey).

At 30 DAS, the data showed that the treatment T_5 (65 % Milk + 35 % custard apple pulp + 5 % Jaggery) recorded the maximum non-reducing sugar (3.12%), which was found statistically at par with the treatments T_2, T_3 and T_0 having non-reducing sugar content of 3.12%, 3.11% and 3.10% at 5 % level of significance. Similarly the treatments T_6 and T_4 with respective non-reducing sugar of 3.07% and 3.06% were also recorded statistically at par under the present experiment. However the treatments T_0 and T_6having the non-reducing sugar of 3.10% and 3.07 respectively differed significantly. The minimum non-reducing sugar (3.04 %) was registered under T_1 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery).

At 45 day of storage, significant differences were seen among the difference treatment means with respect to non-reducing sugar. As per the table 4.2.7 recorded that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher non-reducing sugar (2.98%), which was found superior from rest of the other treatments. The treatments T_2,T_1 and T_3 having the respective non-reducing sugar of 2.71%, 2.71% and 2.69% maintained statistical parity at 5 % level of significance. The minimum non reducing sugar (2.65%) was noticed under the treatment T_6(60 % Milk + 40 % custard apple pulp + 5 % Jaggery).

In the present experiment, the non-reducing sugar percentage shows a decreasing trend with the increase in storage duration. This might be due to the inversion of non-reducing sugar into reducing sugar, as increase in reducing sugar was correlated with the decrease in non- reducing sugar. The increase in reducing sugar corresponded to the increase in total soluble solids and ultimate decrease in non-reducing sugar in the storage period. Similar findings were also reported by the Sharma and Singh (2005), Patel *et al.* (2011) in custard apple.

Table. 4.2.7: Effect of different recipe treatments on non-reducing sugar of custard apple shake during storage

Treatments	Non-reducing (%)				
	0 DAS	**15 DAS**	**30 DAS**	**45 DAS**	**Mean**
T_0:100 % Cow Milk (Control)	3.24^{b}	3.16^{a}	3.10^{bc}	2.93^{f}	3.10
T_1:70 % Cow milk + 30 % Custard Apple pulp + 5 % Honey	3.19^{a}	3.04^{a}	3.04^{a}	2.71^{cd}	2.99
T_2:65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey	3.56^{g}	3.16^{a}	$3.12d^{e}$	2.71^{d}	3.13
T_3:60 % Cow milk + 40 % Custard Apple pulp + 5 % Honey	$3.46d^{e}$	3.16^{a}	3.11^{cd}	2.69^{bc}	3.10
T_4:70 % Cow milk + 30 % Custard Apple pulp + 5 % Jaggery	3.54^{fg}	3.08^{a}	3.06^{a}	2.98^{g}	3.16
T_5: 65 % Cow milk + 35 % Custard Apple pulp + 5 % Jaggery	3.34^{c}	3.11^{a}	3.12^{e}	2.84^{e}	3.10
T_6: 60 % Cow milk + 40 % Custard Apple pulp +5 % Jaggery	3.46^{e}	3.40^{b}	3.07^{a}	2.65^{a}	3.14
SEm±	**0.01**	**0.024**	**0.07**	**0.012**	
CD at 5 %	**0.029**	**0.073**	**0.021**	**0.037**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means.

4.2.8 Protein (%)

The data presented in table 4.2.8 clearly indicates that the protein percentage of custard apple milk shake increased with the advancement of storage period from 0 to 45 days.

At 0 DAS the protein content of custard apple shake was found highest (2.80 %) under the treatment T_4 which was statistically at par with T_5 under the present investigation. The treatments T_5, T_3, T_1 and T_0 having the respective protein of 2.78%, 2.78%, 2.78% and 2.78% were found non- significant with each other at 5% level of significance. However, the treatments T_6 and T_2 with protein percentage of 2.74% were found at par with each other. The minimum protein (2.74%)was noticed under the treatment T_2 .

At 15 days of storage, the protein content was found to be highest (2.87%) under the treatment T_0 (control) which was noted statistically at par with treatment T_4 (2.85%) but was statistically superior than T_1 (2.83%). The treatments T_1, T_2 and T_5 having respective protein of 2.83%, 2.79% and 2.79% showed non-significant difference with each other at 5 % level of significance. The minimum protein (2.74%) were confirmed under the treatment T_6(60 % Milk + 40 % custard apple pulp + 5 % Jaggery).

At 30 DAS, similar increasing trend with respect to protein was recorded under the various treatments. The data showed that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) recorded the maximum protein (3.26 %), which was found statistically superior over all the treatments followed by the treatment T_3 (3.19%). The treatments T_3, T_1 , T_2 and T_5 having the protein content of 3.19%, 3.16%, 3.16% and 3.16% were found non-significant with each other. The minimum protein (2.87%) was registered under control (T_0).

At 45 day of storage, significant differences were seen among the different treatment means with respect to protein content. As per the table 4.2.8 treatment T_0 (control) achieved significantly higher protein (3.46%), which was found superior than rest of the other treatments and significantly followed by T_4 (3.42%) under the present trial. The treatmentsT_2 and T_5 having the respective protein per cent of 3.22% and 3.22 % were non-significant with each other at 5 % level of

significance. Whereas, treatment $T_{1,}$ T_3 andT_6 having respective protein content of 3.23%, 3.28% and 3.19% were statistically significant with $T_{0.}$ The minimum protein content was recorded under T_6 (3.19%).

It was observed that as the quantity of custard apple pulp is increased there was decrease in protein content, which might be due to less protein in custard apple pulp as compared to cow milk. The results are in conformity with the finding of Poul *et. al*(2010) in custard apple milk shake. Kashid *et al*. (2005) found the similar observation in golden milk shake from cows combined with safflower milk and also reported by Nakaya *et al.* (1991).

Table 4.2.8: Effect of different recipe treatments on Protein (%) of custard apple shake during storage

Treatments	Protein (%)				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 : 100 % Milk (Control)	2.78^{bc}	2.87^{f}	2.87^{e}	3.46^{f}	2.99
T_1 : 70 % milk + 30 % Custard Apple pulp +5 % Honey	2.78^{bc}	2.83^{bc}	3.18^{c}	3.23^{c}	3.00
T_2 : 65 % milk + 35 % Custard Apple pulp + 5 % Honey	2.74^{a}	2.79^{b}	3.16^{c}	3.22^{b}	2.97
T_3 : 60 % milk + 40 % Custard Apple pulp +5 % Honey	2.78^{cd}	2.82^{cd}	3.19^{bc}	3.28^{d}	3.01
T_4: 70 % milk + 30 % Custard Apple pulp +5 % Jaggery	2.80^{e}	2.85^{ef}	3.26^{a}	3.42^{e}	3.08
T_5: 65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	2.78^{ce}	2.79^{bc}	3.16^{c}	3.22^{bc}	2.98
T_6: 60 % milk + 40 % Custard Apple pulp +5 % Jaggery	2.74^{a}	2.74^{a}	3.12^{d}	3.19^{a}	2.94
SEm±	**0.008**	**0.010**	**0.008**	**0.005**	
CD (P=0.05)	**0.025**	**0.03**	**0.025**	**0.016**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD-value comparison of treatment means.

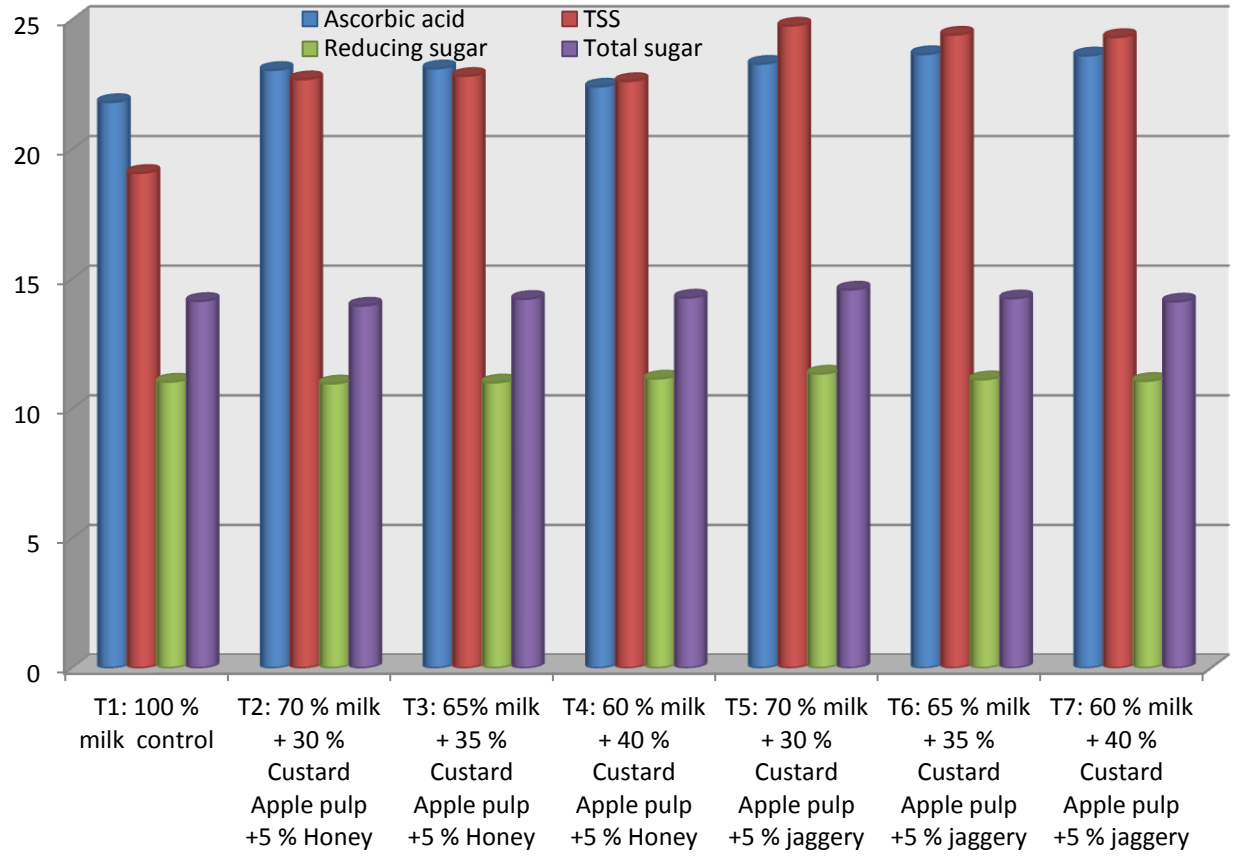


Fig. : Influence of different treatments of custard apple shake on ascorbic acid, TSS, reducing sugar and total sugar

4.3 Organoleptic evaluation of blended custard apple shake during storage

4.3.1 Colour and Appearance

The data presented in table 4.3.1 clearly indicates that the colour and appearance of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the colour and appearance of custard apple shake was found significant superior and record maximum score (8.05) under the treatment T_4 which was statistically superior over the treatment T_1 (7.32). Under the present investigation the treatment T_6 and T_2 and T_1 and T_3 having the respective colour and appearance score of 7.23 and 7.22 and 7.32 and 7.30 were found non-significant different with each other at 5% level of significance. The minimum colour and appearance score of 6.02 was noticed under the treatment T_0 (control).

At 15 days of storage, the colour and appearance score was found to be highest (8.34) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was statistically superior over rest of the treatments. The treatments T_5 and T_6 having respective colour and appearance score of 7.40 and 7.39 showed non-significant difference with each other at 5 % level of significance. The minimum colour and appearance score of 6.34 was obtained under the treatment T_0 (control).

At 30 DAS, similar increasing trend with respect to colour and appearance was recorded under the various treatments. The data showed the superiority of treatments T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) recorded on the maximum hedonic rank for colour and appearance (8.87), which was found significantly superior over treatment T_1 having the colour and appearance score of 7.96 at 5 % level of significance. Similarly the treatments T_3, T_5 and T_2 with respective colour and appearance score of 7.89, 7.79 and 7.67 were also recorded statistically different with each other under the present experiment. The minimum colour and appearance (6.78) was recorded under control (T_0).

At 45 day of storage, significant differences were seen among the difference treatment means in respect to colour and appearance. As per the table

4.3.1 recorded that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher organoleptic score (8.97) for colour and appearance , which was found superior from rest of the other treatments under the present trail. The treatments T_1 and T_3 having the respective colour and appearance score of 8.04 and 8.06 were noticed non-significant difference with each other at 5 % level of significance. Whereas the treatments $T_{5,}$ T_2 and T_6 with respective colour and appearance values of 8.01, 7.93 and 7.82 were statistically significant with each other at 5 % level of significance. The minimum colour and appearance score was recorded in T_0 (7.01)

The maximum score for colour and appearance was obtained in custard apple milk shake prepared by using 70 % Milk + 30 % custard apple pulp + 5 % Jaggery which may be due to natural appealing colour of jaggery. Similar result found in Kashid *et al*. (2007) with safflower milk and Surve *et al*. (2018) in milk shake with date and jaggery.

Table 4.3.1: Effect of different recipe treatments on colour and appearanceof custard apple shake during storage

Treatments	Colour and appearance				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 :100 % Milk (Control)	6.02^{a}	6.34^{a}	6.78^{a}	7.01^{a}	6.53
T_1 :70 % milk + 30 % Custard Apple pulp + 5 % Honey	7.32^{f}	7.72^{e}	7.96^{f}	8.04^{ef}	7.76
T_2:65 % milk + 35 % Custard Apple pulp + 5 % Honey	7.22^{cd}	7.45^{c}	7.67^{c}	7.93^{c}	7.56
T_3:60 % milk + 40 % Custard Apple pulp + 5 % Honey	7.30^{ef}	7.69^{d}	7.89^{e}	8.06^{f}	7.73
T_4:70 % milk + 30 % Custard Apple pulp + 5 % Jaggery	8.05^{g}	8.34^{f}	8.87^{g}	8.97^{g}	8.55
T_5:65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	7.21^{bc}	7.40^{b}	7.79^{d}	8.01^{d}	7.60
T_6: 60 % milk + 40 % Custard Apple pulp +5 % Jaggery	7.23^{de}	7.39^{b}	7.56^{b}	7.82^{b}	7.5
SEm±	**0.033**	**0.007**	**0.006**	**0.007**	
CD (P=0.05)	**0.100**	**0.021**	**0.018**	**0.022**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means.

4.3.2 Flavour

The data presented in table 4.3.2 clearly indicates that the flavour of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the flavour of custard apple shake was found significantly superior and recorded highest (8.47) value in the treatment T_4 (70 % Cow milk + 30 % Custard Apple pulp + 5 % Jaggery) as compared to rest of the other treatment. The treatments T_1 and T_3 having the respective flavour of 8.15 were found non-significant with each other at 5% level of significance. However the treatment $T_{6,}$ T_5 andT_2 with flavour score of 8.29, 8.02 and 7.09 registered significant differences with each other. The minimum flavour (7.04) was noticed under the treatment T_0 (control).

At 15 days of storage, the flavour was found to be highest (8.89) under the treatment T_4 (70% milk + 30 % custard apple pulp + 5 % jaggery) which was noted superior for rest of treatment . All the treatments under the present study showed significant differences in respect to flavour observed at 15 DAS. The treatments $T_{1,}$ T_2, $T_{3,}$ T_5 and T_6 having the respective flavour of 8.43, 7.23, 8.44, 8.15 and 8.55 showed significant different with each other at 5 % level of significance. The minimum flavour (7.34) was confirmed under the treatment T_0 (Control).

At 30 DAS, similar increasing trend with respect to flavour was recorded under the various treatments. The data showed that the treatment T_3 (60% Milk + 40 % custard apple pulp + 5 % Honey) recorded the maximum hedonic rank for flavour (8.85), which was found significantly superior with the treatment T_0, T_1, T_2 and T_6 having organoleptic score for flavour of 7.78, 7.74, 7.67 and 7.26, respectively at 5% level of significance. Similarly the treatments T_4 and T_5 with respective flavour of 8.54 and 8.12 were also recorded statistically at par with T_3 under the present experiment. The minimum score for flavour (7.26) was registered under T_6 (60 % Milk + 40 % custard apple pulp + 5 % jaggery)

At 45 day of storage, significant differences were seen among the difference treatment means in respect to the flavor of custard apple milk shake. As per the table 4.3.2 recorded that the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher flavour (8.90), which was found

superior from rest of the other treatments whereas, statistically at par with the treatments T_3 and T_5 with respective flavor value of 8.72 and 8.32 under the present trail. Similarly, the treatments T_1, T_2 and T_6 having the respective flavour of 8.73, 7.38 and 7.87 were noticed statistically at par with each other at 5% level of significance. The treatment T_0 (Control) was least preferred organoleptically for flavor which scores 7.56.

It was observed from above finding that as the percentage of custard apple pulp increased in the blend, the flavour score of the product also increased. This may be due to pleasant flavour of custard apple pulp which of preferably enhanced its flavour of custard apple milk shake. The data observed in our experiment is in conformity with the findings of Repate *et al.* (2010).

Table 4.3.2: Effect of different recipe treatments on Flavour of custard apple shake during Storage

Treatments	Flavour				Mean
	0 DAS	15 DAS	30 DAS	45 DAS	
T_0 :100 % milk (Control)	7.04^{a}	7.34^{b}	7.78^{a}	7.56^{a}	7.43
T_1 :70 % milk + 30 % custard apple pulp + 5 % Honey	8.15^{d}	8.43^{de}	7.74^{a}	8.73^{a}	8.26
T_2 :65 % milk + 35 % custard apple pulp + 5 % Honey	7.09^{b}	7.23^{a}	7.67^{a}	7.38^{a}	7.34
T_3 :60% milk + 40%custard apple pulp + 5 % Honey	8.15^{d}	8.44^{e}	8.85^{b}	8.72^{b}	8.54
T_4 :70 % milk + 30 % custard apple pulp + 5 % Jaggery	8.47^{f}	8.89^{g}	8.54^{b}	8.90^{b}	8.7
T_5 :65 % milk + 35 % custard apple pulp + 5 % Jaggery	8.02^{c}	8.15^{c}	8.12^{b}	8.32^{b}	8.15
T_6 :60 % milk + 40 % custard apple pulp +5 % Jaggery	8.29^{e}	8.55^{f}	7.26^{a}	7.87^{a}	7.99
SEm±	**0.007**	**0.009**	**0.25**	**0.33**	
CD (P=0.05)	**0.020**	**0.028**	**0.77**	**1.03**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. These letters have been affixed based on CD- value comparison of treatment means.

4.3.3 Taste

The data presented in table 4.3.3 clearly indicates that the taste of custard apple milk shake increased with the advancement of storage period.

At 0 DAS the taste of custard apple shake was found significantly superior and recorded highest organoleptic score of 8.17 from test of the other treatment under the treatment T_4: 70 % milk + 30 % custard apple pulp + 5 % jaggery in the present investigation and was observed statistically superior over the treatment T_3 with taste value of 8.12. The treatment T_1, T_2 and T_6 having the respective taste value of 7.12, 7.16 and 8.01 were significantly different with each other at 5% level of significance. The less preferred taste score of 7.07 was noticed under the treatment T_0 (control).

At 15 days of storage, the organoleptic score for taste was found to be highest (8.28) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was noted superior from rest of treatments. All the treatments under the present study showed significant differences in respect to taste observed at 15 DAS. The treatments T_1, T_2, T_3, T_5 and T_6 having respective taste values of 7.24, 7.22, 8.23, 7.17 and 8.06 were significantly different with each other at 5 % level of significance. The less preferred score for taste (7.17) was obtained by the treatment T_0 (control).

At 30 DAS, similar increasing trend with respect to taste was recorded under the various treatments. The data showed the superiority of treatment T_4 (70% Milk + 30% custard apple pulp + 5% Jaggery) recorded the maximum taste (8.42), differed found significant with rest of other the treatments at 5 % level of significance. Similarly the treatments T_1 and T_2 with respective taste values of 7.41 and 7.39 were recorded statistically at par under the present experiment. However, the treatments T_3, T_6, and T_5 having the taste of 8.32, 8.12 and 7.26, respectively were showed significant differences with each other. The minimum taste (7.25) was registered under T_0 (control).

At 45 day of storage, significant differences were seen among the difference treatment means in respect to taste. As per the table 4.3.3 recorded that

the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher taste (8.54), which was found superior from rest of the other treatments under the present trial. The treatments T_2 and T_5 and T_2 and T_1 having the respective taste of 7.44 and 7.42 and 7.44 and 7.46 displayed were noticed statistically non-significant with each other at 5 % level of significance. The minimum organoleptic score for taste (7.32) was recorded under treatment T_0 (control).

The most preferred taste of custard apple shake was obtained with the recipe 70% Milk + 30 % custard apple pulp + 5 % Jaggery which may be due to taste of jaggery. Similar findings were also reported in the experiments done by Repate*et al*. (2010), Kashid *et al*. (2007) and in milk shake with date and jaggery by Surve *et al*. (2018).

Table 4.3.3: Effect of different recipe treatments on Taste of custard apple shake during storage

Treatments	Taste				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0: 100 % Milk(Control)	7.07^{a}	7.17^{a}	7.25^{a}	7.32^{a}	7.20
T_1 : 70 % milk + 30 % Custard Apple pulp + 5 % Honey	7.12^{b}	7.24^{b}	7.41^{b}	7.46^{c}	7.30
T_2 : 65 % milk + 35 % Custard Apple pulp + 5 % Honey	7.16^{c}	7.22^{b}	7.39^{b}	7.44^{bc}	7.30
T_3 : 60 % milk + 40 % Custard Apple pulp + 5 % Honey	8.12^{e}	8.23^{d}	8.32^{d}	8.39^{e}	8.26
T_4 :70 % milk + 30 % Custard Apple pulp + 5 % Jaggery	8.17^{f}	8.28^{e}	8.42^{e}	8.54^{f}	8.35
T_5 :65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	7.07^{a}	7.17^{a}	7.26^{a}	7.42^{b}	8.23
T_6 :60 % milk + 40 % Custard Apple pulp +5 % Jaggery	8.01^{d}	8.06^{c}	8.12^{c}	8.23^{d}	8.10
SEm±	**0.006**	**0.008**	**0.017**	**0.019**	
CD (P=0.05)	**0.018**	**0.026**	**0.052**	**0.058**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means.

4.3.4 Texture

The data presented in table 4.3.4 clearly revealed that the texture of custard apple milk shake decreased with the advancement of storage period.

From the table, it is vivid that at 0 DAS the texture of custard apple shake was found significant superior and recorded highest (7.74) in the treatment $T_{6.}$ The treatment $T_6$and T_5having the respective texture of 7.41 and 7.39 were found non-significant different with each other at 5% level of significance. However, the treatments T_3, T_1 and T_2 with texture value of 7.67, 7.56 and 7.44 showed statistically dissmilarity with each other under present study. The minimum texture value (6.98)of custard apple milk shake was noticed under the treatment T_0 (control).

At 15 days of storage, the sensory score for texture was found to be highest (7.53) under the treatment T_3 (60 % milk + 40 % custard apple pulp + 5 % honey) which was noted superior from rest of treatment . All the treatments under the present study showed significant differences in respect to texture observed at 15 DAS except the treatments T_2, T_6 and T_5 which received the organoleptic score for texture of 7.32, 7.32 and 7.30, respectively with statistical parity with each other. The treatments T_1 and T_4 having respective texture value of 7.60 and 7.41 differed significantly with each other at 5 % level of significance. The minimum texture (6.85) was recorded in the treatment T_0 (control).

At 30 DAS, similar decreasing trend with respect to texture of custard apple shake was recorded under the various treatments. The data revealed that the treatment T_1 (70% Milk + 30% custard apple pulp + 5% honey) recorded the highest value for texture (7.46), which was found statistically similar with the treatment T_3 and T_5 having texture content of 7.42 and 7.40 while it is statistically superior from treatment T_4 with texture score of 7.33 at 5 % level of significance. Similarly the treatments T_2 and T_6 with respective texture of 7.25 and 7.24 were also recorded statistically at par with each other under the present experiment. The minimum texture (6.65) was registered under control (T_0).

At 45 day of storage, significant differences were seen among treatment means with respect to texture. As per the table 4.3.4, it is clear that the treatment

T_1 (70 % Milk + 30 % custard apple pulp + 5 % Honey) achieved significantly higher texture (7.32) was found superior over T_3, T_4 and T_2 treatments having the texture score of 7.27, 7.23 and 7.13 under the present trial. The treatments T_5 and T_6 having the respective texture of 7.11 and 7.12 were noticed non-significant with each other at 5 % level of significance. The minimum texture (6.44) was registered under control (T_0).

Under the present investigation, decreasing trend of texture was noticed under all other treatments with the increasing storage period. On the basis of mean value the sensory score for texture was found to be preferable with custard apple blended milk shake. It might be due to the fact that custard apple pulp improves the texture of the milk shake. Similar results were also found by Hinganee*t al.* (2016) and Patil*et al*. (2019) in papaya milk shake and in almond milk shake by Kuchekar*et al*. (2019).

Table 4.3.4: Effect of different recipe treatments on Texture of custard apple shake during storage

Treatments	Texture				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 :100 % Milk (Control)	6.98^{a}	6.85^{a}	6.65^{a}	6.44^{a}	6.73
T_1 :70 % milk + 30 % Custard Apple pulp + 5 % Honey	7.56^{d}	7.60^{e}	7.46^{d}	7.32^{g}	7.48
T_2 :65 % milk + 35 % Custard Apple pulp + 5 % Honey	7.44^{c}	7.32^{b}	7.25^{b}	7.13^{d}	7.28
T_3 :60 % milk + 40 % Custard Apple pulp + 5 % Honey	7.67^{e}	7.53^{d}	7.42^{d}	7.27^{f}	7.47
T_4 :70 % milk + 30 % Custard Apple pulp + 5 % Jaggery	7.74^{f}	7.41^{c}	7.33^{c}	7.23^{e}	7.42
T_5 :65 % milk + 35 % Custard Apple pulp + 5 % Jaggery	7.39^{b}	7.3^{b}	7.40^{d}	7.11^{bc}	7.30
T_6 :60 % milk + 40 % Custard Apple pulp +5 % Jaggery	7.41^{b}	7.32^{b}	7.24^{b}	7.12^{cd}	7.27
SEm±	**0.008**	**0.009**	**0.013**	**0.006**	
CD at 5 %	**0.023**	**0.029**	**0.041**	**0.018**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD-value comparison of treatment means

4.3.5 Overall acceptability

The data presented in table 4.2.2 indicates that the overall acceptability of custard apple shake increased with the advancement of storage duration.

At 0 DAS the most acceptable custard apple shake was treatment T_4 with highestoverall acceptability 8.26 which was statistically superior over treatments T_3 and T_5 with respective overall acceptability score of 8.21 and 8.17. The treatments T_5 and T_6 were statistically different from each other in the present trial. However, the treatment $T_{6,}T_2$ and T_1 having the respective overall acceptability score of 8.13, 8.13 and 8.13 were found statistically similar with each other at 5% level of significance. The minimum overall acceptability (7.06) was noticed under the treatment T_0 (control).

At 15 days of storage, the overall acceptability content was found to be highest (8.44) under the treatment T_4 (70 % milk + 30 % custard apple pulp + 5 % jaggery) which was noted superior from rest of treatment . All the treatments under the present study showed significant differences in respect to overall acceptability observed at 15 DAS. The treatments T_5, T_3 and T_6having respective overall acceptability of 8.23, 8.21 and 8.19 showed significantly different with each other at 5 % level of significance. The minimum overall acceptability (7.13) was confirmed under the treatment T_0(control).

At 30 DAS, similar increasing trend with respect to overall acceptability was recorded under the varioustreatments. The data revealed the superiority of treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) recorded the maximum overall acceptability (8.49), which was found statistically superior over T_5 (8.29).The treatment T_5 and$T_{3,}$ T_2 and T_1 and T_1 and T_6 were non-significant with each other having overall acceptability score of 8.29 and 8.28, 8.24 and 8.24, 8.24 and 8.23 at 5 % level of significance. Whereas, the treatments T_3 and T_2 with respective overall acceptability of 8.28 and 8.24 were also recorded statistically significant with each other. The minimum overall acceptability (7.17) was registered under control (T_0).

At 45 day of storage, significant differences were seen among the treatment means with respect to overall acceptability. Data presented table 4.3.4 showed that

the treatment T_4 (70 % Milk + 30 % custard apple pulp + 5 % Jaggery) achieved significantly higher overall acceptability (8.51), which was found superior from rest of the other treatments under the present trial. The treatments T_5 and T_3, T_1 and T_6 and T_6 and T_2 having the respective overall acceptability of 8.39 and 8.39, 8.37 and 8.36, 8.36 and 8.36 were noticed non-significant with each other at 5 % level of significance. However, the treatments T_3 and T_1 were significantly different with each other with overall acceptability of 8.39 and 8.37, respectively. The minimum overall acceptability (7.32) was registered under control (T_0).

All the organoleptic quality attributes are also affected by different ratios of fruit pulp blended with milk. The treatments prepared with the addition of jaggery was most acceptable by the judges. The increasing trend in overall acceptability was found during refrigerated storage. This increasing trend in overall acceptability might be due to increase in all other sensory parameters (colour and appearance, flavour and taste). The results are in agreement with the work done by Ubale *et al.* (2014) in sapota milk shake and Bakane *et al.* (2016) in custard apple milk shake.

Table 4.3.5: Effect of different recipe treatments on overall acceptability ofcustardappleshake during storage

Treatment	Overall acceptability				
	0 DAS	15 DAS	30 DAS	45 DAS	Mean
T_0 :100 % Cow Milk (Control)	7.06^{a}	7.13^{a}	7.17^{a}	7.32^{a}	7.17
T_1 :70 % Cow milk + 30 % Custard Apple pulp + 5 % Honey	8.13^{bc}	8.19^{cd}	8.24^{cd}	8.37^{d}	8.23
T_2 :65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey	8.13^{cd}	8.18^{bc}	8.24^{d}	8.36^{bc}	8.22
T_3 :60 % Cow milk + 40 % Custard Apple pulp + 5 % Honey	8.21^{f}	8.21^{e}	8.28^{ef}	8.39^{ef}	8.27
T_4 :70 % Cow milk+ 30 % Custard Apple pulp + 5 % Jaggery	8.26^{g}	8.44^{g}	8.49^{g}	8.51^{g}	8.42
T_5 :65 % Cow milk+ 35 % Custard Apple pulp + 5 % Jaggery	8.17^{e}	8.23^{f}	8.29^{f}	8.39^{f}	8.27
T_6 :60 % Cow milk+ 40 % Custard Apple pulp +5 % Jaggery	8.13^{d}	8.19^{d}	8.23^{bc}	8.36^{cd}	8.22
SEm±	**0.004**	**0.005**	**0.006**	**0.005**	
CD(P=0.05)	**0.012**	**0.017**	**0.018**	**0.015**	

1. DAS: Days after storage
2. Super script letter allocated in the data indicated that the treatment means with same letters are not significant different according to Duncan's multiple range test at 5 % level of significance, while the means with different letters are significantly different at 5 % level of significance. Those letter have been affixed based on CD- value comparison of treatment means

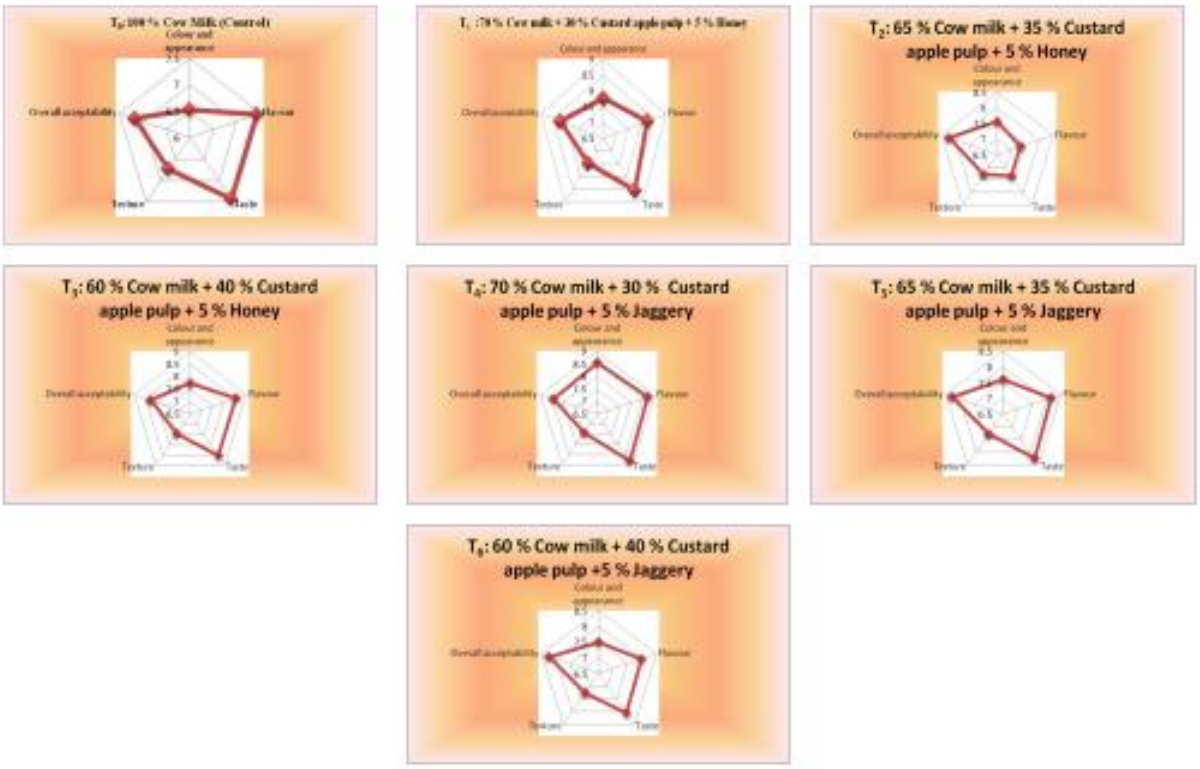


Fig. : Radar graph of organoleptic parameters of different treatments of custard apple shake

CHAPTER –V
SUMMARY AND CONCLUSION

The current study entitled **"Studies on standardization of recipe and storage behaviour of flavoured custard apple (*Annona squamosa* L.) shake"** was done during the year 2020-21 in the Horticulture Processing Laboratory, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The purpose of the study was to determine the physico-chemical composition of Custard apple fruit, the effects of blending on shake recipe standardization, organoleptic quality, and shelf life of blended fruit.

Seven treatment combinations of custard apple fruit pulp Milk, 5% jaggery and Honey, cardamom, and sodium benzoate were used in the experiment planned under Completely Randomized Design with three replications. Fresh and ripe custard apple fruits were purchased from a local market of Kanker district (CG) and physico-chemical characteristics were determined. For chemical analyses, prepared blended custard apple shakes were kept in a refrigerator up to 45 days- and analysed at an interval of 15 days. The outcomes of the experiment are presented below.

- The data on different physical parameter *viz.*, average fruit weight, fruit volume, fruit length, fruit diameter, seed weight, pulp weight and pulp/ seed ratio of custard apples were 170.16 g, 200 cc, 6.83cm, 22.6 cm, 11.7g, 42.59 g and 3.63, respectively was obtained prior to the preparation of custard apple shake. With respect to the chemical composition of fruits the data revealed that the total soluble solids (TSS) is 20.43^0 Brix, acidity of 0.20 per cent, total sugar 17.65 per cent, reducing sugar13.65 per cent, non-reducing sugar 3.5 per cent and ascorbic acid 15.65 mg/100g.

- From the chemical analysis of the product the result indicates that the TSS, total sugar, reducing sugar, ascorbic acid and protein of custard apple increased gradually during storage non-reducing and acidity is gradually decrease during storage.

- The amount of TSS is one of the important parameter of custard apple. After processing, the TSS content in blended custard apple shake increased with increase in storage period upto 45 days at refrigerated condition. The maximum TSS was retained in the shake having recipe T_4 (70 % Cow milk+ 30 % Custard Apple pulp + 5 % jaggery) (24.77.) The level of TSS was found to be minimum T_0 (100 % Cow milk (control))(19.09)
- The acidity in blended custard apple shake decreased with all the recipe treatments at increasing period of storage upto 45 days under refrigerated condition. The acidity was found to be highest having recipe T_2 (65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey) (0.17) for shake and the minimum acidity during storage and without pulp blended T_0 (100 % Cow milk (control)) (0.16).
- The pH during the preservation time, the Shake continuously increased up to 45 days at refrigerated condition. The maximum pH content was recorded under T_3 (65 % Cow milk + 35 % Custard Apple pulp + 5 % Honey) (6.36) for shake, the minimum pH was recorded with the treatment T_0 (100 % Cow milk (control)) during storage(5.83).
- A gradual increasingthe ascorbic acid of shake represents the values to the end of the storage period 45 days. The maximum Ascorbic acid was found with the recipe T_4 (70 % Cow milk + 30 % Custard Apple pulp + 5 % jaggery) (27.03) for shake. Whereas, the minimum Ascorbic acid should be included in the treatment T_0 (100 % Cow milk (control)) during storage (24.04).
- The total sugar content of the shake increased with all the treatments as storage time increased up to 45 days under refrigerated conditions. The treatment using recipe T_4 (15.81) had a highest total sugar level in the custard apple shake T_4 (70 % Cow milk + 30 % Custard Apple pulp + 5 % jaggery), while the treatment T_1 (70% cow milk + 30% custard apple pulp + 5 % Honey) (15.11) during storage in shake its minimum level during storage upto 45 days.

- There was also an increasing trend of reducing sugar in custard apple shake with all the recipe, treatments, at increasing, period of storage under refrigerated condition. The treatment having recipe T_4 (70 % Cow milk + 30% Custard Apple pulp + 5 % jaggery) (12.83) had a higher content of reducing sugar in custard apple shake T_0 (100 % Cow milk (control)) (12.50) in custard apple shake contained its minimum level during storage upto 45 days.
- During the storage period at refrigerated temperatures, non-reducing sugar levels decreased gradually. In the shake using the recipe, the maximum amount of non-reducing sugar was preserved T_4 (70 % Cow milk + 30% Custard Apple pulp + 5 % jaggery) (2.98). The minimum amount of non-reducing sugar was in shake T_6 (60 % Cow milk + 30 % Custard apple pulp + 5 % jaggery) (2.65).
- During the 45 day storage period, an increase in the protein content of the shake was observed. With this recipe, we were able to get the greatest amount of protein T_0 (100 % Cow milk (control)) (3.46) for shake. Whereas, the recipe included a notation about the required amount of protein T_6 (60 % cow milk + 40 % custard apple pulp+ 5% jaggery) (2.91)duringstorage
- A progressive increase in colour and appearance was noted throughout the storage period at refrigerated condition. The highest colour and appearance was retained in the shake having recipe T_4 (70 % Cow milk + 30 % Custard apple pulp + 5 % jaggery) (8.97) while, it is lowest in shake T_0 (100 % Cow milk (control) during storage (7.01).
- A progressive increase in flavour was noted during the storage period at refrigerated condition. The maximum flavour was retained in the shake having recipe T_4 (70% Cow milk + 30% Custard apple pulp + 5% Jaggery) (8.90). The minimum flavour was found in shake T_2 (65% Cow milk + 35 % Custard Apple pulp + 5 % Honey) (7.38).
- A progressive increase in taste was noted during the storage period at refrigerated condition. The maximum taste was retained in the shake having recipe T_4 (70 % Cow milk + 30 % Custard Apple pulp + 5 % jaggery)

(8.54). The level of taste was found to be minimum in shake T_0 (100 % Cow milk (control)) during storage (7.32).

- A progressive decrease in texture was noted during the storage period at refrigerated condition. The maximum texture was retained in the shake having recipe T_1 (70 % milk + 30 % Custard Apple pulp + Honey) (7.32). The level of taste was found to be minimumscoreT_0 (100 % Cow milk (control)) during storage (6.44).
- A gradual increase in overall acceptability was noted during the storage period at refrigerated condition. The maximum overall acceptability was retained in the shake having recipe T_4 (70 % Cow milk + 30 % Custard Apple pulp + 5 % jaggery) (8.51). The level of overall acceptability was found to be minimum in shake T_0 (100 % Cow milk (control)) during storage (7.32).

CONCLUSIONS

- The custard apple pulp can very well utilized for the preparation of acceptable custard apple shake.
- The custard apple shake prepared from the recipe 70 % cow milk + 30% custard apple pulp + 5% Jaggery (T_4) contained highest TSS, ascorbic acid, total sugar, reducing sugar and non-reducing sugar. Therefore, the custard apple shake may be marketed using the above mentioned standardized recipe.
- The study concludes that ratio 70 % cow milk + 30 % custard apple pulp + 5% Jaggery for blending of custard apple shake was most acceptable for preparation of shake.

SUGGESTIONS FOR FUTURE RESEARCH WORK

Following suggestions are being made future research work based on the findings of the present investigation.

- The current investigation is based on analysis of the up to 45 days study. Hence, it may be repeated for 45 or more day to determine the consistency of the data in order to make specific suggestions for blended custard apple shake preparation.
- After concrete suggestions, the standardized recipes for custard apple shake can be used commercially.
- Commercially recommended cultivars/varieties of custard apple should be experimented for blending with milk and other treatment combinations stimultaneously economics should be worked out.
- Custard apple is abundantly found in Chhattisgarh, but due to short shelf life of the fruit, farmers are bound to sell it immediately at lower price. Thus, processing technology may increase the income, providing employment, up liftment of poor, small/ marginal and tribal farmers and the development of different value added products from custard apple.

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APPENDICES - A
HEDONIC RATING TEST FOR JUDGES

Name: Date:

Product:

Taste the sample and check how much you like or dislike. Use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the sample. Remember you are the only who can tell what you like. An honest expression of your personal feeling will help in evaluation.

Treatments	**Colour and Appearance**	**Flavour**	**Taste**	**Texture**
T_0				
T_1				
T_2				
T_3				
T_4				
T_5				
T_6				
T_7				
T_8				
T_9				

Scale:

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

APPENDICES -B

Weekly meteorological data during experimental period (from Nov.05, 2020 to Dec. 16, 2021)

Week No.	Date	Max. Temp (°C)	Min. Temp (°C)	Relative Humidity (%)	
				RH I	RH II
45	**Nov 05-11**	30.3	12.5	87	28
46	**Nov 12-18**	32.7	18.9	87	37
47	**Nov 19-25**	31	15.9	88	35
48	**Nov 26 – Dec 02**	28.6	14.7	81	35
49	**Dec 03-09**	30.7	11.9	89	33
50	**Dec 10-16**	30.2	15.8	86	37

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Awards / Recognitions (If any): No

Publications (if any): No

Chetna

Signature

New article submission by Chetna kashyap, #9741

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