

**PRE AND POST HARVEST STUDIES AND VALUE
ADDITION IN SPONGE GOURD (*Luffa cylindrica* L.)**

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

in

Horticulture (Vegetable Science)

By

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LOVELY PROFESSIONAL UNIVERSITY, PUNJAB

2022



DECLARATION

I hereby declare that the thesis entitled “**PRE AND POST HARVEST STUDIES AND VALUE ADDITION IN SPONGE GOURD (*Luffa cylindrica* L.)**” submitted for **Doctor of Philosophy in Horticulture (Vegetable Science)** to the School of Agriculture, Lovely Professional University is entirely original work and all ideas and references are duly acknowledged. The research work has not been formed the basis for the award of any other degree.

Place: LPU, Phagwara

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CERTIFICATE-I

This is to certify that the thesis entitled, “**PRE AND POST HARVEST STUDIES AND VALUE ADDITION IN SPONGE GOURD (*Luffa cylindrica* L.)**” submitted in fulfillment of the requirement for the degree of **DOCTOR OF PHILOSOPHY (Ph.D.)** in the discipline of **Horticulture (Vegetable Science)** embodies the results of a piece of bonafide research carried out by **Mani Salaria** under my guidance and supervision. To the best of my knowledge, the present work is the result of original investigation and study. No part of this thesis has ever been submitted for any other degree, diploma or equivalent course.

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CERTIFICATE-II

This is to certify that the thesis entitled “**PRE AND POST HARVEST STUDIES AND VALUE ADDITION IN SPONGE GOURD (*Luffa cylindrica* L.)**” submitted by “**Mani Salaria (Registration No. 11919240)** to the Lovely Professional University, Phagwara in partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY (Ph.D.)** in the discipline of **Horticulture (Vegetable Science)** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an external examiner.

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LIST OF ABBREVIATIONS

Abbreviations		Meaning
%	:	Percentage
@	:	at the rate
°C	:	Degree celcius
C.D.	:	Critical difference
CV	:	Co-efficient of Variation
cm	:	Centimeter
cm ²	:	centimeter square
DPPH	:	2,2-diphenylpicrylhydrazyl
<i>et al.</i>	:	<i>et alii</i> (Co-workers)
CRD	:	Completely Randomized Design
Fig.	:	Figure
FW	:	Fresh weight
g	:	Gram
ha	:	Hectare
i:e	:	That is
kg	:	Kilometer
L.	:	Linneous
m	:	meter
mg	:	milligram
mg/g	:	milligram per gram
No.	:	Number
NS	:	Non-significant

Ppm	:	Parts per million
SE(d)	:	Standard error deviation
SE(m)	:	Standard error mean
TSS	:	Total soluble solids
T	:	Tonne

Title : Pre and Post Harvest studies and value addition in sponge gourd (*Luffa cylindrica* L.)

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Punjab

ABSTRACT

The present research study entitled “Pre and Post Harvest studies and value addition in sponge gourd (*Luffa cylindrica* L.) was carried out for the two consecutive cropping seasons of 2020-2021 and 2021-2022 at farm of Lovely Professional University, Phagwara, Punjab to evaluate the four different varieties of sponge gourd viz. Shivanya, Payal, Alok & Garima based on their morphological as well as yield related traits. With respect to growth and yield related parameters the experimental results revealed that variety shivanya under open field conditions had maximum plant yield of 353.18kg per plot whereas Alok variety had least plant yield of 145.63kg per plot. Further the four varieties grown in the field were checked for shelf-life studies and therefore herbal composite coatings from chitosan, aloevera, mint leaves juice were prepared under different formulations that were coated with different treatments under refrigerator conditions. Among different treatments of coatings best combination was recorded in T₄ chitosan 0.75% + aloevera 2.5% + mint leave juice 1% based on physiological, quality, biochemical and sensory parameters. Then the research study was pursued with the view to develop the extruded pasta from the two highest yielded varieties of sponge gourd that were harvested under field conditions and continued for preparing value-added pasta with different variations/treatments. The results based on cooking quality, biochemical, nutritional and sensory testing parameters clearly indicates that the T₄ sample pasta incorporation of semolina flour 20g, durum wheat 90g, sponge gourd pulp 60g gave better organoleptic acceptability. The variety shivanya contributes more nutritional and less cooking quality loss when compared with payal varieties pasta samples.

Keyword: morphological, value addition, Post Harvest, organoleptic acceptability, herbal composite coatings

CHAPTER- 1

INTRODUCTION

Vegetables are consumed worldwide because of their high nutritional value and because of their biodegradability; they donate to a healthier ecosystem. Beyond this their low cost and practical performance fulfill the economic interests of various industries. Sponge gourd belongs to the cucurbitaceae family with several species out of which only 2 species are domesticated namely *L. cylindrica* and *L. acutangula*. Luffa consists of fibers and has 60 % cellulose, 30 % hemicellulose, and 10 % lignin (Wu *et al.*, 2020). The sponge gourd is composed of 117 genera and about 825 species in warmer parts of the world. Sponge gourds occupy an area of 73273 ha and have an annual production of 685224 tonnes worldwide (NHB, 2020).

In India, the states that have sponge gourd production are Karnataka, Kerala, Andhra Pradesh, and Tamil Nadu, Maharashtra, and Madhya Pradesh states. Luffa is a sub-tropical plant that requires summer temperature for production. It is known as a summer season vegetable with its cultivation in the tropical countries of Asia and Africa. Luffa production is mostly from countries like China, Korea, India, Japan, and Central America. For proper growth, it requires well-drained sandy loam soil with a pH of 6 to 6.8 and also needs a high level of potassium & phosphorus.

Luffa peels is a major waste that has good utilization for the production of healthy foods. It can become promising raw material for possible future production. The sponge gourd fruit is taken to treat imbalances in the body. Luffa has various applications in shoe mats, bath sponges, proof linings, packing medium, and utensil cleaning sponges, adsorbent for removal of heavy metal. Its seeds and peels have a large amount of phenolic, flavonoids present which have the potency to treat many diseases. Fresh sponge gourd pulp has a high amount of vitamin C, considered good for health. Luffa has been rewarded with a bundle of polyphenols and has great applications in the food, agriculture, and cosmetics industries. However, sponge gourd is very perishable after harvest and easily gets deteriorated. Mainly the deterioration starts with wilting and yellowing appearance causes loss of texture.

Post-harvest losses cause deterioration during handling, transport, and

storage. The usage of edible coating is a way helps to improve quality and shelf life. These edible coatings are safe for consumption and don't add undesirable flavors to food (Jafarzadeh *et al.*, 2021). There has been great interest in the usage of herbal coatings to enhance the properties of horticulture products. The high wastage in the value chain, poor transportation, and storage of fruits and vegetables is one of the biggest problems in the world. Mainly the losses of quality are weight loss, color deterioration, softening, and rachis browning which ultimately causes a reduction in shelf life and quality. Edible coatings are defined as a thin layer on the produce that improves the quality and enhances food. These films add barriers from chemical, physical, and biological changes. The tough problem in the fruit market is to keep clean best and avoid the growth of spoilage and pathogenic microorganisms.

Coatings improve food safety by inhibiting the growth of microbes. Different coating materials are used for food products such as fruits, vegetables, and meat, by application of different techniques such as dipping, spraying, panning, and fluidized-bed. These methods depend on the nature of food, the surface area, and the objective of coating. These coatings have several advantages as it protects food products from moisture, avoid growth of microbes and enhances the physical strength of products, retain volatile compounds, and preserve antimicrobial agents and antioxidants. Apart from advantages there are few disadvantages that use of edible coating can enhance high carbon dioxide and low oxygen concentration. Composite edible coatings are gaining more limelight as improving the produce characteristics more and enhance the shelf life of produce.

Herbal coatings are mostly prepared by the addition of herbs such as tulsi, beeswax, mint, and aloe vera, etc. Aloe vera because of its beneficial antioxidant and antimicrobial properties is an edible coating material. Aloe vera gel coating prevents loss of moisture, firmness, delayed browning, respiratory rate, and maturation development. The consumer's demand to reserve food biopolymers and components is possible by the application of edible films which ultimately adds quality improvement to produce and fresh product.

Chitosan is a polymer that originated from deacetylated chitin which is non-toxic, biodegradable, biofunctional and biocompatible. It has great antifungal and antimicrobial activities that resist fruit decay. Chitosan is the best alternative and

practical approach to protecting postharvest fruits and vegetables. Its structure looks like cellulose and is biodegradable, and non-toxic for usage in coatings and emulsions. It is an easy coating on fruits and vegetables and restricts the rate of respiration rate and avoids moisture loss in produce. The properties of chitosan make it unique to be used on many postharvest fruits and vegetables such as grape, berry, guava, papaya, toria, okra. To improve the shelf life of postharvest produce chitosan coating is more convenient and safe in the food industry.

Effective methods are employed for preserving the quality characteristics of sponge gourd. It required proper maintenance to increase the shelf life and to reduce the thermal decomposition & respiration processes. As sponge gourd is chilling sensitive it required ambient temperature for storage (Han *et al.*, 2014). The development of bio-based materials to prolong the shelf life of sponge gourds is gaining attention among researchers and industries. Among them, chitosan is regarded as excellent coating for shelf-life improvement and quality enhancement of vegetables. Also, aloe vera as well as mint is good at providing water holding capacity and enhancing the transpiration rate of sponge gourd.

Consumers demand for nutritional products pasta being the most common product now-days widely accepted among youngsters. Pasta is known as traditional based product with longer shelf life considered as suitable in worldwide due to its low cost, easy production and sensory characteristics. These days chickpea, moong bean, green bean flours are also available that provides nutritional benefits to human body. This cereal-based product is prepared through dough and shaped in forms of spaghetti, macaroni and vermicelli. The products formed by addition of different ingredients and the byproduct provide compounds such as flavonols, polyphenols, resveratrol and dietary fibers. Pasta prepared from semolina has desirable texture during cooking and natural amber color. Besides, these flours also add bioactive constituents to diet and enhance the health benefits. The presence of different components in sponge gourd enhanced its value addition properties (Sohrab *et al.*, 2003).

Pasta product is high in starch content but has less dietary fibers, minerals, vitamins, phenolic compounds. Due to health concerns nutritious pasta products rich in fiber and essential micronutrients with low glycemic index may be preferred.

Different healthy additives are added for the production of pasta to increase nutritional and functional value. The raw material added in substitute of wheat flour adds more nutrients to pasta. Different studies are worked to develop pasta with improved nutritional attributes such as insulin enriched pasta, cereal brans pasta, pearl millet pasta, ragi pasta, barley and whey protein pasta (Hirdyani, 2014).

In addition, value added products are good for consumption as they provide good nutritional value to consumers and add more active components to diet. Adding value is the way of changing a product from its original state to more valuable one. Two terms convenience and palatability make the pasta most popular worldwide and is gaining popularity. These food products adds beneficial diet to the human body and opened new sources at the market level.

Most of the research has been done with regard to production and breeding programmes in context to sponge gourd but the work related to post harvest technology and value addition in *Luffa* species is the least. So keeping in view present study has been undertaken with the following objectives:

Objectives

1. To study the morphological and yield related traits in *Luffa cylindrica* L.
2. To evaluate the influence of composite herbal based edible coating on post-harvest shelf-life of sponge gourd.
3. To perform the physiochemical analysis of post edible coating application on sponge gourd.
4. To standardize the value-added product prepared from sponge gourd.

CHAPTER - 2

REVIEW OF LITERATURE

The present investigation entitled “Pre and Post Harvest studies and value addition in sponge gourd (*Luffa cylindrica* L.)” was carried out during the time period of year 2019-2022 in laboratory conditions and open fields available at Lovely Professional University, Punjab in the vicinity of Phagwara district. The production of new food products from luffa is adding value to the agriculture and food technology field. The creation of dried and processed and value-added products from luffa vegetables is an innovative creation and also these products add beneficial role to our health status. Therefore, the present study revolves around 3 main objectives under sub-headings:

- 2.1 Varietal evaluation of different cultivars of sponge gourd**
- 2.2 Effect of yield related traits on different varieties of luffa.**
- 2.3 Effect of morphological traits & quality parameters on different varieties of luffa.**
- 2.4 Effect of composite herbal coatings and physio-chemical parameters of coating on sponge gourd.**
- 2.5 Value added products of vegetables**

2.1 Varietal evaluation of different cultivars of sponge gourd

The varietal effect of cucurbita pepo, cucurbita maxima, and cucurbita moschata cultivars were evaluated by Loy, (2004). The different morphological, physiological, and ecological factors of productivity were studied. The selection of different breeding and cultural techniques to define the yield, and morphological traits had been done. These cultivars have usage in vegetable oils, pharmaceutical areas, snack seeds, and also physiological aspects. These cultivars are used as yield components and enhance the productivity of species.

Harika *et al.*, (2012) investigated the 25 genotypes of bottle gourd to identify the horticultural characteristics of bottle gourd. The different genotypes of bottle gourd were Sarika, Anand, samridhi, Gaja, Sharada, super Dhana, arka bahar, krushi

sampada. Etc. The Sarika genotype provides primary branches whereas the Anand genotype had maximum vine length. The cultivar samridhi had the maximum number of leaves; cultivar NBBL-12 had earliness for flowering & fruiting. The cultivar Gaja had a lower sex ratio, more fruits per vine, and good fruit yield and seed yield. The study defined that Gaja, Sharada, NS-421, NBBL-12, super Dhana, arka bahar, krushi sampada had higher fruit yield whereas the cultivar Anand, Gaja, NS-443, and gutkha had higher seed yield.

The varietal characterizations of 10 genotypes in bottle gourd were identified using 18 random primers. In 8 primers total of 60 bands were identified and out of which 60.29 % were polymorphic. The molecular diversity of 10 bottle gourd varieties was accessed by RAPD (Random Amplified Polymorphic DNA) marker. The genotypes Narendra Jyoti and NDBG 132 had 90.90 % of similarities whereas the genotypes NDBG 132 and andromon 6 had 75.75 % of similarities. The highest protein bands were identified in the fruits & leaves region of Narendra Sravasti whereas the lowest bands were identified in the Narendra Shishir and Narendra Shivani. The genotypes of bottle gourd had improved cultivars and improved the quality and quantity of genotypes reported by Srivastava *et al.*, (2014).

The varietal effect on the growth and yield of cucumber was carried out by Adesina and Benjamin, (2016). The four different varieties such as Ashley, Nonadini, Murano, and Ande were used to determine the yield of cucumber. The different parameters such as vine length, leaf area, number of branches, number of fruits, and total fruit weight were evaluated for growth and yield determination. The genotypes Nonadini and Ashley had the highest yield as compared to Murano and Ande. The significant behavior has resulted in both Nonadini and Ashley's genotypes.

The genetic variability, genetic behavior, and heritability in cucumbers were studied in which total of 12 genotypes were identified using a randomized block design. The genetic variability, genetic behavior, and heritability were used as characteristics for all the genotypes of cucumber. The phenotypic and genotypic behavior was detected for the presence of the number of females and the number of males per vine, fruit yield per vine, number of fruits per vine and branches per vine, number of nodes, and fruit length. The maximum genetic behavior was observed for fruit yield and male and female flowers per vine (Rajawat and Collis, (2017).

Karthick, (2017) studied the performance, varieties, and nature of ridge gourd vegetables. The two genotypes Pusa Nasdar and PKM-1 were evaluated for different performances. The ridge gourd defined the maximum length of vine, branches per plant, leaf area, and chlorophyll index for both the varieties. The Pusa Nasdar had maximum vine length, leaf area, and number of flowers whereas the PKM-1 had maximum vine length and branches per plant but at last harvest. Beyond this, these two cultivars recorded nodes on female flowers, the number of male flowers, and the maturity of male and female flowers.

In bottle gourd, Mashilo *et al.*, (2017) identified the genotypic and phenotypic responses of 14 genotypes with diverse landrace varieties and 15 genotypes were utilized for research and development with 16 genotypes for genetic improvement. The genotypes have variations in genetic diversity, genetic resources, population structure, and breeding programs. The genomic resources for genetic analysis & genomic selection were identified by conventional breeding and ultimately improved the productivity and organized conservation of crops.

The varietal studies of cucumber genotypes under agro-climatic conditions studied and the genotypes CUCUVAR-6, Supriya 100, AK-47, and KARAN were used for the determination of growth, yield and quality traits. The genotype CUCUVAR-6 provides maximum fruit per vine, fruit length, fruit yield, and fruit weight. The AK-47 had maximum fruit weight and fruit yield and KARAN had the highest fruit diameter. Overall, CUCUVAR-6 defined the highest growth, yield, and quality aspects as compared to other genotypes (Rajawat *et al.*, (2018).

Kumari *et al.*, (2019) evaluated the effect of luffa vegetables using morphometric, phylogenetic, and organoleptic features. The data related to vegetative and reproductive relations was collected for the morphometric study. The genotypes of luffa were accessed for organoleptic features based on aroma, taste, bitterness, color, texture, and overall acceptance. The difference in the vegetative & reproductive characters is divided into two distinct clusters. The genotypes of luffa defined different taste parameters among different varieties. The study identified the phylogenetic and varietal cultivars and provides distinct morphological and organoleptic characteristics of each genotype.

2.2 Effect of yield related traits on different varieties of luffa

Pandey *et al.*, (2012) studied the effect of sponge gourd on yield and yield-related traits. The 30 genotypes were used to evaluate the yield and yield-related traits. The factors such as average fruit length, number of leaves, number of fruits, vine length, and fruit yield. Fruit yield defined high heritability but had a low genetic advance. The heritability for yield traits is due to environmental conditions.

The effect of variability and yield traits of ridge gourd genotypes observed where 60 genotypes were evaluated in the present study to identify the yield per plant, vine length, fruit weight, and fruit length. Genetic variation is used for the development of the gene pool which provides reservoirs of genes. The utilization of the morphological approach is to identify the variation and divergence and also to study the environmental factors (Rabbani *et al.*, 2012).

Dubey *et al.*, (2013) conducted the variability, yield related traits of luffa vegetables. Genotypic variation and heritability-related characteristics are fruit length, number of fruits, fruit diameter, and number of branches per plant. Genotypic variation and heritability indicated the female flowers, male flowers, and days to first harvest. The number of fruits per plant and fruit weight defined the maximum fruit yield per plant. Fruit length, number of fruits, fruit weight, and vine length are utilized to enhance the fruit yield in luffa vegetables.

Uzma *et al.*, (2016) evaluated the yield in the *Luffa acutangula*. 40 genotypes were identified for significant variation among genotypes for yield-related traits. The aspects of fruit vine per plant, pedicel length, fruit length, fruit weight, days to the first harvest, fruit diameter, fruit yield, and number of fruits per plant were studied. The maximum effect on fruit yield was related to average fruit weight and length.

Likewise, Koppad *et al.*, (2016) investigated the effect of various growth and yield-related traits on ridge gourd. The genotypic and phenotypic behavior of ridge gourd was observed to study the total yield factors. The vine length, number of leaves, fruit yield, number of fruits, fruit length, and fruit diameter aspects are indicated the positive impact on the growth and yield of ridge gourd.

Muthaiah *et al.*, (2017) conducted the yield and yield-related traits in ridge gourd. The two genotypes DMRG-36 and Arka defined the significant contribution to yield and yield-related traits. The factors number of fruits, yield per vine, and fruit

weight were studied. Out of other genotypes, DMRG-36 and Arka indicated the best yield-related aspects.

The effect of yield traits in sponge gourds was investigated by Yadav *et al.*, (2017). The aspects of fruit weight, fruit length, fruit yield per plant, vine per plant, and vine length are related to positive correlation and are affecting yield and related traits directly and indirectly. The study revealed that the number of fruits per plant and fruit weight is considered for the enhancement of genotypes in respect of yield.

The fruit yield and its related components in ridge gourd were studied. The aspects such as primary branches, length of fruit, number of seeds, length per vine, number of vines per plant, seed weight, and fruit weight are studied to evaluate the fruit yield. The 8 genotypes of ridge gourd defined the positive relation effect on fruit yield. The cultivars such as Pusa Nasdar, Arka Sujat, and Jaipur Long had good yield and related traits as compared to other cultivars (Jadav *et al.*, 2018).

Singh *et al.*, (2018) studied the yield, growth, and related traits in sponge gourds. The 5 genotypes were identified and aspects number of nodes, days to anthesis, primary branches, internodal length, vine length, fruit length, fruit weight, and fruit yield were conducted. Fruit yield is not an independent factor and is affected by several factors directly and indirectly. The effect of yield and related traits in ridge gourd investigated by Muthaiah *et al.*, (2017) where 8 different genotypes were identified for calculating the variation among genotypes. The genotypes DMRG-25, Arka Sumeet, and DMRG-22 define the highest yield and positive impact on the total yield of fruit.

Harshitha *et al.*, (2019) indicated the effect of different factors on ridge gourd. 25 genotypes were evaluated to identify the different characters of yield and related traits. The factors were affecting the yield directly and indirectly. The number of fruits per plant, average fruit weight, fruit length, and vine length are contributing factors toward yield-related traits. The positive correlation and these aspects are effective in the development of high-yielding cultivars.

The impact of morphological, yield traits in sponge gourds were evaluated by Hai *et al.*, (2019). A positive relation was identified between the fruit yield, fruit diameter, fruit weight, and the number of fruits per plant. The fruit length, leaf shape, leaf color, fruit color, fruit weight, diameter related aspects defined the highest yield

in sponge gourds. The components of fruit yield are the number of fruits, fruit weight, and fruit diameter that affect the sponge gourd directly and indirectly.

The growth, yield, and genetic variability of ridge gourd investigated in which 11 selected genotypes were used for calculating the significant effect of different characteristics such as fruit weight, fruit harvest, vine length, fruit weight, days to the first harvest, and the number of fruits per plant. These parameters had a direct positive impact on fruit yield and yield-related traits (Vijayakumar *et al.*, 2020).

Srikanth *et al.*, (2021) studied the impact of yield and growth factors in ridge gourd. Suitable breeding methods are required for crop improvement and quality traits. The genotypes VRG-11, VRG-23, VRG-24, VRG-25, Swarna Manjari, and Arka Prasan are used as factors for yield and growth aspects. Gene action was used for the variation of growth and yield-related traits of ridge gourd.

2.3 Effect of morphological traits & quality parameters on different varieties of luffa.

Prakash *et al.*, 2013 conducted research experiments using morphological changes in leaf, fruit, and seed characteristics, to distinguish between cultivated and wild Luffa species. Two main groups were identified using cluster analysis: one contained 30 *L. aegyptiaca* accessions and the other 36 *Luffa acutangula* accessions. Along with farmed *L. acutangula* and wild *L. acutangula* var. *amara*, a local cultivar called "*Satputia*" (*L. hermaphrodita*) was categorised. Nearer to the *L. acutangula* were wild species including *L. graveolens* and *L. echinata*.

During the current study, Jamwal *et al.*, 2015 conducted experiments on two species of the genus Luffa, specifically *L. cylindrica* and *L. acutangula*, to learn more about morphological and meiotic diversity. While the latter is grown both in the wild and on a modest scale in the Jammu district, the former is exclusively found in cultivation. In comparison to *L. cylindrica*, which has somewhat abnormal meiosis and has lower pollen viability of 30.34%, *L. acutangula* has a more efficient meiotic system with minimal abnormalities and better pollen vitality of 70.64%. Despite having lower pollen viability, *L. cylindrica* has a significantly more efficient reproductive system than *L. acutangula* in terms of fruit size, fruit set, and

percentage.

Varalakshmi *et al.*, 2016 tested 51 ridge gourd germplasm samples over a three-year trial period for yield and qualitative attributes in their study. All 11 quantitative and nine out of the 22 qualitative characteristics that were examined showed a significant difference between the germplasm. The earliest germplasm among those examined was IC20404 (5.2 and 41.3), followed by IC23259 in terms of the number of nodes and the days for the first female flower to appear (6.0 and 41.2). Fruit length and weight, which are crucial fruit factors that affect yield, were noted as being highest for Arka Sumeet and Co-1. IIHR-21 and IIHR-6 both recorded the highest average fruit output per vine i.e. 2.8 kg & 2.6 kg. It is possible that this variation among the genotypes tested for yield and quality criteria.

Zhang *et al.*, 2019 reported that to assess genetic uniformity, morphological classification is based on molecular characterization. This method makes evaluating genetic uniformity with genotypes in the current environmental conditions. To determine the genetic diversity of luffa, molecular markers are used to distinguish between genetics and plant breeding (Zhang *et al.*, 2019). The polymorphic markers are used to assess the variability in luffa. Molecular markers are used to determine the genetic makeup of luffa vegetables based on morphological variation.

2.4 Effect of composite herbal coatings and physio-chemical parameters of coating on sponge gourd

Yuan *et al.*, (2012) investigated the effect of chitosan coating on summer squash. The different concentrations such as 5, 10, and 15 % of chitosan coating were evaluated on summer squash. The coating of 10 % provided effective results as compared to other treatments. The effect of chitosan coating provides a barrier against atmosphere conditions, gas permeability, and transmission rate on the surface of the fruit. The physiochemical parameters of the coating were accessed during storage conditions such as soluble solids, acidity, pH, transmission rate, phenolic content, and flavonoid content.

Adetunji *et al.*, (2014) studied the effect of Aloe vera + chitosan (1 %) on cucumber. The storage of cucumber was done at 25 °C as an effective storage condition. The coating was produced by a simple stirring method for 30 min. The

application of coating was done by dipping of produce for 1 min. The physiochemical parameters such as soluble solids, acidity, pH, phenolic content, and flavonoid content were studied and improved the cucumber during storage conditions.

The composite coating of chitosan (0.1, 1, 1.5 %) + aloe vera + polyethylene on sponge gourd evaluated by Han *et al.*, (2014). The coating emulsion was formed by magnetic stirring + homogenization for half an hour. The sponge gourd was dipped in emulsion for 1 min and dried at ambient conditions. The produce was stored at a storage condition of 25 ± 1 °C with a relative humidity of 90-95 %. The physiochemical parameters including soluble solids, acidity, pH, phenolic content, and flavonoid content was accessed during storage conditions. The addition of chitosan coating provides a barrier against microbes and outer environmental conditions and provides shelf life and quality to produce.

Arjun *et al.*, (2015) indicated the effect of chitosan (2 %) + soy protein (1, 2 %) on fresh-cut cucumber by storage of produce under ambient conditions. The coating was prepared by stirring for 10 min and dipping vegetables for 1 min in an emulsion. The clear emulsion was prepared for application on produce. The addition of chitosan and soy protein provides an effective layer against transmission rate, gas permeability, water absorption, and swelling index. The physiochemical behavior of cucumber was accessed and parameters such as soluble solids, acidity, pH, phenolic content, and flavonoid content were studied. The quality and shelf life are maintained for 4 days.

The effect of guar gum on cucumber at concentration of 5, 10, 15, 20 % studied by Al-Juhaimi *et al.*, (2016). The storage of vegetables is done at 10 & 25 °C. Simple stirring for 30 min and dipping of produce was done to provide clear emulsion. The coating provides a barrier against gas transmission rate, water permeability, and respiration rate. The storage conditions maintain the effect of cucumber for 7 days. The coating was effective in the storage of soluble solids, pH, and acidity of produce.

Saha *et al.*, (2016) evaluated the effect of guar gum (1.5, 2 %) + essential oil (0.2, 0.3%) + emulsion agent on cucumber. The addition of guar gum maintains the quality and shelf life of produce. The essential oil was effective against microbes.

The emulsion agent maintains the effect of guar gum and essential oil and maintains the produce clear emulsion. The storage of cucumber was done at 25 & 70 °C. The treatment of cucumber was done by stirring and dipping vegetables for 1 min in an emulsion. The physiochemical parameters such as pH, soluble solids, acidity, phenolic content, and flavonoid content were accessed and enhanced the cucumber during storage days.

The coating of salicylic acid at 1.5 % on sponge gourd with storage of fresh produce was done at 9 & 20 °C (Cong *et al.*, 2017). Simple stirring for 20 min was done to produce coating emulsion. The coating provides a good barrier against microbes and environmental conditions. The physiochemical behavior of sponge gourd was studied and parameters such as soluble solids, acidity, transmission rate, phenolic content, flavonoid content, and pH were accessed and improved the sponge gourd vegetable during storage conditions. The coating provides a smooth, clear layer on the outer surface of the produce.

Raghav and Saini, (2018) identified the effect of corn starch (1.5 %) + mint emulsion on cucumber at 25 & 10 °C. The coating was prepared by stirring for 15 min and the dipping of vegetables was done for 2 min. The addition of corn starch + mint provides an effective layer against gas transmission, respiration rate, and water permeability, etc. The application of corn starch and mint emulsion improves the soluble solids, acidity, loss in weight, phenolic content, and flavonoid content was accessed on cucumber during storage conditions.

Bakliwal *et al.*, (2019) studied the effect of corn starch (1.5 %) + tulsi (2 %) on cucumber. The storage of fresh produce was done at 10 °C. The emulsion was prepared by magnetic stirring and dipping of produce for 1 min in emulsion for further storage. The coating prepared provides effective gas permeability, water transmission, and soluble solids to produce. The physiochemical parameters were accessed and soluble solids, acidity, phenolic content, and transmission loss were improved. The application of corn starch and tulsi on cucumber vegetables improved the physicochemical behavior. The treated produce is effective as a comparison to control produce during storage conditions.

The effect of gum Arabic (5, 10, 15 %) on summer squash with 10 % gum arabic is effective in minimizing the water loss, respiration rate, and firmness, as

compared to other concentrations. The simple magnetic stirring for 30 min is used for the production of emulsion for summer squash. Overall, the 10 % gum provides better postharvest quality retention properties. The physiochemical conditions such as soluble solids, acidity, pH, phenolic acid, flavonoid, transmission rate, and absorption power were accessed to evaluate the condition of coating on summer squash during storage conditions (Kannaujia *et al.*, 2019).

Sarker *et al.*, (2021) investigated the effect of Aloe vera (1, 2%) + glycerol (1 %) on minimally processed cucumber. The produce was stored at 4 & 20 °C for estimation of physicochemical parameters. The simple stirring for 20 min is done and the produce was dipped in emulsion for 2 min. Aloe vera provides a thin layer of vegetables and provides a barrier against the microbes. The physiochemical parameters such as total soluble solids, titratable acidity, loss in weight, and phenolic content were estimated. The application of Aloe vera coating improves the soluble solids, acidity, and phenolic content of cucumber vegetables. The quality and storage life of cucumber is maintained for a longer duration.

2.5 Value added products of vegetables

Lee *et al.*, (2002) developed the noodles by addition of pumpkin powder (0, 2.5, 5, 10 %). The different parameters were evaluated such as β -carotene content, physical dough properties, color, cooking properties, and sensory characteristics. The pasta with 5% of pumpkin powder was most favorable and had good taste, texture, appearance, and acceptability. The viscosity, stability, and absorption of pasta were maintained.

Kundu *et al.*, (2014) evaluated the impact of pumpkin powder and guar gum enriched pasta. The prepared pasta is assessed for proximate, dietary fiber, and mineral composition. The incorporation of pumpkin powder (5-15 %) and guar gum (0.5-1.5 %) improved the viscosity, swelling, cooking quality, and time of pasta prepared. The addition of different levels of pumpkin powder with guar gum defined the rheological and biochemical characterization of pasta. The 5 % pumpkin powder is regarded as good for the preparation of pasta and had health benefits.

Mirhosseini *et al.*, (2015) prepared the pasta by incorporating pumpkin (0, 25, 50 %) to have gluten-free pasta. The prepared pasta has desirable characteristics

including cooking yield, moisture content, hardness, adhesiveness, acceptability, texture, and color. The incorporation of 25 % pumpkin was obtained as desirable pasta with good sensory attributes. Park *et al.*, (2015) developed the noodles developed by incorporating sweet pumpkin powder. The pastais prepared according to the preference of consumers. The physiochemical behavior of pumpkin was studied and it was identified that dough rheology, cooking quality, and sensory aspects were improved by the addition of pumpkin powder. The prepared pasta had good moisture, protein, dietaryfiber, and crude fat content.

Devi and Geethanjali, (2017) developed the pasta from ridge gourd peel (2.5, 5, 7.5 %). The product formed by ridge gourd pasta defined sensory quality with good nutritional value, great cooking quality, and low microbial attack. The ridge gourd peel powder has great nutritional quality and storage for upto 15 days. The results indicated that the incorporation of ridgegourd peel has greatfiber and protein content. The 5 % of pasta is defined as good organoleptic quality.

Minarovičová *et al.*, (2017) prepared the pasta by addition of pumpkin powder. The incorporation of pumpkin powder (5, 7.5, 10 %) affects the dough rheology, cooking quality, and sensory properties, of pasta. The pasta prepared with pumpkin powder had good water absorption, cooking quality, hardness, and shorter cooking time. The results defined that the addition of pumpkin powder defined moisture (6.1 %), protein (8.2 %), crude fat (0.7 %), ash (2.3 %), and total dietary fiber (27.4 %). The prepared pasta is health beneficial and had good active constituents.

Kang, (2017) developed the pumpkin and carrot-based pasta. The sensory aspect of pumpkin puree and carrot puree was estimated and defined the color, viscosity, appearance, aroma, viscosity, taste, and also overall acceptability. The rheological characteristics of pasta defined the yield stress, flow behavior, and consistency flow at the temperaturesof 5 °C, 25 °C, and 85 °C. Moisture, viscosity, pH, and total soluble solids are approved for the optimization of pumpkin-carrot pasta.

Angelica, (2019) prepared the noodles from rice bran flour and pumpkin paste powder. The addition of pumpkin paste improves the dough rheology, cooking quality, and sensory aspects. The prepared pasta was identified with moisture (7 %), protein (8.8 %), crude fat (0.65 %), and ash (3.4). The prepared pasta had good

absorption water, cooking quality, cooking time, hardness, and acceptability. The pasta had active constituents and a beneficial effect on human health.

The cassava-based pasta by addition of peach, palm, and linseed was observed by Sakurai *et al.*, (2019). The value-added property of cassava increased with the addition of these ingredients. The drying temperatures of 60, 75, and 90 °C were used for pasta production. The quality and textural properties were studied to assess the quality of pasta.

Swathi *et al.*, (2019) studied the impact of jackfruit enriched red amaranthus prepared pasta. The cooking quality, nutritional composition, and consumer acceptability were checked. The production of jackfruit-based pasta is enriched in proteins, carbohydrates, fiber, and active constituents. It is regarded as promising pasta with health benefits both domestically and international level.

Kaur *et al.*, (2021) evaluated the effect of antioxidant-rich tricolor pasta prepared with cucumber peel powder. The produced pasta is identified for its cooking, nutraceutical, textural and sensory features. The pasta is evaluated for total phenolic content, flavonoid content, and firmness. The incorporation of 20% cucumber peel powder is beneficial for health and provides good quality pasta.

Lawal *et al.*, (2021) prepared the pasta from pumpkin and cassava powder. The concentrations of 5 and 10 % are used for the preparation of pasta. The addition of powder of cassava and pumpkin improved the water solubility, swelling power, and oil adsorption capacity. The textural properties of pasta are improved by the addition of a stabilizer. The 10 % pasta is beneficial for health and proved an effective preparation.

CHAPTER-3

MATERIALS AND METHODS

The present study entitled “**Pre and Post Harvest Studies and Value addition in Sponge gourd (*Luffa cylindrica* L.)**” was conducted in the vegetable farm, Domain of horticulture, School of Agriculture for two consecutive cropping seasons of 2020-2021 and 2021-2022 and further under Post harvest Laboratory, Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, India.

3.1 Material:

Freshly harvested healthy and uniform sponge gourd from the department of fruit science.

3.2 Geographical location:

Lovely Professional University, Phagwara, Punjab is located at 31.22°N (latitude) and 75.7 °E (longitude) at the altitude of 234m above sea level.

3.3 Climate:

Phagwara (Jalandhar) had a humid subtropical climate with hot summers and winds from April-July followed by a hot humid rainy season and cold winters associated from December- January.

3.4 Details of Experiment:

In the field experimental trial during year of 2021& 2022, four varieties of sponge gourd (*Luffa cylindrica* L.) were grown in Randomized Block Design with five replications each. The comparative yield analysis was performed among the four varieties of sponge gourd and observations were recorded based on morphological yield traits as well as physicochemical data. The four varieties grown in the field were further checked for shelf-life studies for both years 2021 and 2022. Herbal composite coatings were prepared under different formulations and the fruits of the varieties from the field trial were harvested and were coated with different treatments under refrigerator conditions. The two highest yielded varieties of sponge gourd under field conditions were harvested and continued for preparing value-added pasta with different variations/treatments.

Layout plan of experiment

Experimental site	:	Lovely Professional University vegetable farm
Design	:	Randomized Block Design (RBD)
Experimental materials	:	4 varieties of sponge gourd
Varieties	:	Shivanya, Payal, Alok, Garima
Treatments	:	4 viz. T ₁ , T ₂ , T ₃ , T ₄
Replications	:	5
Date of sowing	:	7 th of February
Plant to Plant spacing	:	1.6m
Row to row spacing	:	0.75m
Experimental Area	:	700m ²










3.5 Methodology for field preparation:

The seeds were collected from the local market. For proper germination of seeds, the sponge gourd seeds were soaked for 24 hours. Direct seeds were grown in the soil during February month in both year of 2021 & 2022 with watering to have fast germination. Seeds were sown in raised ridges & furrows @ 2.5-5.0 Kg/ha and spacing of row-to-row 1.5-2.5 m and hill-to-hill distance of 60-120 cm was given for the crop. A fertilizer dose of NPK was given for proliferation and good yield of the crop. Sponge gourd was grown for two years and continues to have two years of pooled data.

Soil preparation:

The soil was given couple of ploughing using rotary tillers to make it in weed free and fine tilth stage. The addition of farmyard manure was done to attain good yield and quality. It was grown on well-drained loamy soil with a pH of 6.5 to 7 i.e. neutral to slightly alkaline soil and seeds were sown in ridges for production. The first irrigation was carried out just after sowing and later twice a week.

Plate-I

		
Land preparation & seed sowing of different varieties of <i>Luffa cylindrica</i> L.	Emergence of seedlings	Cotyledonary leaf stage of sponge gourd
		
3-4 leaf stage of luffa	Young seedlings	Anthesis of male flower
		
Anthesis of female flower	First fruiting stage	Harvesting of sponge gourd

Overview of production of different varieties of *Luffa cylindrica* L.

3.6 Methodology for preparation of composite herbal-based edible coating:

Preparation of herbal composite coatings:

The requirement of three basic components were needed for preparing herbal composite coatings viz. chitosan, aloe vera and mint leaves juice with different concentrations shown below:

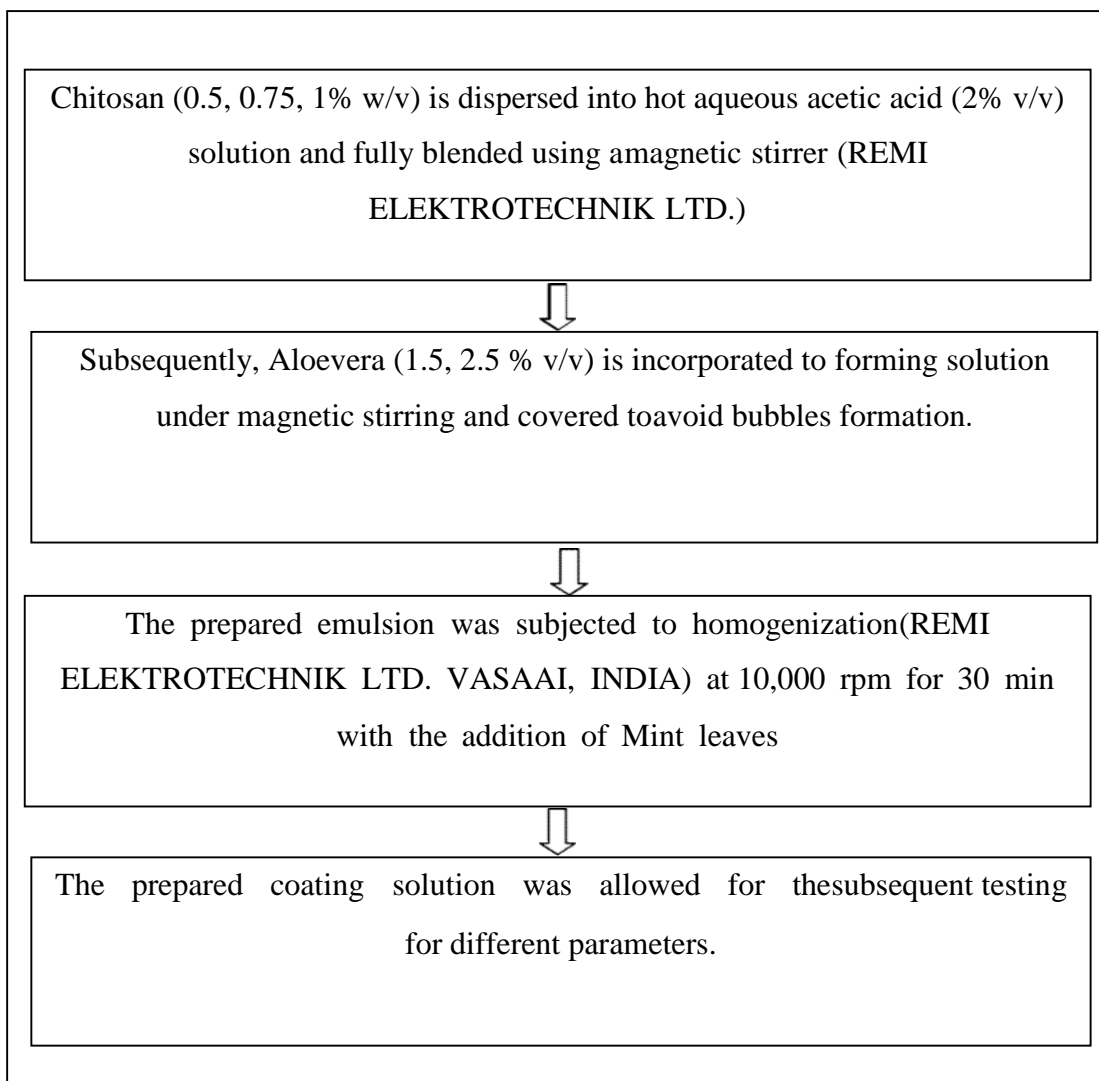
- ❖ Chitosan (0.5, 0.75, 1% w/v)
- ❖ Aloe vera (1.5, 2.5 % v/v)
- ❖ Mint leaves juice (1% v/v)

The different treatments for experimental research were formulated in the table given below for each four varieties of sponge gourd.

Experimental Treatments per variety:

Treatment details	Treatment numbers
Control	T₀
Chitosan (0.5%) + Aloe vera (1.5%) + Mint leaf juice (1%)	T₁
Chitosan (0.5%) + Aloe vera (2.5%) + Mint leaf juice (1%)	T₂
Chitosan (0.75%) + Aloe vera (1.5%) + Mint leaf juice (1%)	T₃
Chitosan (0.75%) + Aloe vera (2.5%) + Mint leaf juice (1%)	T₄
Chitosan (1%) + Aloe vera (1.5%) + Mint leaf juice (1%)	T₅
Chitosan (1%) + Aloe vera (2.5%) + Mint leaf juice (1%)	T₆

Procedure to follow for herbal composite coating:



Method of application of the composite herbal coating on Luffa species:

The dipping method has been selected for applying coating on the sponge gourd in which 1 minute was the dipping time for fruits to be immersed in the different coating emulsions and then allowed to dry the coated fruits at ambient temperature maximum for 2 hrs.

Plate II

		
<p>Washed four different varieties viz. Shivanya, Payal, Alok & Garima of <i>Luffa cylindrical</i> before the application of coating</p>		
	<p>Basic components for herbal composite coating i.e. chitosan, Aloe vera, mint leaves juice</p>	
		<p>Emulsion of herbal composite coating of different treatments</p>
<p>Dipping method for application of different varieties of <i>Luffa cylindrical</i> L.</p>	<p>Shelf life study of coated Luffa's under refrigerator conditions</p>	

Overview of application of herbal composite coating on different varieties of *Luffa cylindrical* L.

3.7 Methodology for preparation of value-added product i.e., pasta from sponge gourd:







Materials required: The sponge gourd fruits were procured from university farm. Other ingredients(wheat flour, semolina, oil, salt) were purchased from local market.

Preparation of Pasta: The freshly harvested sponge gourd fruits firstly were washed and the peel of the fruit was separated using peeler. Then the gourds were cut out into small pieces and grinded to form pulp. The dough was prepared by mixing sponge gourd pulp, semolina and wheat flour with different variations/treatments and pasta was prepared by using pasta maker extruded machine (Devi & Geethanjali, 2017). Different samples of pasta were formulated respectively as per the treatments given below:

Treatments per variety for preparing 170gram pasta each

Treatments	Semolina flour (g)	Wheat flour (g)	Sponge gourd pulp (g)
T₀	85	85	-
T₁	10	90	70
T₂	10	80	80
T₃	10	70	90
T₄	20	90	60
T₅	20	80	70
T₆	20	70	80
T₇	30	70	70
T₈	30	80	60
T₉	30	90	50

Plate III

		
<p>Harvested sponge gourd fruit from field</p>	<p>Development of pasta from kneaded dough through pasta extruder machine</p>	
		
<p>Drying of pasta in hot air oven</p>	<p>Packaging of different samples of pasta under different composition of treatments</p>	
		
<p>Boiled pasta sample</p>	<p>Roasted pasta for sensory testing</p>	

Overview of development of value added product pasta from sponge gourd

3.8 Observations recorded for morphological yield traits:

Detailed observations and data were evaluated to check the performance of four different varieties of sponge gourd in the form of morphological, physico-chemical & quality parameters. The data was collected for two consecutive years i.e., 2020-2021 and 2021-2022 & described under following major sub headings:

3.8.1 Morphological parameters

3.8.1.1 Days sown to emergence

3.8.1.2 Emergence Percentage (%)

3.8.1.3 Days to anthesis of first male flower

3.8.1.4 Node to anthesis of first male flower

3.8.1.5 Days to anthesis of the first female flower

3.8.1.6 Node to anthesis of the first female flower

3.8.1.7 Number of fruits per plant

3.8.1.8 Average fruit weight per plant (g)

3.8.1.9 Average Fruit yield per plant (kg)

3.8.1.10 Yield per plot (kg/plot)

3.8.1.11 Main vine length (m)

3.8.1.12 Fruit length (cm)

3.8.1.13 Fruit diameter (mm)

3.8.2 Physicochemical parameters:

3.8.2.1 pH

3.8.2.2 Total soluble solid(° Brix).

3.8.2.3 Ascorbic acid (mg/100g)

3.8.2.4 Moisture content (%)

3.8.2.5 Titrable acidity(%)

3.8.2.6 Pulp Peel ratio

3.8.2.7 DPPH (%)

3.8.2.8 Phenols (mg/100g)

3.9 Description of recorded observations for field parameters

3.9.1 Morphological parameters:-

3.9.1.1 Days sown to Emergence

The number of days from seedling to emergence and days of emergence was calculated.

3.9.1.2 Emergence Percentage (%)

The emergence percentage was calculated by dividing the number of emerged seedlings by the number of seeds planted for each seed lot and multiplying the product by 100 (Sidhu and Kaur, 2021).

3.9.1.3 Days to anthesis of first male flower

Each germplasm was observed for the appearance of the male flower and days to the first male flower opening were recorded in each case.

3.9.1.4 Node to anthesis of first male flower

The order of nodes at which male flowers appeared was recorded by counting the number of nodes from ground level.

3.9.1.5 Days to anthesis of the first female flower

Each germplasm was observed for the appearance of a female flower and days to the first female flower opening were recorded in each case.

3.9.1.6 Node to anthesis of the first female flower

The order of nodes at which the first female flower appeared was recorded by counting the number of nodes in each replication.

3.9.1.7 Number of fruits per plant

The total number of fruits of selected plants from each germplasm was recorded and the mean was found.

3.9.1.8 Average fruit weight per plant (g)

The total number of fruits of selected plants from each germplasm was recorded and the mean was found (Joshi *et al.*, 2005)

3.9.1.9 Average Fruit yield per plant (kg)

The average fruit yield per plant was calculated by taking the average weight of fruits.

3.9.1.10 Yield per plot (kg/plot)

The weight of fruits of selected plants from each germplasm was weighed in

kilograms.

3.9.1.11 Main vine length (m)

The lengths of the petiole of three mature leaves were measured in centimeters with the help of a measuring scale and then the mean was recorded (Wijewardane, 2013).

3.9.1.12 Fruit length (cm)

The ripened fruits were randomly selected from each replication plant and their length was measured with the help of an ordinary scale (marked in cm). Thereafter, the average fruit length for each treatment was worked out and is expressed in centimeters.

3.9.1.13 Fruit diameter (mm)

The width of fruits was measured through a digital vernier caliper and final readings are expressed in mm.

3.9.2 Physicochemical analysis:

3.9.2.1 pH

The pH of fruits was measured using a pH meter (Hong *et al.*, 2012).

3.9.2.2 Total soluble solid (°Brix)

Total soluble solids (TSS) were measured using an Erma hand refractometer (0 to 32°B and 58 to 92°B) and the results were expressed as degree Brix (°B). The readings were corrected by incorporating the appropriate correction factor for temperature variation (A.O.A.C., 1980).

3.9.2.3 Ascorbic acid (mg/100g)

0.5g of sample blended with 3% HPO₃ and volume was made up to 100ml with 3% HPO₃. Then the sample was filtered. An aliquot (2 to 10 ml) was titrated against standard dye to the pink color endpoint which persisted for 15 sec. (Ranganna, 1986)

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre(ml)} \times \text{Dye factor (ascorbic acid mg/ml)} \times \text{Volume made up(ml)}}{\text{Extract taken for elimination (ml)} \times \text{weight of sample (g)}}$$

3.9.2.4 Moisture content (%)

The moisture of different sample was determined by using a hot air oven maintained at $105 \pm 5^\circ\text{C}$ for 90 min. drying was continued until two consecutive readings were obtained. Then percentage moisture content was determined (AOAC, 2016)

$$\text{Moisture content (\%)} = \frac{\text{Initial weight-final weight}}{\text{Initial weight}} \times 100$$

3.9.2.5 Titratable acidity (%)

A known weight of the fruit juice was taken in a 100 ml volumetric flask and the volume was made up to 100 ml by adding distilled water. Take 10 ml of filtrate in another flask. Add 2 drops of phenolphthalein as an indicator and titrate against 0.1 N (4g/1000g) sodium hydroxide. The end point was determined by the appearance of a faint pink color. Note the readings and calculate using the formula.

$$\text{Titrate acidity (\%)} = \frac{\text{MlsNaOH used} \times 0.1 \text{ N NaOH} \times \text{Milliequivalent factor}}{\text{Grams of sample}} \times 100$$

3.9.2.6 Pulp Peel ratio

Pulp and peel are separated, weighed individually, and expressed as pulp to peel ratio (Rangana, 1986)

3.9.2.7 DPPH (%)

DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical which reduce itself and give the reading of the percent inhibition. 3.9 ml of 6×10^{-5} mol/L DPPH which was made in methanol was put into a test tube with 0.1 ml of sample extract. The sample was then kept in the dark for 30 min and then the absorbance was measured at 515 nm (Brand and Williams, 1995). The methanol solution was used as blank. Antioxidant activity was calculated using the following equation:-

$$\text{Antioxidant activity (\%)} = \frac{\text{Ab(B)} - \text{Ab(S)}}{\text{Ab(B)}} \times 100$$

Were,

$Ab_{(B)}$ = Absorbance of blank $Ab_{(S)}$ = Absorbance of sample

3.9.2.8 Phenols (mg/100g)

The amount of total phenols in the sample was determined with the Folin-Ciocalteu reagent using Gallic acid as a standard. One gram of sample was taken and grinded with 10 ml of 80 percent ethanol in pestle and mortar and centrifuged for 20 min at 1000 rpm and filtered. The filtrate was evaporated in the oven up to dryness and the dried extract was dissolved in 5 mL of distilled water.

0.2-2.0 mL aliquot was taken in different test tubes and the volume was made up to 3 mL with the distilled water. Then 0.5 ml Folin-Ciocalteu reagent was added. After 3 min 2 ml of Na_2CO_3 (20%) was added to the test tube. Test tubes were placed in a boiling water bath for one min and then allowed to cool. The absorbance was measured at 650nm. The concentration was determined as per the standard procedure from the standard curve. The standard curve was prepared using different concentrations of gallic acid using the same method. The final results were expressed in terms of mg per g or percent.

3.10 Observations recorded for composite herbal-based edible coating

3.10.1 Physiological Parameters

3.10.1.1 Physiological loss in weight (%)

3.10.1.2 Decay loss (%)

3.10.1.3 Pulp: peel ratio

3.10.2 Quality Parameters

3.10.2.1 pH

3.10.2.2 TSS (° Brix).

3.10.2.3 Acidity (%)

3.10.2.4 Ascorbic acid (mg/100g)

3.10.2.5 TSS: acid ratio

3.10.2.6 Fruit length (cm)

3.10.2.7 Fruit weight (g)

3.10.3 Biochemical parameter

3.10.3.1 Phenols(mg/100g)

3.10.3.2 DPPH (%)

3.10.3 Sensory evaluation

3.10.3.1 Overall acceptability

3.10.3.2 Firmness (kg/cm²)

3.11 Description of recorded observations for herbal composite coatings parameters:

3.11.1 Physiological Parameters

3.11.1.1 Physiological loss in weight (%)

The percentage of physiological weight loss was calculated by taking the difference between the initial weight of the fruit and the weight of fruit after storage and was expressed as a percentage (Srivastava and Tandon 1968). The percentage loss of weight for each statement was calculated by using the following formula as suggested by

$$\text{PLW (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

3.11.1.2 Decay loss (%)

The fruit spoilage was performed as per the method suggested by (Mohammadi *et al.*, 2015). The fruits showing visible decay features were counted at every storage interval and the total number was evaluated by adding up all the decayed fruits from the succeeding storage intervals. It is calculated as the number of fruits in a lot that showed any fungal rots or any visible decay features to the total number of fruits that are kept in a lot and multiplying the results by 100.

$$\text{Fruit spoilage (\%)} = \frac{\text{Number of fruits decayed}}{\text{Total number of fruits stored}} \times 100$$

3.11.1.3 Pulp: peel ratio

Pulp and peel are separated, weighed individually, and expressed as pulp to peel ratio.

3.11.2 Quality Parameters

3.11.2.1 pH

The pH of fruits was measured using a pH meter.

3.11.2.2 TSS (°Brix)

Total soluble solids (TSS) were estimated as per the method determined by (Gol *et al.*, 2013) by using a handheld refractometer (Erma Company with a range of 0 to 32 °B). The pulp was extracted from fruits followed by placing a few drops on the prism of the refractometer and observance was recorded through eyepiece with final results expressed as degree Brix (°B).

3.11.2.3 Acidity (%)

A known weight of the fruit juice was taken in a 100 ml volumetric flask and the volume was made up to 100 ml by adding distilled water. Take 10 ml of filtrate in another flask. Add 2 drops of phenolphthalein as an indicator and titrate against 0.1 N (4g/1000g) sodium hydroxide. The end point was determined by the appearance of a faint pink color. Note the readings and calculate using the formula.

3.11.2.4 Ascorbic acid (mg/100g)

0.5g of sample blended with 3% HPO₃ and volume was made upto 100ml with 3% HPO₃. Then the sample was filtered. An aliquot (2 to 10 ml) was titrated against standard dye to the pink color endpoint which persisted for 15 sec.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre(ml)} \times \text{Dye factor (ascorbic acid mg/ml)} \times \text{Volume made up (ml)}}{\text{Extract taken for elimination (ml)} \times \text{weight of sample (g)}}$$

3.11.2.5 TSS: acid ratio

TSS/Acid ratio was measured by dividing the Total Soluble Solids value by the titrable acidity percent and mean values were expressed.

3.11.2.6 Fruit length (cm)

The fruit length was estimated through a digital vernier caliper and final readings are converted into cm (Wijewardane, 2013).

3.11.2.7 Fruit weight (g)

The weight of fruits was estimated with the help of a weighing machine and final readings were expressed in grams (Wijewardane, 2013).

3.11.3 Biochemical parameters

3.11.3.1 Phenols (mg/100g)

The number of total phenols in the sample was determined with the Folin-Ciocalteu reagent using Gallic acid as a standard. One gram of sample was taken and grinded with 10 ml of 80 percent ethanol in pestle and mortar and centrifuged for 20 min at 1000 rpm and filtered. The filtrate was evaporated in the oven up to dryness and the dried extract was dissolved in 5 mL of distilled water. 0.2-2.0 mL aliquot was taken in different test tubes and the volume was made up to 3 mL with the distilled water. Then 0.5 ml Folin-Ciocalteu reagent was added. After 3 min 2 ml of Na₂CO₃ (20%) was added to the test tube. Test tubes were placed in a boiling water bath for one min and then allowed to cool. The absorbance was measured at 650nm. The concentration was determined as per the standard procedure from the standard curve. The standard curve was prepared using different concentrations of gallic acid using the same method. The final results were expressed in terms of mg per g or percent.

3.11.3.2 DPPH (%)

DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical which reduce itself and give the reading of the percent inhibition. 3.9 ml of 6x10⁻⁵ mol/L DPPH which was made in methanol was put into a test tube with 0.1 ml of sample extract. The sample was then kept in the dark for 30 min and then the absorbance was measured at 515 nm. The methanol solution was used as blank. Antioxidant activity was calculated using the following equation:-

$$\text{Antioxidant activity (\%)} = \frac{\text{Ab(B)} - \text{Ab(S)}}{\text{Ab(B)}} \times 100$$

Where,

Ab_(B) = Absorbance of blank Ab_(S) = Absorbance of sample

3.11.4 Sensory evaluation

3.11.4.1 Overall acceptability

The sensory evaluation of fruit samples was assessed by post-graduate students and staff members of the horticulture department at different storage intervals. Nine points hedonic scale was adopted for the summation of sensory parameters such as color, texture, taste, and overall acceptability. The wholesome

fruits were presented to judges and on nine points hedonic scale, point 9 was allocated as 'like extremely' and point 1 was assigned as 'dislike extremely'.

3.11.4.2 Firmness (kg/cm²)

The firmness of fruits was performed by the method described by (Sun *et al.*, 2018) by using a penetrometer texture analyzer (Model GY-1) with head dimension (3.5 mm) and range (0.5 - 4 kg/cm²×10⁵ Pa). The penetrometer recorded the pressure utilized to plunge into the skin of fruits and the final results were expressed as (kg/cm²) (Sun *et al.*, 2018).

3.12 Observations recorded for value added parameters:

3.12.1 Cooking quality parameters

3.12.1.1 Cooking loss (g)

3.12.1.2 Water absorption (%)

3.12.1.3 Swelling index (%)

3.12.1.4 Cooking Time (min.)

3.12.2 Biochemical Parameters

3.12.2.1 Ascorbic acid (mg/100g)

3.12.2.2 DPPH (%)

3.12.3 Nutritional parameters

3.12.3.1 Protein(%)

3.12.3.2 Fat (%)

3.12.3.3 Ash (%)

3.12.3.4 Crude fibre (%)

3.12.3.5 Carbohydrate (%)

3.12.4 Sensory quality evaluation

3.13 Description of recorded observations for value added pasta product parameters:

3.13.1 Cooking quality parameters

3.13.1.1 Cooking loss (g)

10.0 ml of the aliquot was transferred to a pre-weighed Petri plate and let it dry at 105 °C until there were no differences in the weight observed. The weight of the dry solids was noted, and cooking loss (CL) was expressed as the percentage of dry solids loss during cooking (Surasani *et al.*, 2019).

3.13.1.2 Water absorption (%)

In the 50 ml centrifuge tube the 2 gm of the sample was taken which was then mixed with 20 ml of deionized water (Surasani *et al.*, 2019). It was then incubated at 30°C with regular shaking of the tube every 5 minutes for 30 minutes. It was then centrifuged at 3000 rpm for 15 min. The supernatant was then collected in a pre-weighed Petri plate and was then kept for drying for 5h at 100 °C. After drying, the weight of the dry solids and gel was noted. Water absorption capacity (WAC) and water solubility (WSI) were calculated by equations:-

$$\text{WAC} = \frac{\text{Weight of gel after removal of supernatant (g)}}{\text{Weight of sample}} \times 100$$

3.13.1.3 Swelling Index (%)

0.5 gm was mixed in the 15 ml of deionized water in the 50ml centrifuge tube which was pre- weight. For 30 minutes it was heated at 85°C and then cooled to room temperature (Surasani *et al.*, 2019). Then it was centrifuged at 3000 rpm for 15 min. The supernatant was discarded, and the weight of swollen sediments was noted down. The swelling power (SP) was calculated by the following equation:

$$\text{SI} = \frac{\text{Weight of swollen sediments(g)}}{\text{Weight of sample(g)}} \times 100$$

3.13.1.14 Cooking time (min)

Take the beaker with 100ml deionized water and mix 10 gm of sample in it which was then cooked to the optimum time. The optimum time was checked by the disappearance of the white core using the slide test (by squeezing between the plates) after every 30seconds. The time (min) taken for the complete disappearance of the central white core is considered optimal cooking time (OCT) (Surasani *et al.*, 2019).

3.13.2 Biochemical analysis

3.13.2.1 Ascorbic acid (mg/100g)

0.5g of sample blended with 3% HPO₃ and volume was made upto 100ml with 3% HPO₃. Then the sample was filtered. (Ranganna, 1986).An aliquot (2 to 10 ml) was titrated against standard dye to the pink color endpoint which persisted for 15 sec.The ascorbic acid can be calculated by following formula:

$$\text{Ascorbic acid} = \frac{\text{Titre value (ml)} \times \text{Dye factor (ascorbic acid mg/ml)} \times \text{Volume made up (ml)}}{\text{Extract taken for elimination (ml)} \times \text{weight of sample (g)}}$$

3.13.2.2 DPPH (%)

DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical which reduce itself and give the reading of the percent inhibition. 3.9 ml of 6×10^{-5} mol/L DPPH which was made in methanol was put into a test tube with 0.1 ml of sample extract. The sample was then kept in the dark for 30 min and then the absorbance was measured at 515 nm (Brand and Williams, 1995). The methanol solution was used as blank. Antioxidant activity was calculated using the following equation: -

$$\text{Antioxidant activity (\%)} = \frac{\text{Ab(B)} - \text{Ab(S)}}{\text{Ab(B)}} \times 100$$

Where,

$$\text{Ab}_{(B)} = \text{Absorbance of blank} \quad \text{Ab}_{(S)} = \text{Absorbance of sample}$$

3.13.3 Nutritional parameters

3.13.3.1 Protein (%)

0.5 g sample was taken along with 0.5g digestion mixture (2.5g SeO_2 + 20g $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ + 100g K_2SO_4) was digested in 25 ml concentrated H_2SO_4 until it became colorless which takes approximately 5 hours. Digestion flasks were cooled overnight at ambient temperature. After that, the digest was poured into a 100 ml volumetric flask and volume makeup was made with distilled water and protein content was estimated by the following equation.

$$\text{Nitrogen \%} = \frac{(\text{Sample titre} - \text{Blank titre}) \times \text{Normality of HCl} \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

$$\text{Protein \%} = \text{Nitrogen \%} \times 6.25$$

3.13.3.2 Fat (%)

Fat content was estimated using the soxhlet apparatus. The sample (2gm) was taken into a thimble and placed in a siphoning tube. The weight of the empty soxhlet flask was noted and filled with 80 ml of petroleum ether. The flask content was

initially heated for 1 hour at 70°C and then at 140°C (AOAC, 2016). After evaporation, the final weight of the flask was noted (Note- Cool the flask in the desiccator). Fat content is given by the following equation

$$\mathbf{Fat(\%)} = \frac{W_2 - W_1}{S} \times 100$$

Where W1 = Weight of the empty flask (g)

W2 = Weight of the flask – weight of the sample (g)
S = Weight of the sample (g)

3.13.3.3 Ash (%)

5g of dried sample was taken in a silica crucible and ignited on a bunsen burner until become smokeless. (AOAC, 2016)

Then ashing was done in a muffle furnace at 550°C ± 5°C for 6-8 hrs.

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

3.13.3.4 Crude fiber (%)

Crude fiber is determined by using the method of AOAC, 2016. 2g of defatted sample was hydrolyzed in a beaker containing petroleum ether and after that, the sample was boiled under reflux for 30 min with 200 ml of H₂SO₄ solution (1.25% H₂SO₄ per 100 ml of solution). Then the solution was filtered using filter paper with the help of a funnel. After the filtration, the samples were washed with boiled water until they were no longer acidic. Then the residue was transferred onto a beaker and boiled for another 30 min with 200 ml of a solution containing 1.25% H₂SO₄ per 100 ml of solution. The boiled sample was washed with boiled distilled water. The residue was filtered through a Gooch filter crucible dried at 100°C for 2 hrs in an oven, cooled, and washed the percentage of crude fiber in the sample was calculated as per the formula.

Calculations:

$$\% \text{ Crude fiber} = \frac{\text{Weight after drying}}{\text{Weight of sample}} \times 100$$

3.13.3.5 Carbohydrate (%)

The carbohydrate was calculated by the method followed by Stephen *et al.*, 2017 by using equation

$$\text{Carbohydrate} = 100 - (\% \text{Moisture} + \% \text{Fat} + \% \text{Ash} + \% \text{Fiber})$$

3.13.4 Sensory quality evaluation

The sensory evaluation of fruit samples was assessed by post-graduate students and staff members of the horticulture department at different storage intervals. Nine points hedonic scale was adopted for the summation of sensory parameters such as color, texture, taste, and overall acceptability. The wholesome fruits were presented to judges and on nine points hedonic scale, point 9 was allocated as 'like extremely' and point 1 was assigned as 'dislike extremely'. The different parameters for sensory were estimated as color, flavor, texture, firmness, stickiness, and overall acceptability.

3.14 Statistical analysis

The recorded data were analyzed as per standard statistical procedure at level of 95 % significance for both the cropping season of 2020-2021 and 2021-2022 via software OPSTAT. The five replications for field experimental using RBD (randomized block design) and three replications for laboratory trial using CRD (completely randomized design) were laid out to verify the influence of different variables.

RESULTS AND DISCUSSION

The present study entitled “**Pre & Post harvest studies and value addition in sponge gourd (*Luffa cylindrica* L.)**” was conducted in the experimental field of Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara during the cropping season of 2020-2021 and the field research trial was again conducted in the next year of 2021-2022. Further the laboratory experimental work related to herbal edible coating was conducted under Post Harvest Laboratory, Department of Horticulture during two consecutive years of 2020-2021 & 2021-2022 and the laboratory research work related to value added product directed under the Post- Harvest Laboratory, Lovely Professional University, India.

Experiment 1: Study of morphological and yield related traits in different varieties of *Luffa cylindrica* L.

4.1 Morphological & yield parameters:

4.1.1 Days sown to emergence

The data presented in Table 4.1 indicates that there exists a significant variation among all the varieties for days to emergence. Among all 4 varieties, in year of 2020-2021 Alok variety took the maximum 13.20 days to emerge followed by Garima variety with 12.00 days. However, Shivanya variety took the minimum 8.40 days to germinate. On the other hand, in year of 2021- 2022 Garima variety took the maximum 14.40 days to emerge followed by Alok variety with 11.60 days. However, Shivanya variety took the minimum 8.00 days to germinate.

Moreover, in pooled data Shivanya variety was earliest to emerge. In contrast, Garima was last to emerge. The rapid germination in Shivanya variety may be due to soft seed coat and good seed adaptability to adapt in the soil condition and the reason for other varieties such as Payal variety, Garima variety, Alok variety might be a variation attribute to climatic factor. These results are in conformity with the findings of Joshi *et al.*, (2004); Gaffar *et al.*, (2008) and Okusanya (1978).

Table 4.1: Performance of different varieties on days sown to emergence of *Luffa cylindrica* L.

Varieties	Days sown to Emergence		
	2020-2021	2021-2022	Pooled
Shivanya	8.40	8.00	8.20
Payal	11.20	11.20	11.20
Garima	12.00	14.40	13.20
Alok	13.20	11.60	12.40
CD ($p \leq 0.05$)	2.08	0.81	1.21
CV (%)	14.02	5.42	8.10

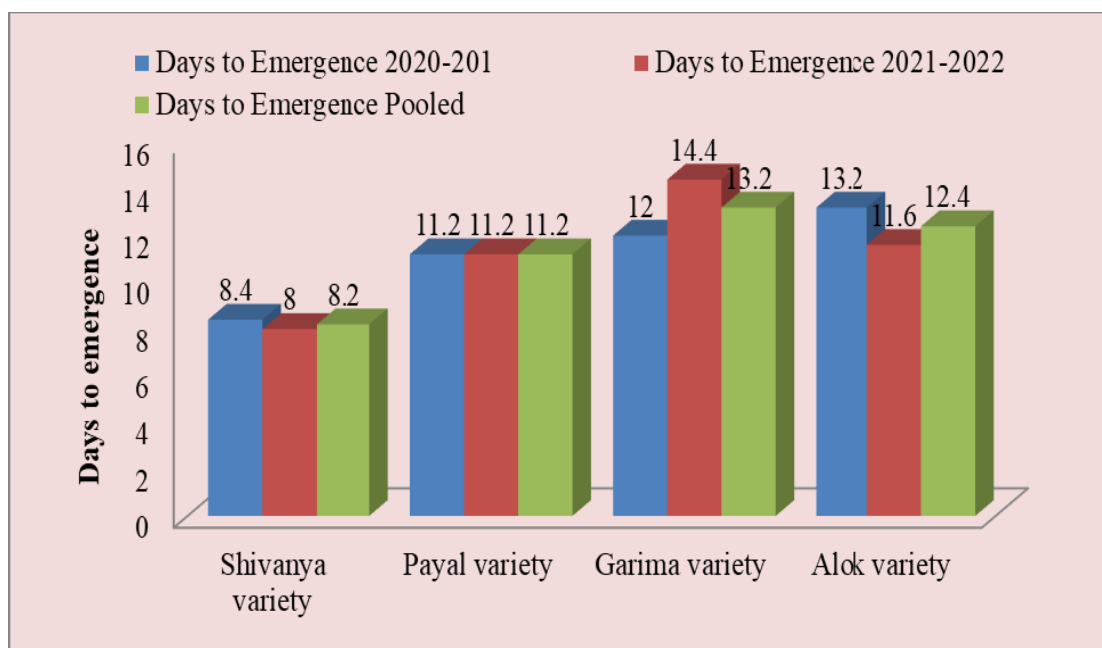


Figure 1: Performance of different varieties on days sown to emergence of *Luffa cylindrica* L.

4.1.2 Emergence Percentage (%)

The data related to emergence percentage elaborated in table 4.2 in which each of the four varieties has its own distinct values. In 2020-2021 Shivanya had maximum emergence percentage (95.60%) followed by Payal variety (92.00%), Alok variety (83.60%). In contrary, Garima variety had minimum emergence (82.60%). On the other hand, in year of 2021-2022 Shivanya had maximum emergence (96.20%) followed by Payal variety (93.60%), Alok variety (83.00%). However, Garima

variety took minimum days to germinate (84.60%). The data showed in table is significantly different.

Additionally, it is clearly seen in pooled data Shivanya variety had maximum emergence percentage. In contrast, Garmia had least emergence percentage. Highest germination percentage in Shivanya variety might be due to good ability of the seed to adopt in the soil condition and the reason for low emergence percentage of other varieties such as Payal, Garima and Alok variety may be due to less and poor adaptation. The result from present statement was in confirmation with the findings of Sohrab *et al.*, (2003); Jiang *et al.*, (2009) and Medeiros *et al.*, (2019).

Table 4.2: Performance of different varieties on seed emergence percentage of *Luffa cylindrica* L.

Varieties	Emergence Percentage (%)		
	2020-2021	2021-2022	Pooled
Shivanya	95.60	96.20	95.90
Payal	92.00	93.60	92.80
Garima	82.60	84.60	83.60
Alok	83.60	83.00	83.30
CD ($p \leq 0.05$)	0.70	1.0	0.58
CV (%)	0.60	0.85	0.50

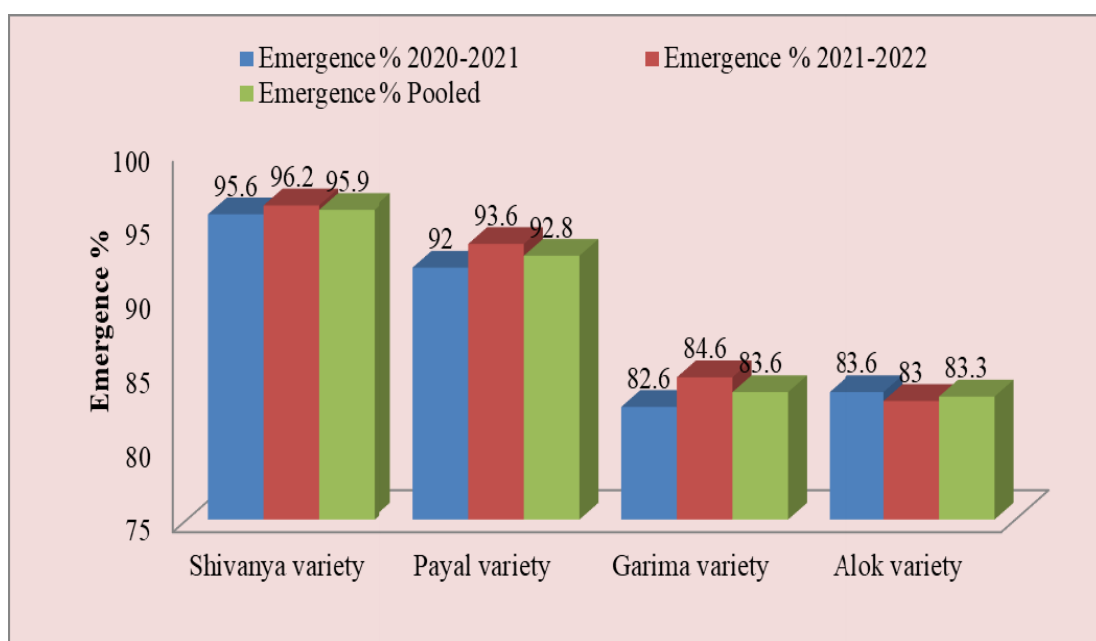


Figure 2: Performance of different varieties on seed emergence percentage of *Luffa cylindrica* L.

4.1.3 Days to anthesis of first male flower

The data revealed to days to anthesis of first male flower represented in Table 4.3 among all 4 varieties, in year of 2020-2021, Alok variety required highest days of the floral anthesis of first male (61.60) followed by Garima (56.00) and Payal variety (51.20). However, Shivanya variety took minimum days required of the floral anthesis of first male (48.60). In contrast, in the year of 2021-2022 Alok variety took maximum days to anthesis of first male flower (61.80) followed by Garima variety (58.40), Payal variety (51.40). However, Shivanya took less days (46.60).

In addition, it is clear from pooled data Alok variety took maximum days to anthesis of first male flower and Shivanya variety took minimum days to anthesis of first male flower. It might be due to effects of different kinds of variety used and climatic variations.

Table 4.3: Performance of different varieties on days to anthesis of first male flower of *Luffa cylindrica* L.

Varieties	Days to anthesis of first male flower		
	2020-2021	2021-2022	Pooled
Shivanya	48.60	46.60	47.60
Payal	51.20	51.40	51.30
Garima	56.00	58.40	57.20
Alok	61.60	61.80	61.70
CD ($p \leq 0.05$)	0.93	1.03	0.70
CV (%)	1.29	1.42	0.97

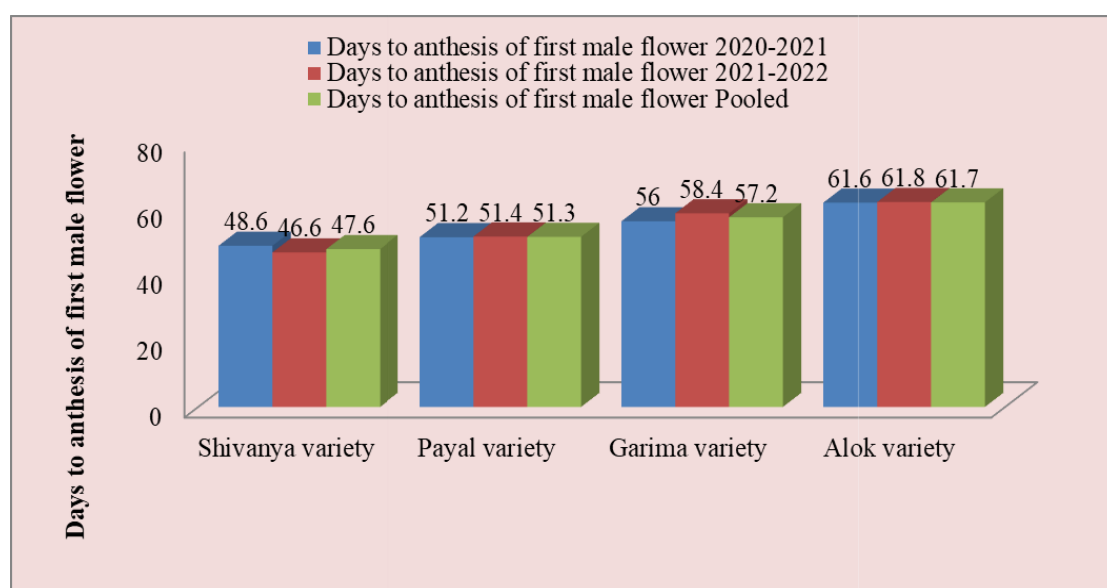


Figure 3: Performance of different varieties on days to anthesis of first male flower of *Luffa cylindrica* L.

4.1.4 Node to anthesis of first male flower

The data related to node to anthesis of first male flower represented in Table 4.4 among all 4 varieties, in year of 2020-2021 maximum number of nodes was observed in Garima variety (4.60) followed by Alok variety (4.00), Shivanya variety (2.60) and minimum value for number of node of first male flower in Payal variety was observed (2.60). Whereas in year of 2021-2022, Alok variety had maximum number of node of first male flower (5.40), followed by Garima variety (4.20), Shivanya variety (3.00) while, least number of nodes of first male flower was seen in Payal variety(2.60).

Moreover, pooled data showed Alok variety had higher number of node of first male flower (2.80) and Payal and Shivanya varieties had lower number of node of first male flower (4.70). This might be due to climatic variation. These results are in accordance with the results of Kumar *et al.*, 2008; Lal *et al.*, 2021.

Table 4.4: Performance of different varieties on node to anthesis of first male flower of *Luffa cylindrica* L.

Varieties	Node to anthesis of first male flower		
	2020-2021	2021-2022	Pooled
Shivanya	4.0	5.40	4.70
Payal	4.20	4.20	4.20
Garima	2.40	2.60	2.50
Alok	2.40	3.00	2.70
CD ($p \leq 0.05$)	0.88	0.81	0.40
CV (%)	19.5	16.12	8.59

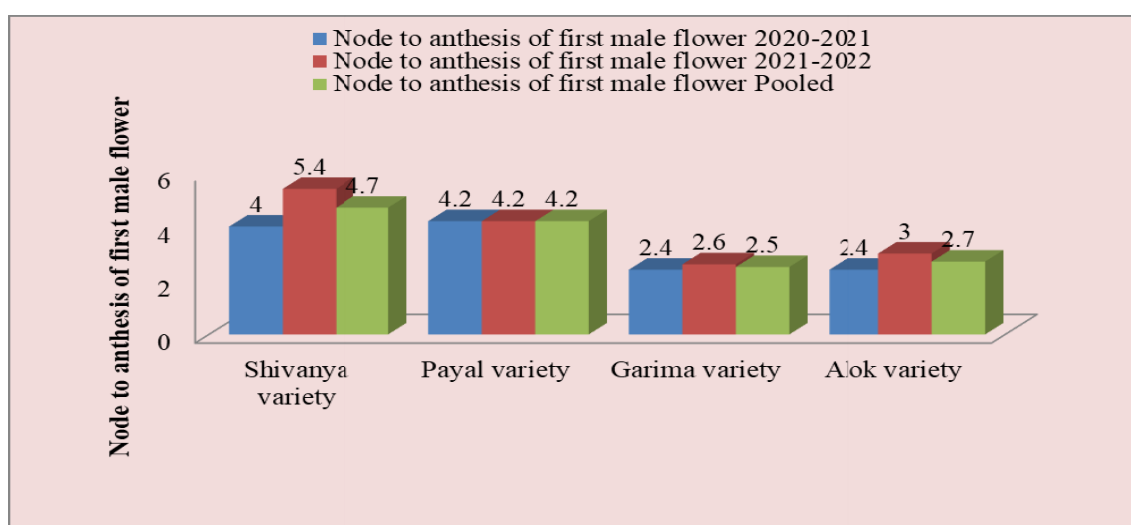


Figure 4: Performance of different varieties on node to anthesis of first male flower of *Luffa cylindrica* L.

4.1.5 Days to anthesis of first female flower

The data obtained to days to anthesis of first female flower represented in Table 4.5 among all 4 varieties, in year of 2020-2021, Shivanya variety required highest days of the floral anthesis of first female (60.00) followed by Garima variety (59.60), Payal variety (53.60). However, Alok variety took minimum days required of the floral anthesis of first female (52.20). In contrast, in the year of 2021-2022 Payal variety took maximum days to anthesis of first female flower (60.60) followed by Shivanya variety (58.40), Payal variety (51.40) and Alok variety took less days (52.80).

In addition, it is observed from pooled data Alok variety took maximum days to anthesis of first female flower and Shivanya variety took minimum days to anthesis of first female flower. This might be due to inherent genetic makeup variations.

Table 4.5: Performance of different varieties on days to anthesis of first female flower of *Luffa cylindrica* L.

Varieties	Days to anthesis of first female flower		
	2020-2021	2021-2022	Pooled
Shivanya	60.00	60.40	60.20
Payal	53.60	60.60	57.10
Garima	59.60	54.20	56.90
Alok	52.20	52.80	52.50
CD ($p \leq 0.05$)	1.08	0.81	0.72
CV (%)	1.33	1.07	0.96

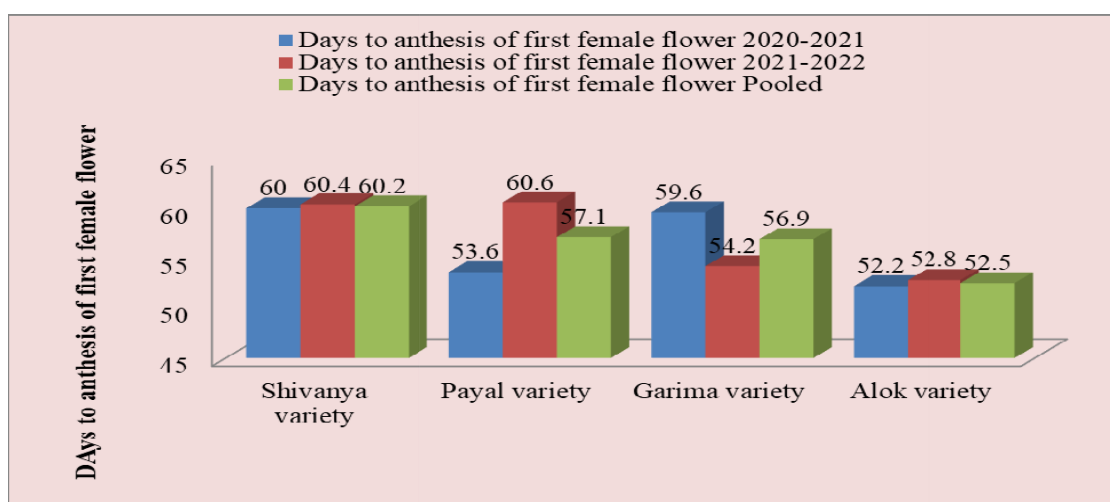


Figure 5: Performance of different varieties on days to anthesis of first female flower of *Luffa cylindrica* L.

4.1.6 Node to anthesis of first female flower:

The data related to node to anthesis of first female flower tabulated in Table 4.6 among all 4 varieties, in year of 2020-2021 maximum number of nodes was observed in Payal variety (8.00) followed by Shivanya variety (7.40), Garima variety (4.80) and minimum value for number of node of first female flower in Alok variety was observed (4.60). Whereas in year of 2021-2022, Shivanya and Payal variety had maximum number of node of first female flower (8.60), followed by Garima variety (5.60) while, least number of nodes of first female flower was seen in Alok variety (4.40).

Moreover, pooled data showed Payal variety had higher number of node of first female flower (8.30) and Alok variety had lower number of node of first female flower (4.50). This can be because of genetic factors. The result from present statement was in confirmation with the findings of Yadav and Kumar, 2012; Singh *et al.*, 2011.

Table 4.6: Performance of different varieties on node to anthesis of first female flower of *Luffa cylindrica* L.

Varieties	Node to anthesis of first female flower		
	2020-2021	2021-2022	Pooled
Shivanya	7.40	8.60	8.00
Payal	8.00	8.60	8.30
Garima	4.80	5.60	5.20
Alok	4.60	4.40	4.50
CD ($p \leq 0.05$)	1.21	0.73	0.81
CV (%)	14.72	8.05	9.39

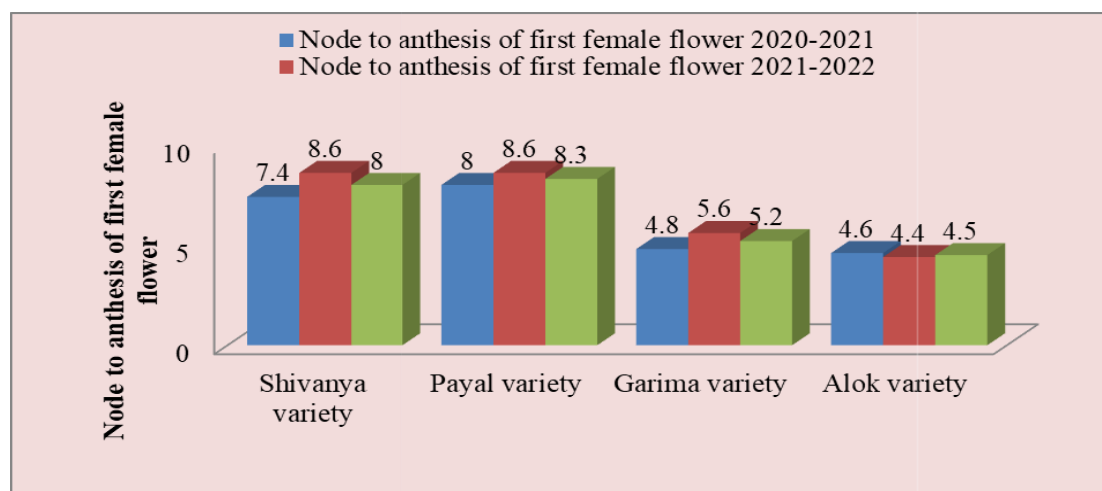


Figure 6: Performance of different varieties on node to anthesis of first female flower of *Luffa cylindrica* L.

4.1.7 Number of fruits per plant

The number of fruits per plant data presented in Table 4.7 showed that various varieties had significant variation in year of 2020-2021 and 2021-2022. Firstly, in the year of 2020-2021 Shivanya variety had maximum number of fruits (6.82) after that Payal variety (5.87), Garima variety (4.37), whereas, Alok variety recorded minimum value (3.85). Secondly, in 2021-2022 year, the more number of fruits per plant observed in Shivanya variety (7.03) followed by Payal variety (6.55). In comparison of other varieties Garima variety (4.48) and Alok variety (4.05) had less number of fruits per plant.

The perusal of data given in table 4.7 and figure 7 shivanya had maximum number of fruits perplant, while other had less number of fruits per plant. The number of fruits per plant depends upon plant density and weather condition. The number of fruits per plant declined linearly as plant density and temperature increases and vice versa (Qiu *et al.*, 2013). The result from present statement was in confirmation with the findings of Du *et al.*, (2006); Kumar *et al.*, (2013).

Table 4.7: Performance of different varieties on number of fruits per plant of *Luffa cylindrica* L.

Varieties	Number of fruits per plant		
	2020-2021	2021-2022	Pooled
Shivanya	6.82	7.03	6.92
Payal	5.87	6.55	6.21
Garima	4.37	4.48	4.42
Alok	3.85	4.05	3.95
CD ($p \leq 0.05$)	0.39	0.52	0.31
CV (%)	5.66	7.10	4.34

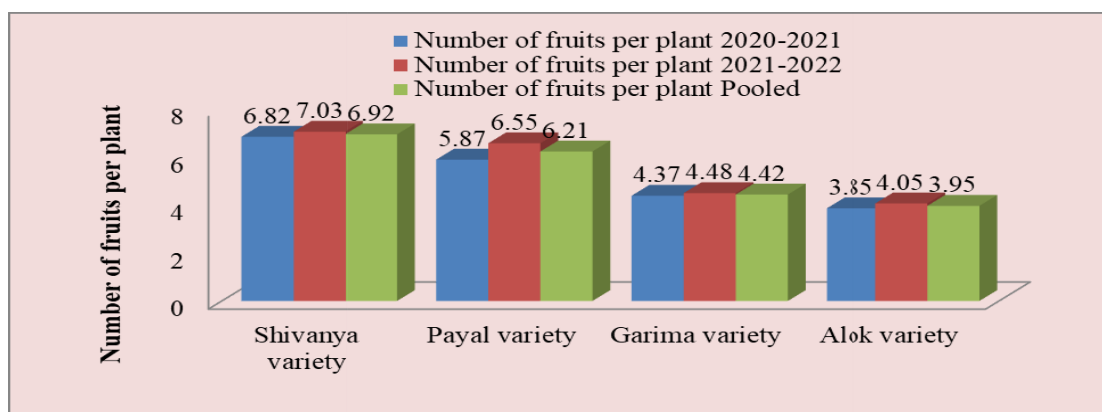


Figure 7: Performance of different varieties on number of fruits per plant of *Luffa cylindrica* L.

4.1.8 Average fruit weight per plant (g)

The average fruit weight per plant in gram elaborated in the Table 4.8 revealed significant variation in four different varieties in year of 2020-2021, 2021-2022 and their pooled.

First and foremost, in the year of 2020-2021, the maximum average fruit weight per plant was shown in Shivanya variety (72.43 g) followed by Payal variety (67.13g). While, the minimum average fruit weight was observed in Alok variety (52.82) and Garima variety (52.16 g). Turning to other year 2021-2022, highest average fruit weight per plant (74.34 g) was present in Shivanya variety followed by Payal variety (67.07 g), Garima variety (57.76g) and minimum values were recorded in Alok variety (55.63g).

Furthermore, it is vividly seen in pooled data Shivanya variety had more average fruit weight per plant and Alok variety had less in comparison of other varieties. Fruit weight and composition depend on the balance between inward and outward fluxes from fruit (mostly water and carbon), which involve many different processes. Transpiration leads to a water loss and may decrease the fruit fresh weight and concentrate the soluble compounds. Adequate temperature leads to moderate transpiration by which average fruit weight increases (Prudent *et al.*, 2009). These results are in accordance with the results of Chen *et al.*, (2014); Han *et al.*, (2014).

Table 4.8: Performance of different varieties on average fruit weight per plant of *Luffa cylindrica* L.

Varieties	Average fruit weight per plant(g)		
	2020-2021	2021-2022	Pooled
Shivanya	72.43	74.34	73.38
Payal	67.13	67.07	67.10
Garima	52.16	57.76	54.96
Alok	52.82	55.63	54.22
CD (p≤0.05)	0.92	0.26	0.35
CV (%)	0.38	0.31	0.42

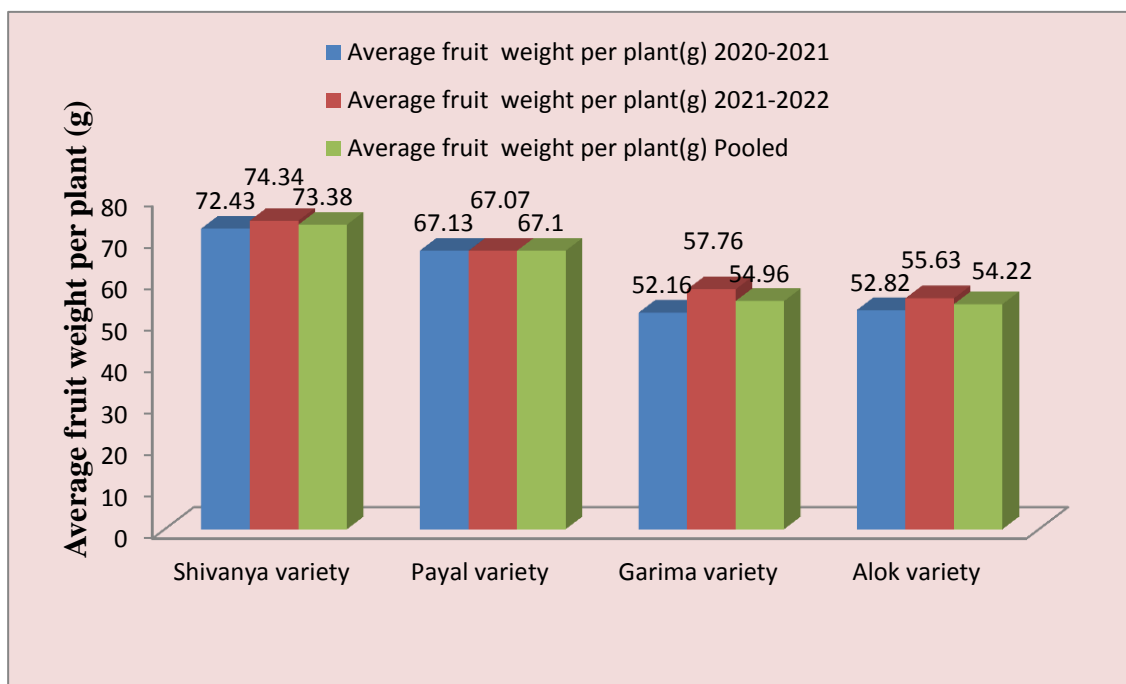


Figure 8: Performance of different varieties on Average fruit weight per plant (g) of *Luffa cylindrica* L.

4.1.9. Average fruit yield per plant (kg)

The data related to average fruit yield per plant in kg represented in Table 4.9 among all 4 varieties, in year of 2020-2021 maximum average fruit yield was observed in Shivanya variety (0.55 kg) followed by Payal variety (0.43 kg), Garima variety (0.25 kg) and minimum value for average fruit yield in Alok variety was observed (0.21 kg). Whereas in year of 2021-2022, Shivanya variety had maximum average fruit yield (0.58 kg), followed by Payal variety (0.46 kg), Garima variety (0.32 kg) while, least average fruit yield per plant was seen in Alok variety (0.25 kg).

Moreover, pooled data showed Shivanya variety had higher average fruit yield per plant (0.56 kg) and Alok variety had lower average fruit yield per plant (0.23 kg). Maximum average fruit yield may be due to higher number of fruits per plant, more fruit size, good soil type, good cultural practices and minimum average fruit yield may be because of lower number of fruits per plant, less fruit size, poor soil type and bad cultural practices (Verma *et al.*, 2018). The result from present statement was in confirmation with the findings of Pandey *et al.*, (2012); Silva *et al.*, (2012).

Table 4.9: Performance of different varieties on average fruit yield per plant of *Luffa cylindrica* L.

Varieties	Average Fruit yield per plant (Kg)		
	2020-2021	2021-2022	Pooled
Shivanya	0.55	0.58	0.56
Payal	0.43	0.46	0.44
Garima	0.25	0.32	0.28
Alok	0.21	0.25	0.23
CD ($p \leq 0.05$)	0.01	0.01	0.01
CV (%)	1.86	1.41	1.48

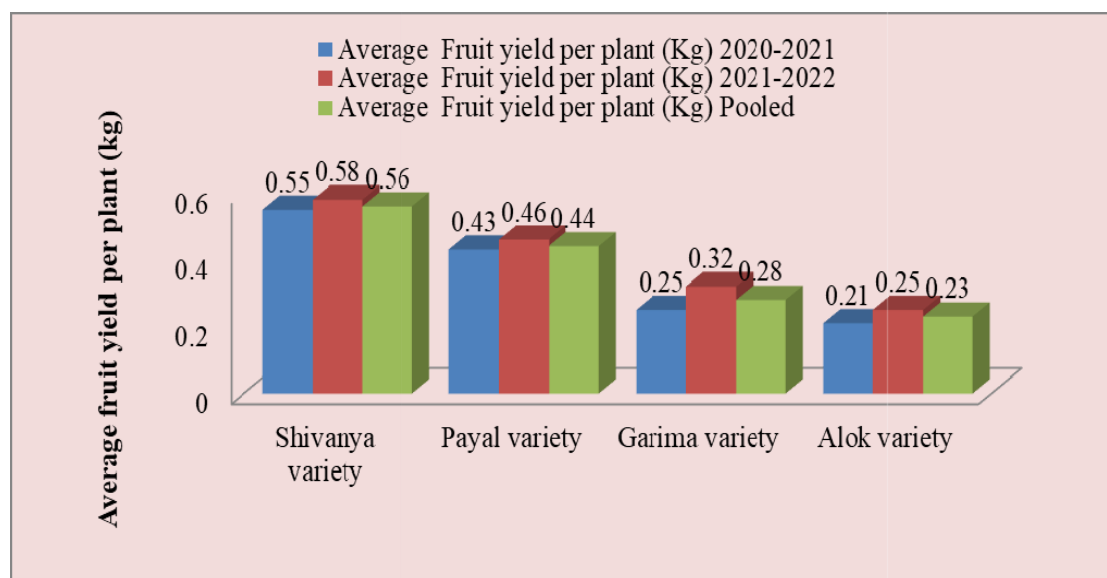


Figure 9: Performance of different varieties on average fruit yield per plant of *Luffa cylindrica* L.

4.1.10 Plant yield per plot (kg/plot)

The data related to Plant yield per plot (kg/plot) is represented in Table 4.10, each of the four varieties has its own different values, in 2020-2021 Shivanya variety had maximum plant yield per plot (342.58 kg) followed by Payal variety (271.97 kg), Garima variety (155.79 kg). In contrary, Alok variety had minimum plant yield per plot (133.80 kg). On the other hand, in year of 2021-2022. Shivanya variety had more plant yield per plot (363.78 kg) followed by Payal variety (288.62 kg), Garima variety (198.38 kg). However, Alok variety had minimum value for plant yield showed in table is significantly different.

Additionally, it is clearly seen in pooled data Shivanya variety had maximum plant yield of 353.18 kg per plot. In contrast, Alok variety had least plant yield of 145.63 kg per plot. The essential factor which effects the growth and productivity of the vegetable crop is balanced nutrition. The optimum level at which nutrients are to be applied and source from which they have derived are equally important (Ananda Murthy *et al.*, 2020). The result from present confirmation with the findings of Anagaw *et al.*, 2019; Peron *et al.*, 2021.

Table 4.10: Performance of different varieties on plant yield per plot of *Luffa cylindrica* L.

Varieties	Plant yield per plot (Kg/plot)		
	2020-2021	2021-2022	Pooled
Shivanya	342.58	363.78	353.18
Payal	271.97	288.62	280.29
Garima	155.79	198.38	177.08
Alok	133.80	157.46	145.63
CD (p≤0.05)	0.83	0.28	0.43
CV (%)	0.28	0.08	0.14

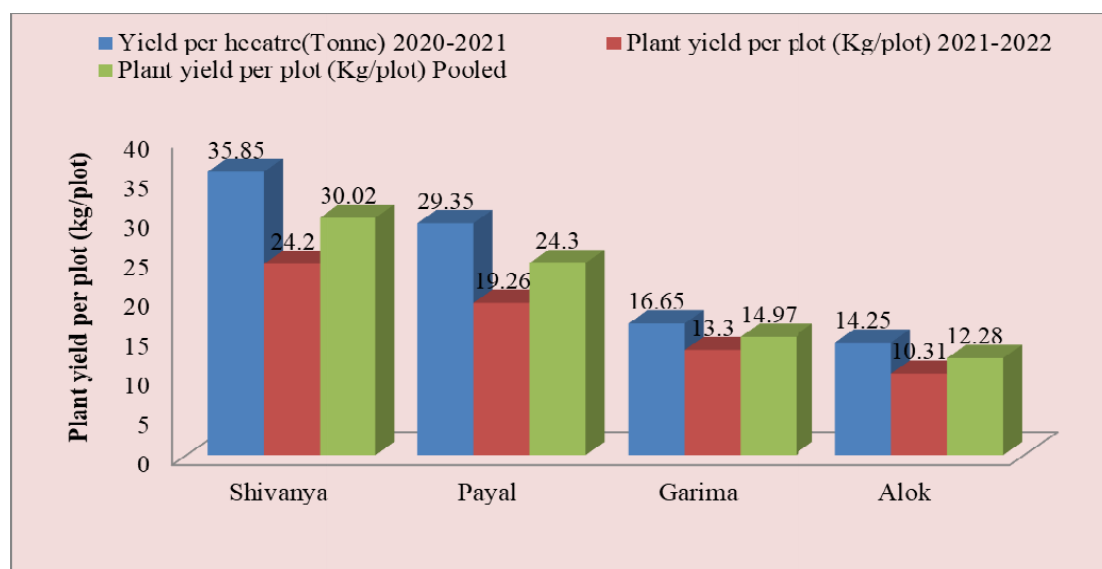


Figure 10: Effect of different varieties on plant yield per plot of *Luffa cylindrica* L.

4.1.11 Yield per hectare (tonne)

The yield per hectare in tonne elaborated in the Table 4.11 revealed significant variation in four different varieties in both the years and their pooled. First and foremost, in the year of 2020-2021, the maximum yield per hectare was shown

in Shivanya variety (35.85 ton) followed by Payal variety (29.35 ton), Garima variety (16.65 ton). While, the minimum yield per hectare was observed in Alok variety (14.25 ton) and. Turning to other year 2021- 2022, highest yield per hectare (24.20 ton) was present in Shivanya variety followed by Payal variety (19.26 ton), Garima variety (13.30 ton) and minimum values were recorded in Alok variety (10.31 ton).

Furthermore, it is recorded that in pooled data Shivanya variety had more yield per hectare of 30.02 tonne and Alok variety had less of 12.28 tonne in comparison of other varieties. Yield per hectare is increase with the standardization of agro techniques such as trailing of vines and other plant nutrition to modify the fruit set and yield (Hili *et al.*, 2010). The result from present statement was in confirmation with the findings of Phan *et al.*, 2015; Rahman *et al.*, 2021.

Table 4.11: Performance of different varieties on yield per hectare of *Luffa cylindrica* L.

Varieties	Yield per hectare(Tonne)		
	2020-2021	2021-2022	Pooled
Shivanya	35.85	24.20	30.02
Payal	29.35	19.26	24.30
Garima	16.65	13.30	14.97
Alok	14.25	10.31	12.28
CD ($p \leq 0.05$)	0.05	0.14	0.08
CV (%)	0.15	0.61	0.37

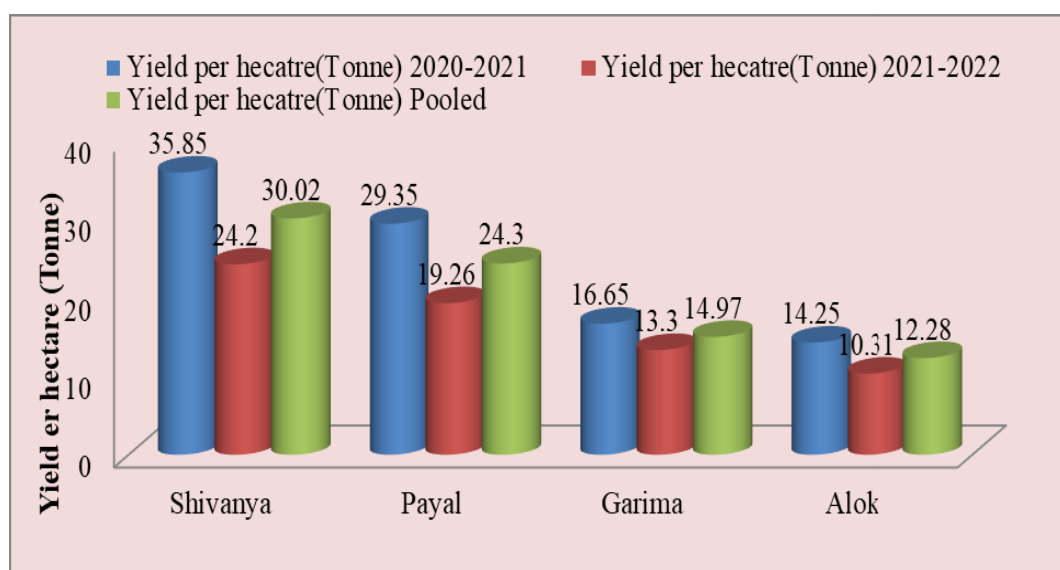


Figure 11: Performance of different varieties on yield per hectare of *Luffa cylindrica* L.

4.1.12 Main vine length (m)

The main vine length presented in Table 4.12 described that various varieties had significant variation in year of 2020-2021 and 2021-2022. Firstly, in the year of 2020-2021 Shivanya variety (8.50m) and Payal variety (8.62m) had maximum vine length after that Garima variety (6.68m), whereas, Alok variety recorded minimum value (6.36m). Secondly, in 2021-2022 year, the more length of vine observed in Shivanya variety (7.70m) followed by Payal variety (7.58m). In comparison of other varieties Garima variety (5.50m) and Alok variety (5.82m) had less vine length.

Furthermore, it is clear from the table 4.12 and figure 12 Shivanya and Payal variety had maximum main vine length, while other had minimum length. An increase in the growth parameter may be attributed to the more penetration and better utilization of sunlight for production maximum number of leaves and side branches because of increased photosynthesis activity and assimilation of photosynthates for increased plant growth (Silva *et al.*, 2012). These results are in conformity with the reports of Chauhan and Maurya, 2019; Singh *et al.*, 2017.

Table 4.12: Performance of different varieties on main vine length per hectare of *Luffa cylindrica* L.

Varieties	Main vine length (m)		
	2020-2021	2021-2022	Pooled
Shivanya	8.50	7.70	8.10
Payal	8.62	7.58	8.10
Garima	6.68	5.50	6.09
Alok	6.36	5.82	6.09
CD (p≤0.05)	0.24	0.27	0.21
CV (%)	2.45	3.04	2.23

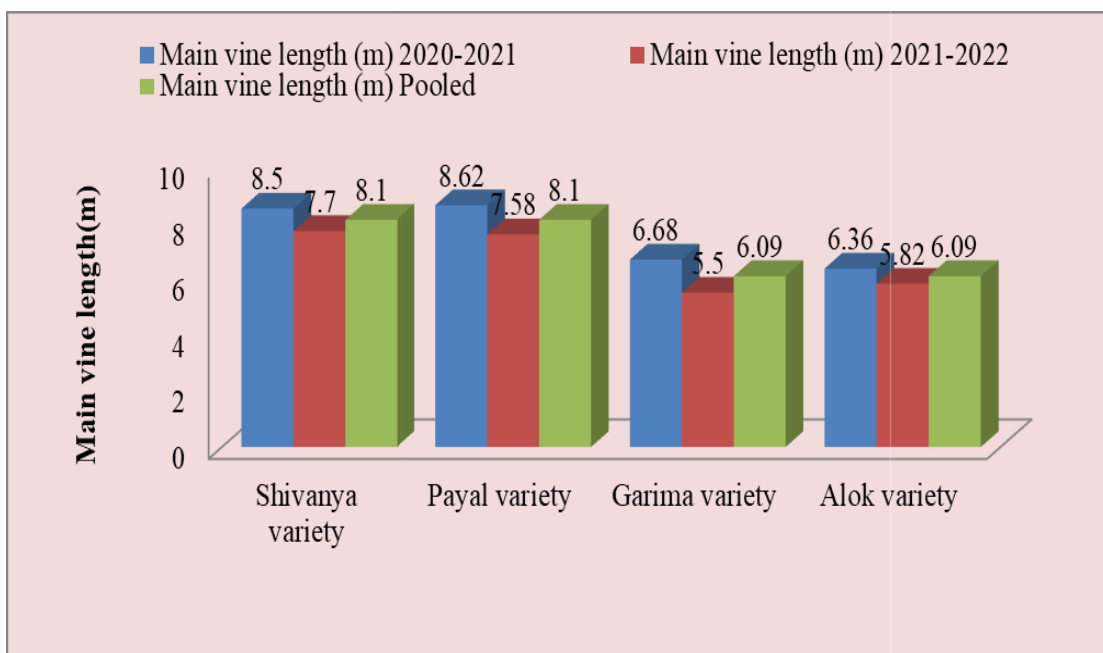


Figure 12: Performance of different varieties on main vine length of *Luffa cylindrica* L.

4.1.13 Fruit length (cm)

The data presented to fruit length represented in Table 4.13 Among all 4 varieties, in year of 2020-2021 Shivanya variety had maximum fruit length (19.52cm) followed by Payal variety (18.58cm), Garima variety (17.62cm). However, Alok variety had minimum length of fruit (17.50cm). On the other hand, in year of 2021-2022 the length of fruit was more in Shivanya variety (23.24m) followed by Payal variety (22.28cm), Garima variety (18.54cm). However, Alok variety had short length (18.06cm). The data showed the significant variation in all four varieties.

Moreover, it is vividly seen in pooled data Shivanya variety had maximum length of fruits. In contrast, Alok variety had minimum length. Increased nutrition to the vines with increase in level of nitrogen and increased synthesis of chlorophyll and amino acids helped in efficient uptake resulting in increased length of fruits (Pandey *et al.*, 2012). The similar findings were reported by Kumar *et al.*, 2013; Chauhan *et al.*, 2020.

Table 4.13. Performance of different varieties on fruit length of *Luffa cylindrica* L.

Varieties	Fruit length (cm)		
	2020-2021	2021-2022	Pooled
Shivanya	19.52	23.24	21.38
Payal	18.58	22.28	20.43
Garima	17.62	18.54	18.08
Alok	17.50	18.06	17.78
CD (p≤0.05)	0.17	0.73	0.41
CV (%)	0.71	2.67	1.58

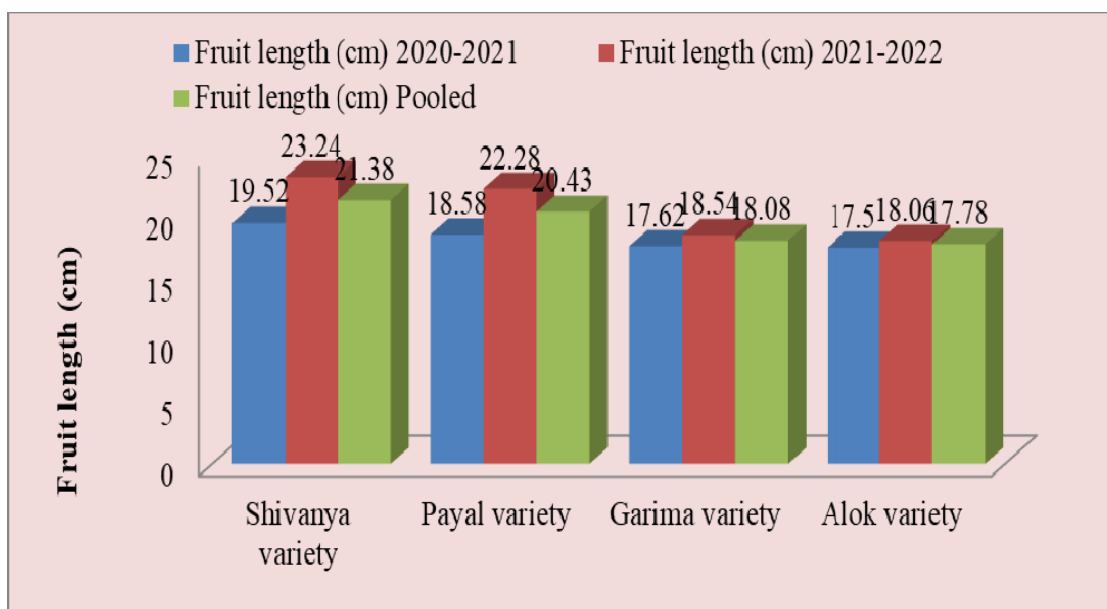


Figure 13: Performance of different varieties on fruit length of *Luffa cylindrica* L.

4.1.14 Fruit diameter (mm)

The data pertaining to fruit diameter presented in Table 4.14 indicated that among all 4 varieties, in year of 2020-2021 Payal variety had maximum fruit diameter (27.42mm) followed by Shivanya (26.36mm) and Alok (24.52mm). However, Garima variety had minimum diameter of fruit (23.54mm). On the other hand, in year of 2021-2022 the diameter of fruit was more in Payal variety (26.52mm) followed by Shivanya (25.66mm) and Alok (23.62mm). However, Garima variety had less diameter (22.66mm). The data showed the significant variation in all four

varieties.

Moreover, it is vividly seen in pooled data Payal variety had maximum diameter of fruits. In contrast, Garima variety had minimum diameter. The increased in fruit length and diameter seems to be due to the increased nutritional level to the vines and increased levels of synthesis of chlorophyll & amino acids (Joshi *et al.*, 2004). The present results are in conformity to the findings of Chen *et al.*, 2014; Kumar *et al.*, 2014.

Table 4.14: Performance of different varieties on fruit diameter of *Luffa cylindrica* L.

Varieties	Fruit diameter (mm)		
	2020-2021	2021-2022	Pooled
Shivanya	26.36	25.66	26.01
Payal	27.42	26.52	26.97
Garima	23.54	22.66	23.10
Alok	24.52	23.62	24.07
CD ($p \leq 0.05$)	0.31	0.21	0.27
CV (%)	0.93	0.64	0.82

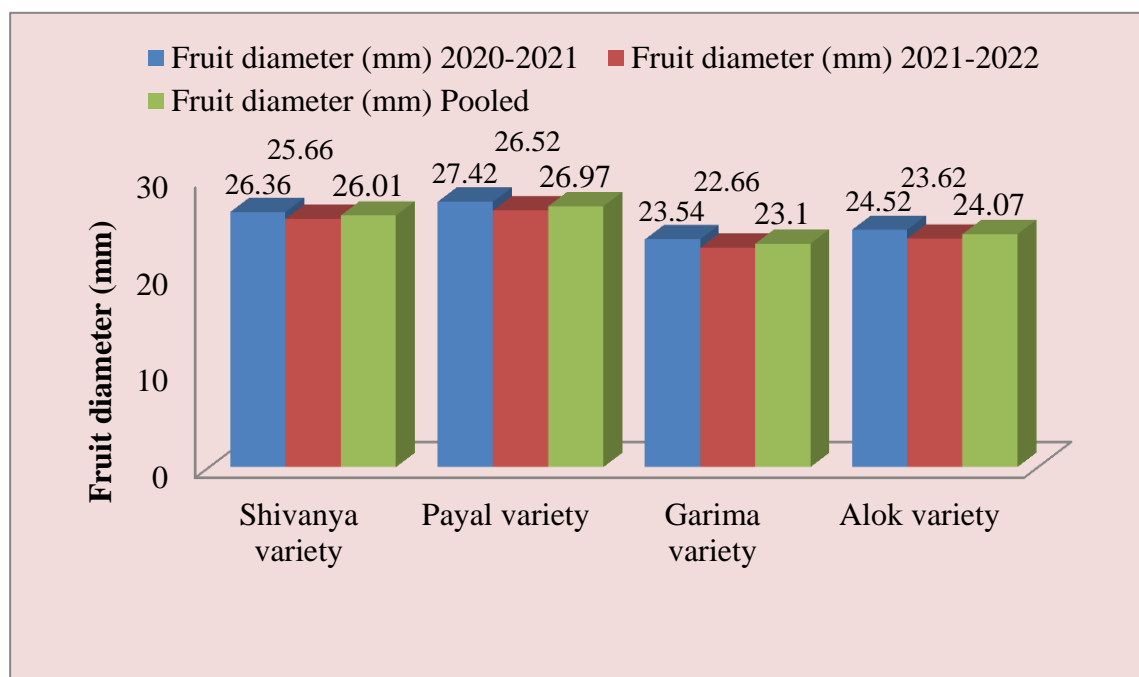


Figure 14. Performance of different varieties on fruit diameter of *Luffa cylindrica* L.

4.2 Physio chemical Parameters

4.2.1 pH

The data related to pH is represented in Table 4.15 each of the four varieties has its own distinct values, in 2020-2021 Shivanya variety had maximum pH (5.30) followed by Payal variety (5.31) In contrary, Garima variety and Alok variety had minimum pH (5.27). On the other hand, in year of 2021-2022 Shivanya variety had maximum pH (6.64) followed by Payal variety (6.64), Garima variety (6.28). However, Alok variety had minimum value (6.24). The data showed in table is significantly different.

Additionally, it is shown in pooled data Shivanya variety has least pH. In contrast, Garmia variety had maximum pH. It can be because of genetic variations among varieties. These results are in accordance with the results of Ighalo *et al.*, 2021; Anastopoulos and Pashalidis, 2020.

Table 4.15: Performance of different varieties on pH of *Luffa cylindrica* L.

Varieties	pH		
	2020-2021	2021-2022	Pooled
Shivanya	5.27	6.28	5.77
Payal	5.31	6.24	5.77
Garima	5.32	6.78	6.05
Alok	5.30	6.64	5.97
CD ($p \leq 0.05$)	0.04	0.13	0.07
CV (%)	0.48	1.15	0.63

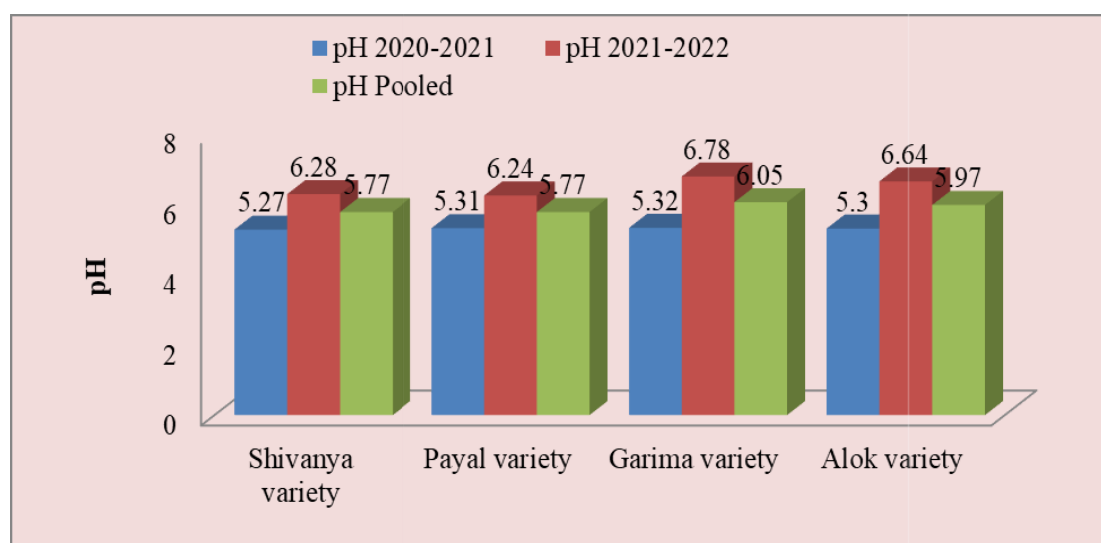


Figure 15: Performance of different varieties on pH of *Luffa cylindrica* L.

4.2.2 TSS (°B)

The TSS in degree Brix presented in Table 4.16 described that various varieties had non-significant variation in year of 2020-2021 and significant variation in 2021-2022. Firstly, in the year of 2020-2021 Shivanya (3.63°B) and Payal variety (3.59°B) had maximum TSS after that Alok variety (3.55°B), whereas, Garima variety recorded minimum value (3.26°B).

Secondly, in 2021-2022 year, the more total soluble solids were observed in Shivanya (2.63°B) and Payal variety (2.63°B). In comparison of other varieties, the highest TSS of 3.13°B was observed in Alok & lowest TSS of 2.88 in Shivanya.

The variation in total soluble solid content of different varieties might be due to the inherent genetic behaviour make-up of the variety. These results are corroborated with the observations of Thakur and Das, 2021 and Hajra *et al.*, 2013.

Table 4.16: Performance of different varieties on TSS of *Luffa cylindrica* L.

Varieties	TSS (°B)		
	2020-2021	2021-2022	Pooled
Shivanya	3.55	2.22	2.88
Payal	3.59	2.19	2.89
Garima	3.26	2.63	2.94
Alok	3.63	2.63	3.13
CD (p≤0.05)	0.44	0.13	0.26
CV (%)	7.02	3.02	4.87

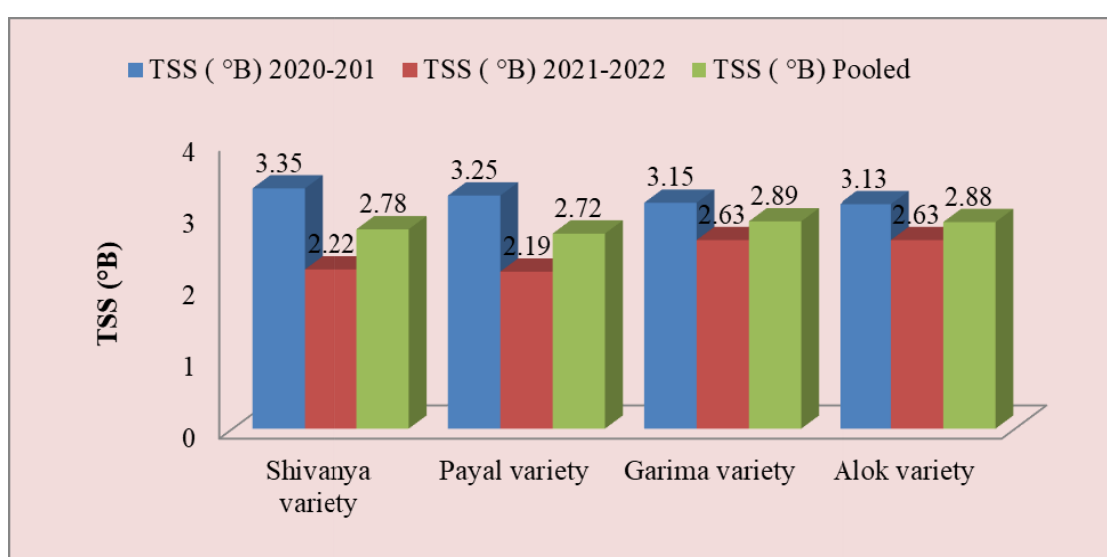


Figure 16: Performance of different varieties on TSS of *Luffa cylindrica* L.

4.2.3 Ascorbic acid (mg/100g)

The ascorbic acid in Table 4.17 elaborated significant variation in four different varieties in year of 2020-2021, 2021-2022 and their pooled. First and foremost, in the year of 2020-2021, the maximum ascorbic acid was shown in Shivanya(34.47mg) followed by Payal (34.46mg) and Garima variety (34.24mg). While the minimum ascorbic acid was observed in Alok variety (34.03mg) and turning to other year 2021-2022, highest ascorbic acid (36.75mg) was present in Shivanya variety followed by Payal variety (36.59mg), Garima variety (36.19mg) and minimum values were recorded in Alok variety (36.24mg).

Furthermore, it is vividly seen in pooled data Shivanya variety had more ascorbic acid and Alok variety had less in comparison of other varieties. This can be due to variation in genetic evaluation of different varieties. These results are in accordance with the significant effect of ascorbic acid on luffa as documented by Azeez *et al.*, 2013 and Du *et al.*, 2006.

Table 4.17: Performance of different varieties on ascorbic acid of *Luffa cylindrica* L.

Varieties	Ascorbic acid (mg/100gm FW)		
	2020-2021	2021-2022	Pooled
Shivanya	34.47	36.19	35.33
Payal	34.24	36.24	35.24
Garima	34.46	36.75	35.60
Alok	34.03	36.59	35.52
CD (p≤0.05)	0.28	0.17	0.13
CV (%)	0.46	0.26	0.20

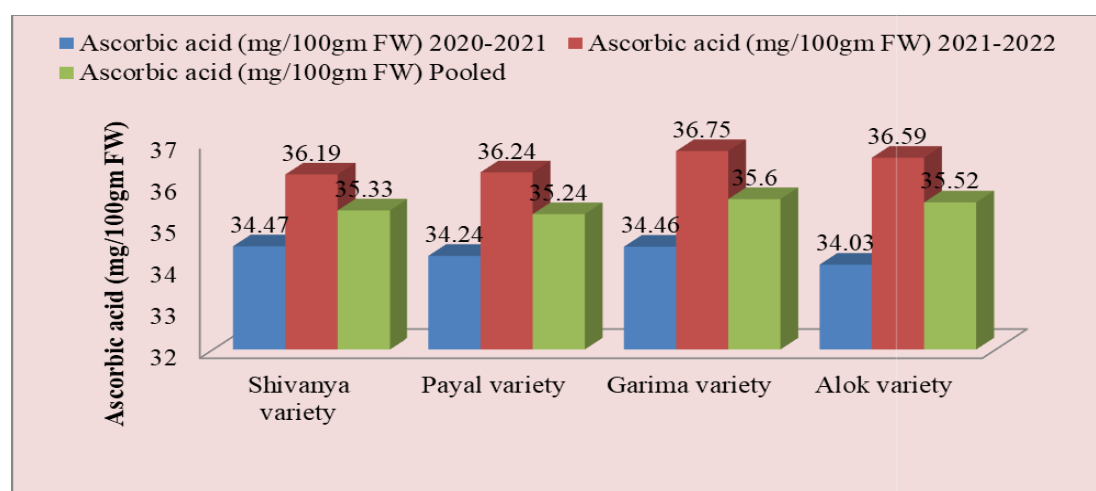


Figure 17: Performance of different varieties on ascorbic acid of *Luffa cylindrica* L.

4.2.4 Moisture content (%)

The data related to moisture content (%) is represented in Table 4.18, each of the four varieties has its own different values, in 2020-2021 Shivanya variety had maximum moisture content (96.97%) followed by Payal variety (95.27%), Alok variety (94.67%). In contrary, Garima variety had minimum moisture content (94.40%). On the other hand, in year of 2021-2022 Shivanya variety had more moisture content (93.37%) followed by Payal variety (93.43%), Garima variety (93.40%). However, Alok variety had minimum moisture content (93.0). The data showed in table is non significantly different.

Moreover, it is clearly seen in pooled data Shivanya variety had maximum moisture content. In contrast, Alok variety had moisture content. The result from present statement was in confirmation with the findings of Ogunyemi *et al.*, 2020; Saw *et al.*, 2013.

Table 4.18: Performance of different varieties on moisture content of *Luffa cylindrica* L.

Varieties	Moisture content (%)		
	2020-2021	2021-2022	Pooled
Shivanya	96.97	93.0	94.98
Payal	95.23	93.43	94.33
Garima	94.40	95.37	94.88
Alok	93.93	93.40	93.66
CD (p≤0.05)	3.58	3.29	1.80
CV (%)	2.10	1.95	1.06

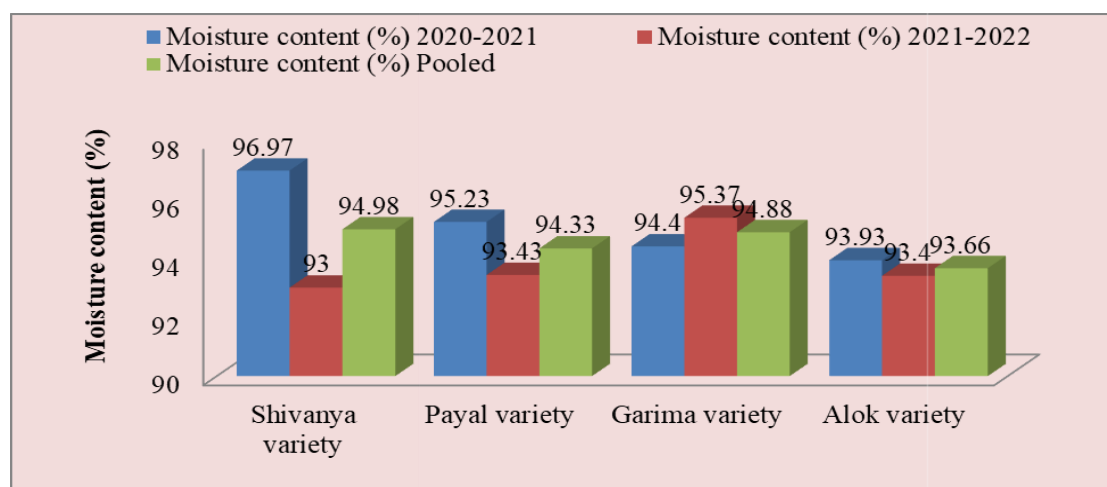


Figure 18: Performance of different varieties on moisture content of *Luffa cylindrica* L.

4.2.5 DPPH (mg/100g)

The data related to DPPH in mg/100g represented in Table 4.19 among all 4 varieties, in year of 2020-2021 maximum antioxidant activity was observed in Shivanya variety (80.40mg) followed by Payal variety (79.31mg), Alok variety (78.56mg) and minimum value for dpph in Garima variety was observed (78.37mg). Whereas in year of 2021-2022, Shivanya variety had maximum antioxidant activity (81.31mg), followed by Payal variety (80.11mg), Garima variety (77.98mg) while, least average antioxidant activity was seen in Alok variety (78.27mg).

Moreover, pooled data showed Shivanya variety had higher antioxidant activity (80.85mg) and Alok variety and Garima had lower antioxidant activity (78.41mg). It might be due to change in genetic makeup among different varieties. The result from present statement was in confirmation with the findings of Tripathi *et al.*, 2016; Raut *et al.*, 2021.

Table 4.19: Performance of different varieties on DPPH of *Luffa cylindrica* L.

Varieties	DPPH (mg/100g)		
	2020-2021	2021-2022	Pooled
Shivanya	80.40	81.31	80.85
Payal	79.31	80.11	79.71
Garima	78.37	77.98	78.17
Alok	78.56	78.27	78.41
CD ($p \leq 0.05$)	0.47	1.63	0.68
CV (%)	0.33	1.14	0.48

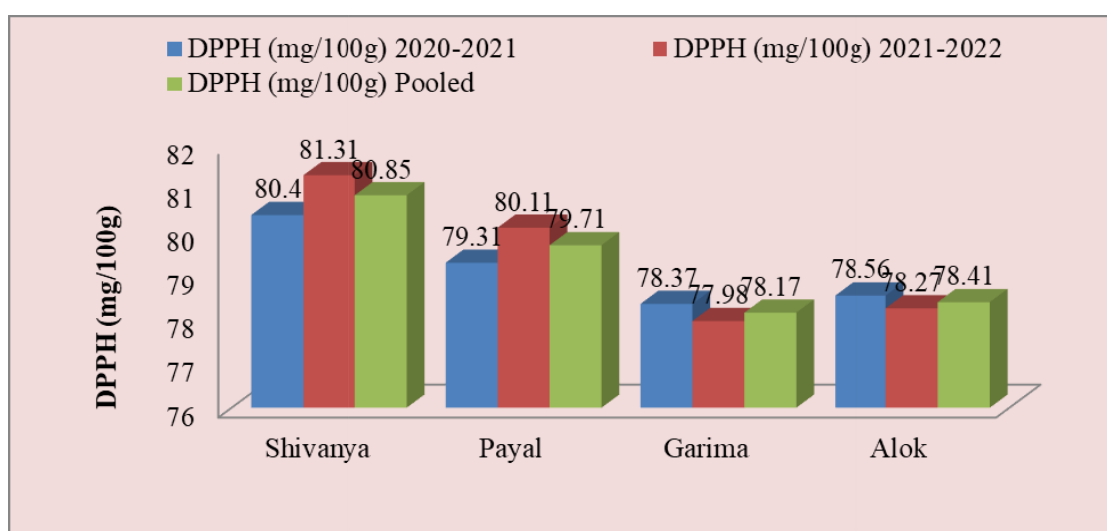


Figure 19: Performance of different varieties on DPPH of *Luffa cylindrica* L.

4.2.6 Acidity (%):

The data presented to acidity represented in Table 4.20 Among all 4 varieties, in year of 2020-2021 Shivanya variety had maximum fruit diameter (0.63%) followed by Payal variety (0.62%). However, Garima variety and Alok variety had minimum acidity (0.61%). On the other hand, in year of 2021-2022 the acidity was more in Shivanya variety (0.76%) followed by Payal variety (0.72%), Garima variety (0.53%). However, Alok variety had less acidity (0.52%). The data showed the significant variation in all four varieties in 2021-2022 and pooled. In contrast, the 2020-2021 data showed insignificant variation.

Moreover, it is shown in figure 20 pooled data Shivanya variety had maximum acidity. On the contrary, Garima variety had minimum acidity. This might be due to genetic variations. The result from present statement was in confirmation with the findings of Azeez *et al.*, 2013; Lucy and Abidemi, 2012.

Table 4.20: Performance of different varieties on acidity of *Luffa cylindrica* L.

Varieties	Acidity (%)		
	2020-2021	2021-2022	Pooled
Shivanya	0.62	0.76	0.69
Payal	0.62	0.72	0.67
Garima	0.63	0.53	0.58
Alok	0.62	0.52	0.57
CD (p≤0.05)	0.02	0.04	0.03
CV (%)	2.09	3.50	2.44

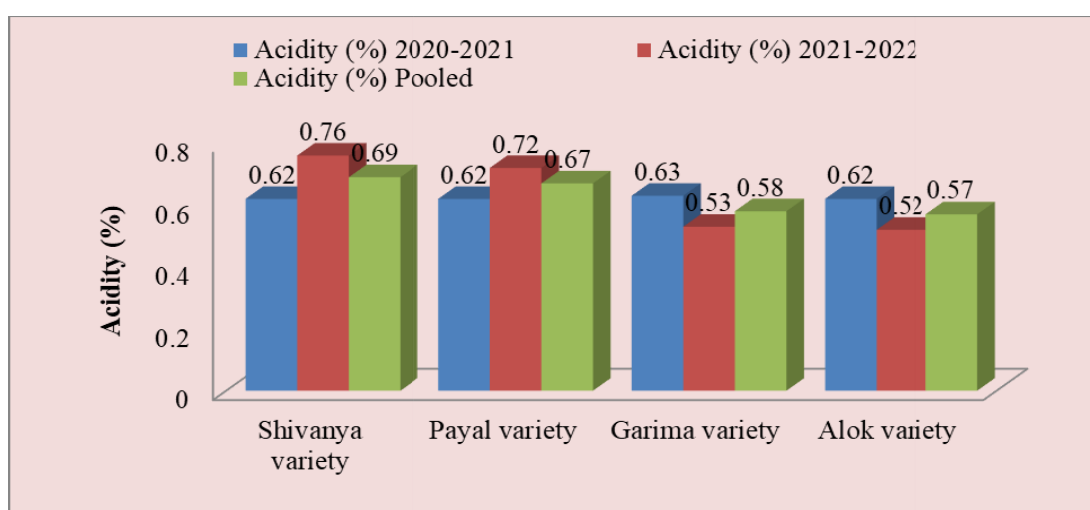


Figure 20: Performance of different varieties on acidity of *Luffa cylindrica* L.

4.2.7 Pulp peel ratio:

The data related to pulp peel ratio is represented in Table 4.21 each of the four varieties has its own distinct values, in 2020-2021 Shivanya variety had maximum pulp peel ratio (7.74) followed by Payal variety (6.34), Alok variety (6.32). In contrary, Garima variety had minimum pulp peel ratio (6.28). On the other hand, in year of 2021-2022 Shivanya variety had maximum pulp peel ratio (8.41) followed by Payal variety (7.49), Garima variety (6.65). However, Alok variety had minimum value (6.64). The data showed in table is significantly different.

Additionally, it is clearly seen in pooled data Shivanya variety had more pulp peel ratio. In contrast, Garima variety had least. The similar results were found by Kao *et al.*, 2012; Verma *et al.*, 2018.

Table 4.21: Performance of different varieties on pulp peel ratio of *Luffa cylindrica*:

Varieties	Pulp peel ratio		
	2020-2021	2021-2022	Pooled
Shivanya	7.34	8.41	7.87
Payal	6.32	7.49	6.90
Garima	6.28	6.65	6.46
Alok	6.34	6.64	6.49
CD ($p \leq 0.05$)	0.05	1.08	0.53
CV (%)	0.42	8.09	4.21

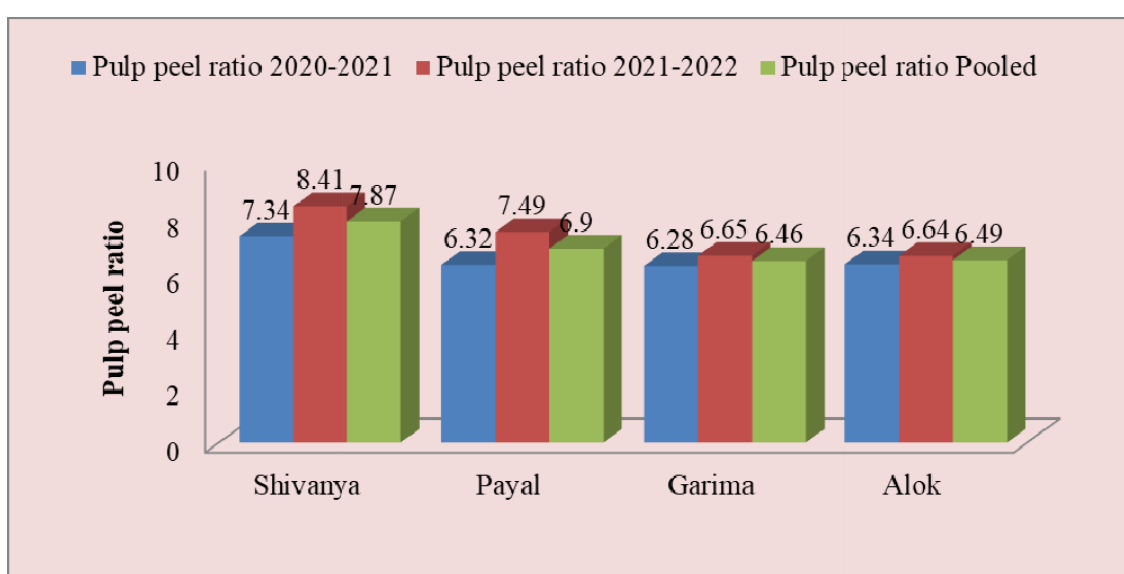


Figure 21: Performance of different varieties on pulp peel ratio of *Luffa cylindrica* L.

4.2.8 Phenolic (mg/100g):

The Phenolic is presented in Table 4.22 described that various varieties had significant variation in year of 2020-2021 and 2021-2022.

Firstly, in the year of 2020-2021 Shivanya variety (10.51mg) had phytochemical activity after that Payal variety (9.44mg). Whereas, Garima variety and Alok variety recorded minimum value (9.34mg). Secondly, in 2021-2022 year, the more phenolics were observed in Shivanya variety (10.68mg) and Payal variety (10.44mg) followed by Alok variety (9.76mg). In comparison of other varieties Garima variety (8.38mg) had less phenolics.

In addition, it is clear from table 4.2.2 and figure 22 Shivanya and Payal variety had maximum phenolics, while other had minimum. The result from present statement was in confirmation with the findings of Umehara *et al.*, 2018; Yadav *et al.*, 2017.

Table 4.22: Performance of different varieties on phenolic content of *Luffa cylindrica*:

Varieties	Phenolic (mg/gm)		
	2020-2021	2021-2022	Pooled
Shivanya	10.51	10.68	10.59
Payal	9.34	10.44	9.89
Garima	9.34	8.38	8.86
Alok	9.44	9.76	9.60
CD (p≤0.05)	0.39	0.56	0.43
CV (%)	2.26	3.17	2.45

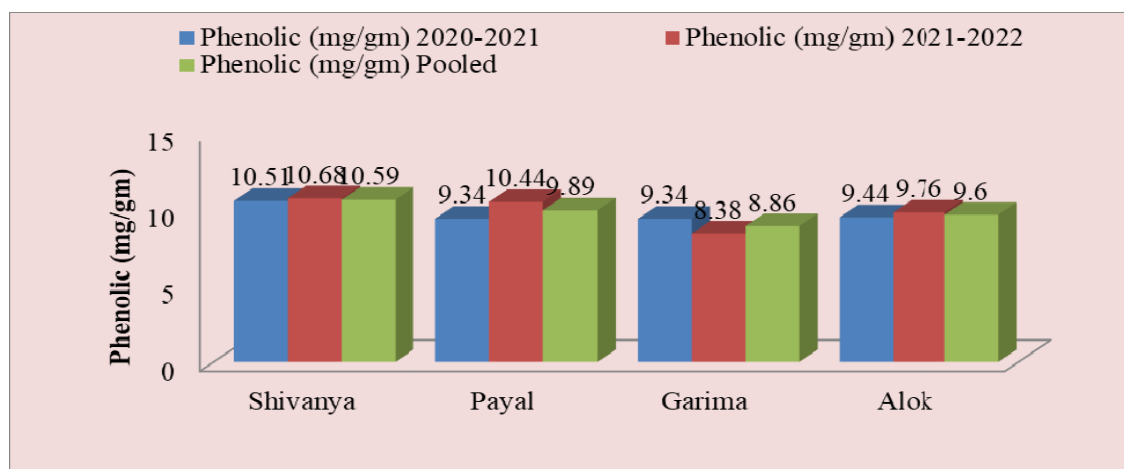


Figure 22: Performance of different varieties on phenolic content of *Luffa cylindrica* L.

Experiment: 2 Study of physiochemical analysis of post-edible coating application effect on sponge gourd.

4.3 Physiological Parameters

4.3.1 Physiological loss in weight

The physiological loss of weight in luffa was reported in Table 4.23(e) described that different varieties had significant variation in the year of 2021-2022. The effect on 4 different varieties including shivanya, payal, alok, and garima data was presented in Figure 23. Firstly in the year 2021 it had been seen that shivanya and payal varieties showed less loss in weight whereas the varieties alok and garima defined more physiological loss in weight. In 2021 the shivanya and payal varieties defined less loss in weight in T4 (5.329%) and (5.312%) as compared to garima and alok varieties. Similarly, in 2022 data shivanya and payal varieties had less physiological loss in weight in T4 (5.318%) and (5.298%) as compared to alok and garima varieties. Control treatment had more loss in weight. In treatments T5 and T6, it had been observed that more loss in weight was due to an increase in the concentration of chitosan (1 %) which causes a barrier on vegetables and produce has no more pores left for respiration process and it causes produce to lose more moisture.

Furthermore, it had been evaluated that shivanya and payal variety had less physiological loss in weight as compared to other varieties less than 10 days of refrigerator conditions. The water present in vegetables starts evaporating with time causing produce to lose its water content and ultimately lose physical weight. The less loss in weight was due to the addition of chitosan as coating material. This may also be because Chitosan acts as a barrier against the outer environment and doesn't allow any microbes and outer hindrance. The chitosan coating provides a transparent smooth layer on the surface of the fruit and provides an effective physical barrier to avoid more respiration and transpiration losses during storage (Han *et al.*, 2014). The pooled data of treatment T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) also had less physiological loss in weight in garima and alok varieties but shivanya and payal varieties had more effect. These results defined that the control treatment had more loss in physiological weight. The addition of aloe vera provides good moisture to vegetable and avoids hindrance to microbes. The mint also adds

flavor to the coating and provides a good barrier to the outer environment. Similar results had been procured from Han *et al.*, (2014) and Gedam and Dongre, (2016).

Table 4.23(a): Effect of different treatments on physiological loss in weight (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Physiological loss in weight (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	2.637	6.457	7.650	9.460	12.447	6.442	0.000	2.620	6.390	7.623	9.433	12.407	6.412
T1	0.000	2.007	5.687	6.497	8.460	10.463	5.519	0.000	1.980	5.653	6.470	8.420	10.430	5.492
T2	0.000	1.977	5.643	6.370	8.333	10.370	5.449	0.000	1.963	5.620	6.337	8.310	10.347	5.429
T3	0.000	1.867	5.477	6.333	8.303	10.277	5.376	0.000	1.827	5.457	6.313	8.280	10.257	5.356
T4	0.000	1.823	5.423	6.270	8.230	10.230	5.329	0.000	1.793	5.407	6.247	8.217	10.207	5.312
T5	0.000	2.230	5.860	6.563	8.543	10.570	5.628	0.000	2.197	5.827	6.527	8.513	10.543	5.601
T6	0.000	2.103	5.767	6.600	8.543	10.686	5.573	0.000	2.150	5.790	6.500	8.437	10.403	5.547
Mean	0.000	2.103	5.767	6.600	8.543	10.686		0.000	2.076	5.735	6.574	8.516	10.656	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.017	0.009	0.006	0.000			Factor (Treatments)	0.018	0.009	0.006	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.017	0.008	0.006	0.000		
	Factor (T × D)	0.042	0.021	0.015	0.000			Factor (T × D)	0.044	0.022	0.016	0.000		

Table 4.23(b): Effect of different treatments on physiological loss in weight (%) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Physiological loss in weight (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	2.730	6.523	7.687	9.510	12.490	6.490	0.000	2.753	6.570	7.657	9.477	12.473	6.488
T1	0.000	2.013	5.697	6.507	8.483	10.473	5.529	0.000	2.037	5.727	6.530	8.527	10.487	5.551
T2	0.000	1.983	5.677	6.377	8.347	10.407	5.465	0.000	2.023	5.720	6.417	8.417	10.423	5.500
T3	0.000	1.883	5.503	6.373	8.293	10.297	5.392	0.000	1.927	5.523	6.400	8.333	10.333	5.419
T4	0.000	1.820	5.450	6.273	8.253	10.237	5.339	0.000	1.867	5.487	6.307	8.300	10.267	5.371
T5	0.000	2.230	5.887	6.567	8.560	10.567	5.635	0.000	2.280	5.930	6.590	8.600	10.583	5.664
T6	0.000	2.173	5.830	6.533	8.473	10.473	5.581	0.000	2.207	5.840	6.580	8.513	10.487	5.604
Mean	0.000	2.119	5.795	6.617	8.560	10.706		0.000	2.156	5.828	6.640	8.595	10.722	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.017	0.009	0.006	0.000			Factor (Treatments)	0.015	0.008	0.005	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.014	0.007	0.005	0.000		
	Factor (T × D)	0.042	0.021	0.015	0.000			Factor (T × D)	0.038	0.019	0.013	0.000		

Table 4.23(c): Effect of different treatments on physiological loss in weight (%) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Physiological loss in weight (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	2.637	6.457	7.650	9.460	12.447	6.442	0.000	2.620	6.390	7.623	9.433	12.407	6.412
T1	0.000	2.007	5.687	6.497	8.460	10.463	5.519	0.000	1.980	5.653	6.470	8.420	10.430	5.492
T2	0.000	1.977	5.643	6.370	8.333	10.370	5.449	0.000	1.963	5.620	6.337	8.310	10.347	5.429
T3	0.000	1.867	5.477	6.333	8.303	10.277	5.376	0.000	1.827	5.457	6.313	8.280	10.257	5.356
T4	0.000	1.823	5.423	6.270	8.230	10.230	5.329	0.000	1.793	5.407	6.247	8.217	10.207	5.312
T5	0.000	2.230	5.860	6.563	8.543	10.570	5.628	0.000	2.197	5.827	6.527	8.513	10.543	5.601
T6	0.000	2.103	5.767	6.600	8.543	10.686	5.573	0.000	2.150	5.790	6.500	8.437	10.403	5.547
Mean	0.000	2.103	5.767	6.600	8.543	10.686		0.000	2.076	5.735	6.574	8.516	10.656	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.017	0.009	0.006	0.000			Factor (Treatments)	0.018	0.009	0.006	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.017	0.008	0.006	0.000		
	Factor (T × D)	0.042	0.021	0.015	0.000			Factor (T × D)	0.044	0.022	0.016	0.000		

Table 4.23(d): Effect of different treatments on physiological loss in weight (%) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of spongegourd and their interaction among treatments and days during 2021-2022.

Treatments	Physiological loss in weight (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	2.730	6.523	7.687	9.510	12.490	6.490	0.000	2.753	6.570	7.657	9.477	12.473	6.488
T1	0.000	2.013	5.697	6.507	8.483	10.473	5.529	0.000	2.037	5.727	6.530	8.527	10.487	5.551
T2	0.000	1.983	5.677	6.377	8.347	10.407	5.465	0.000	2.023	5.720	6.417	8.417	10.423	5.500
T3	0.000	1.883	5.503	6.373	8.293	10.297	5.392	0.000	1.927	5.523	6.400	8.333	10.333	5.419
T4	0.000	1.820	5.450	6.273	8.253	10.237	5.339	0.000	1.867	5.487	6.307	8.300	10.267	5.371
T5	0.000	2.230	5.887	6.567	8.560	10.567	5.635	0.000	2.280	5.930	6.590	8.600	10.583	5.664
T6	0.000	2.173	5.830	6.533	8.473	10.473	5.581	0.000	2.207	5.840	6.580	8.513	10.487	5.604
Mean	0.000	2.119	5.795	6.617	8.560	10.706		0.000	2.156	5.828	6.640	8.595	10.722	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.017	0.009	0.006	0.000			Factor (Treatments)	0.015	0.008	0.005	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.014	0.007	0.005	0.000		
	Factor (T × D)	0.042	0.021	0.015	0.000			Factor (T × D)	0.038	0.019	0.013	0.000		

Table 4.23(e): Average effect of different treatments on physiological loss in weight (%) after 10 days storage in different varieties of sponge gourd.

Treatments	Physiological loss in weight (%)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	6.442	6.402	6.422	6.412	6.384	6.398	6.490	6.454	6.472	6.488	6.463	6.475
T₁	5.519	5.482	5.500	5.492	5.469	5.480	5.529	5.487	5.508	5.551	5.524	5.537
T₂	5.449	5.423	5.436	5.429	5.413	5.421	5.465	5.424	5.444	5.500	5.464	5.482
T₃	5.376	5.347	5.361	5.356	5.336	5.346	5.392	5.355	5.373	5.419	5.392	5.405
T₄	5.329	5.318	5.323	5.312	5.298	5.305	5.339	5.317	5.328	5.371	5.345	5.358
T₅	5.628	5.598	5.613	5.601	5.564	5.582	5.635	5.597	5.616	5.664	5.635	5.649
T₆	5.573	5.539	5.556	5.547	5.522	5.534	5.581	5.550	5.565	5.604	5.576	5.590
CD (p≤0.05)	0.042	0.047	0.044	0.044	0.039	0.041	0.042	0.034	0.038	0.038	0.051	0.044

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆=Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

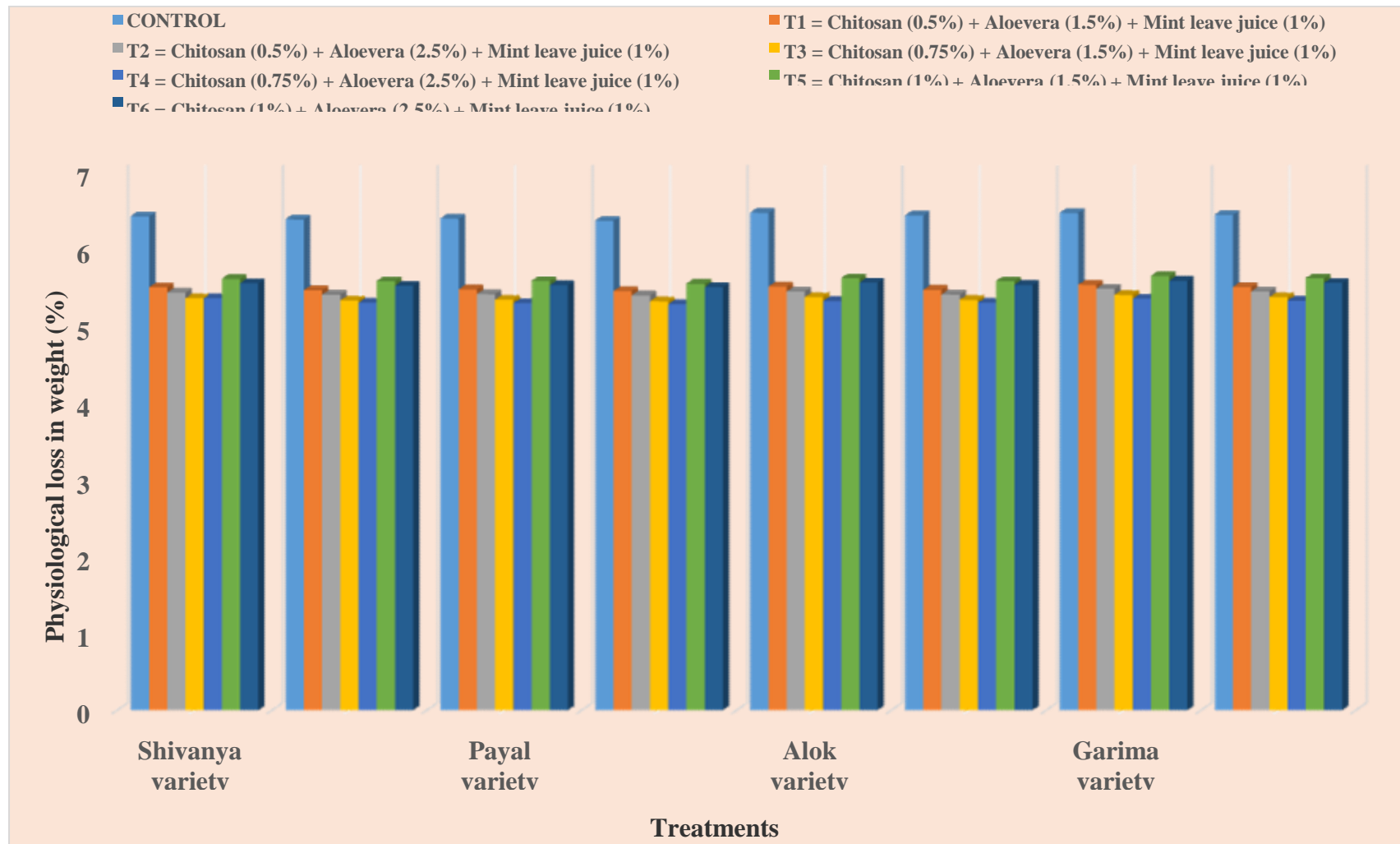


Figure 23: Effect of different treatments on physiological loss in weight (%) after 10 days storage in sponge gourd.

4.3.2 Decay loss (%)

The decay loss in luffa was elaborated in Table 4.24(e) defines that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 24. Firstly in the year 2021 it had been seen that shivanya and payal varieties had less decay loss of 1.521% and 1.532% when compared to garima and alok varieties. Control treatment had more decay loss as compared to treated produce.

Similarly, it had been investigated in second year that Shivanya and Payal showed 1.494 % & 1.511 % less decay whereas the varieties alok and garima defined more decay loss. This can be because the water present in vegetables starts to evaporate with the passage of time and causes produce got deteriorated. Decay loss was due to the deterioration of microbes and causes physical and biochemical changes in produce. The less decay loss was due to the addition of chitosan + aloe vera + mint as coating material. Chitosan acts as a barrier against the outer environment and avoids any microbes' proliferation (Kerch, 2015). These results defined that the control treatment had more decay loss. The incorporation of aloe vera provides good moisture and avoids hindrance to microbes. The mint provides a good barrier to the surface of produce. These results are also defined by authors Seedao *et al.*, (2018) and Han *et al.*, (2014).

Table 4.24(a): Effect of different treatments on decay loss (%) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Decay loss (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	0.093	1.353	1.537	2.340	4.567	1.648	0.000	0.413	1.377	1.593	2.387	4.590	1.727
T1	0.000	0.000	1.260	1.457	2.287	4.523	1.588	0.000	0.000	1.273	1.473	2.307	4.533	1.598
T2	0.000	0.000	1.223	1.427	2.253	4.463	1.561	0.000	0.000	1.233	1.417	2.267	4.487	1.567
T3	0.000	0.000	1.210	1.400	2.193	4.423	1.538	0.000	0.000	1.210	1.410	2.203	4.473	1.549
T4	0.000	0.000	1.183	1.380	2.177	4.387	1.521	0.000	0.000	1.190	1.397	2.193	4.410	1.532
T5	0.000	0.070	1.283	1.470	2.320	4.557	1.617	0.000	0.077	1.300	1.497	2.367	4.557	1.633
T6	0.000	3.363	1.257	1.457	2.303	4.510	2.148	0.000	0.067	1.277	1.463	2.343	4.530	1.613
Mean	0.000	0.504	1.253	1.447	2.268	4.490		0.000	0.080	1.266	1.464	2.295	4.511	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	N/A	0.296	0.209	0.366			Factor (Treatments)	0.064	0.032	0.023	0.000		
	Factor (Days)	0.545	0.274	0.194	0.000			Factor (Days)	0.059	0.030	0.021	0.000		
	Factor (T × D)	N/A	0.724	0.512	0.476			Factor (T × D)	N/A	0.079	0.056	0.500		

Table 4.24(b): Effect of different treatments on decay loss (%) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Decay loss (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	0.163	1.463	1.650	2.433	4.647	1.726	0.000	0.180	1.513	1.740	2.493	4.687	1.769
T1	0.000	0.090	1.363	1.573	2.390	4.587	1.667	0.000	0.097	1.427	1.663	2.463	4.647	1.716
T2	0.000	0.073	1.283	1.527	2.357	4.553	1.632	0.000	0.083	1.387	1.613	2.413	4.607	1.684
T3	0.000	0.063	1.263	1.483	2.327	4.523	1.610	0.000	0.057	1.377	1.583	2.390	4.567	1.662
T4	0.000	0.050	1.233	1.427	2.290	4.483	1.581	0.000	0.053	1.337	1.530	2.347	4.530	1.633
T5	0.000	0.123	1.413	1.593	2.400	4.600	1.688	0.000	0.110	1.453	1.693	2.480	4.667	1.734
T6	0.000	0.113	1.393	1.563	2.373	4.567	1.668	0.000	0.107	1.433	1.663	2.443	4.630	1.713
Mean	0.000	0.097	1.345	1.545	2.367	4.566		0.000	0.098	1.418	1.641	2.433	4.619	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significa nce		
	Factor (Treat ments)	0.025	0.013	0.009	0.000			Factor (Treatmen ts)	0.026	0.013	0.009	0.000		
	Factor (Days)	0.024	0.012	0.008	0.000			Factor (Days)	0.024	0.012	0.009	0.000		
	Factor (T × D)	0.062	0.031	0.022	0.006			Factor (T × D)	N/A	0.032	0.023	0.138		

Table 4.24(c): Effect of different treatments on decay loss (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Decay loss (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	0.093	1.353	1.537	2.340	4.567	1.648	0.000	0.413	1.377	1.593	2.387	4.590	1.727
T1	0.000	0.000	1.260	1.457	2.287	4.523	1.588	0.000	0.000	1.273	1.473	2.307	4.533	1.598
T2	0.000	0.000	1.223	1.427	2.253	4.463	1.561	0.000	0.000	1.233	1.417	2.267	4.487	1.567
T3	0.000	0.000	1.210	1.400	2.193	4.423	1.538	0.000	0.000	1.210	1.410	2.203	4.473	1.549
T4	0.000	0.000	1.183	1.380	2.177	4.387	1.521	0.000	0.000	1.190	1.397	2.193	4.410	1.532
T5	0.000	0.070	1.283	1.470	2.320	4.557	1.617	0.000	0.077	1.300	1.497	2.367	4.557	1.633
T6	0.000	3.363	1.257	1.457	2.303	4.510	2.148	0.000	0.067	1.277	1.463	2.343	4.530	1.613
Mean	0.000	0.504	1.253	1.447	2.268	4.490		0.000	0.080	1.266	1.464	2.295	4.511	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	N/A	0.296	0.209	0.366			Factor (Treat ments)	0.064	0.032	0.023	0.000		
	Factor (Days)	0.545	0.274	0.194	0.000			Factor (Days)	0.059	0.030	0.021	0.000		
	Factor (T × D)	N/A	0.724	0.512	0.476			Factor (T × D)	N/A	0.079	0.056	0.500		

Table 4.24(d): Effect of different treatments on decay loss (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Decay loss (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.000	0.163	1.463	1.650	2.433	4.647	1.726	0.000	0.180	1.513	1.740	2.493	4.687	1.769
T1	0.000	0.090	1.363	1.573	2.390	4.587	1.667	0.000	0.097	1.427	1.663	2.463	4.647	1.716
T2	0.000	0.073	1.283	1.527	2.357	4.553	1.632	0.000	0.083	1.387	1.613	2.413	4.607	1.684
T3	0.000	0.063	1.263	1.483	2.327	4.523	1.610	0.000	0.057	1.377	1.583	2.390	4.567	1.662
T4	0.000	0.050	1.233	1.427	2.290	4.483	1.581	0.000	0.053	1.337	1.530	2.347	4.530	1.633
T5	0.000	0.123	1.413	1.593	2.400	4.600	1.688	0.000	0.110	1.453	1.693	2.480	4.667	1.734
T6	0.000	0.113	1.393	1.563	2.373	4.567	1.668	0.000	0.107	1.433	1.663	2.443	4.630	1.713
Mean	0.000	0.097	1.345	1.545	2.367	4.566		0.000	0.098	1.418	1.641	2.433	4.619	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.025	0.013	0.009	0.000			Factor (Treatments)	0.026	0.013	0.009	0.000		
	Factor (Days)	0.024	0.012	0.008	0.000			Factor (Days)	0.024	0.012	0.009	0.000		
	Factor (T × D)	0.062	0.031	0.022	0.006			Factor (T × D)	N/A	0.032	0.023	0.138		

Table 4.24(e) : Average effect of different treatments on decay loss (%) after 10 days storage in different varieties of sponge gourd.

Treatments	Decay loss (%)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	1.648	1.621	1.634	1.727	1.639	1.683	1.726	1.704	1.715	1.769	1.778	1.773
T₁	1.588	1.571	1.579	1.598	1.576	1.577	1.667	1.642	1.654	1.716	1.719	1.717
T₂	1.561	1.536	1.548	1.567	1.559	1.563	1.632	1.607	1.619	1.684	1.691	1.687
T₃	1.538	1.520	1.529	1.549	1.538	1.543	1.610	1.602	1.606	1.662	1.652	1.657
T₄	1.521	1.494	1.507	1.532	1.511	1.521	1.581	1.569	1.575	1.633	1.623	1.628
T₅	1.617	1.585	1.601	1.633	1.611	1.622	1.688	1.678	1.683	1.734	1.706	1.720
T₆	2.148	1.566	1.857	1.613	1.583	1.598	1.668	1.652	1.660	1.713	1.692	1.702
CD (p≤0.05)	N/A	0.035	0.035	N/A	0.036	0.036	0.062	0.056	0.059	N/A	0.061	0.061

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ =Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

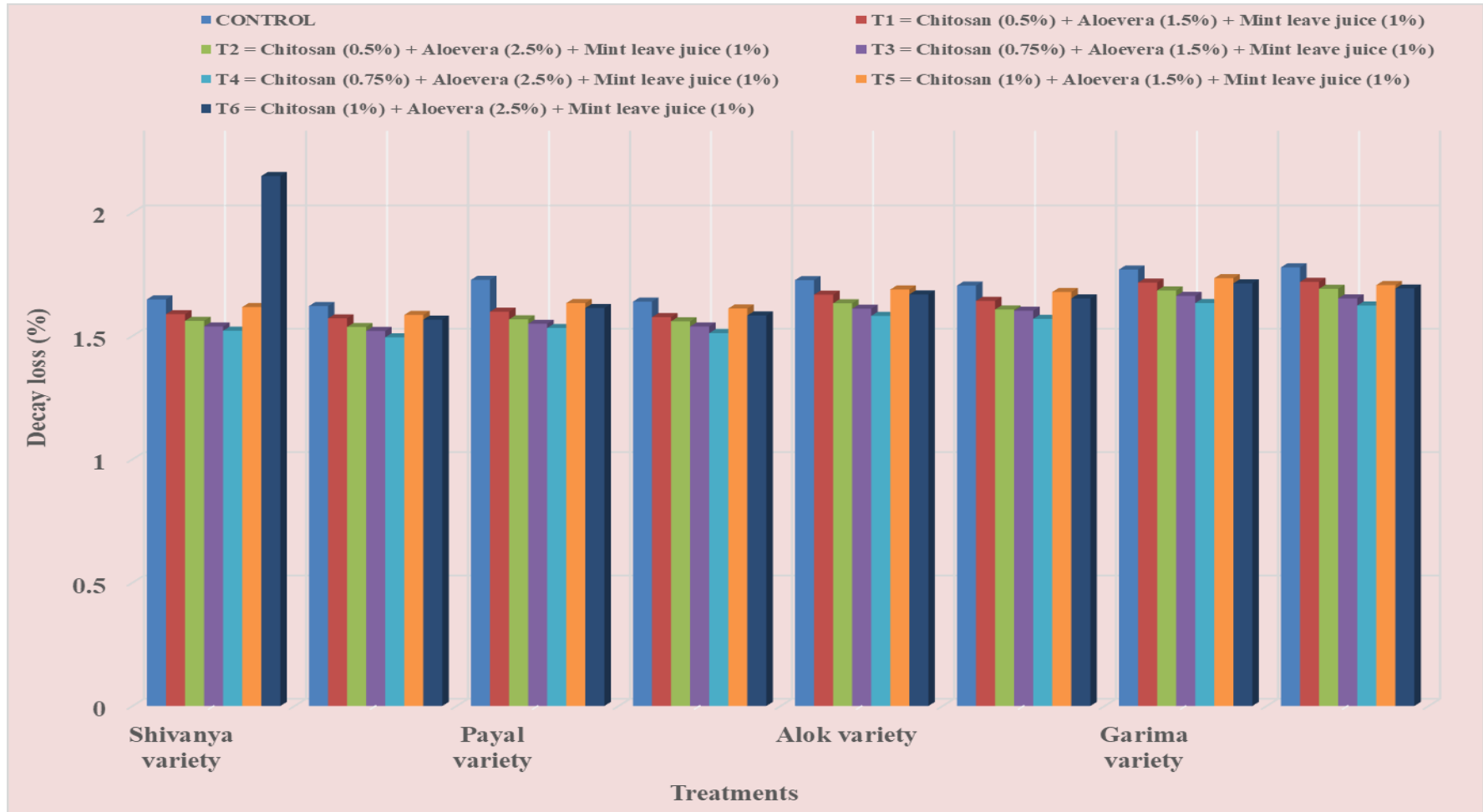


Figure 24: Effect of different treatments on decay loss (%) after 10 days storage in different varieties of sponge gourd.

4.3.3 Pulp peel ratio

The pulp peel ratio in luffa was elaborated in Table 4.25(e) brief that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 25. Firstly in the year 2021 it had been seen that shivanya and payal varieties had good pulp-peel ratio in T4 i:e 5.589 and 5.613 as compared to alok and garima. Likewise, in 2022 data shivanya and payal had high pulp peel ratio of 5.586 & 5.604 in T4 when compared to alok and garima varieties. Treatments T3 and T4 had highest pulp peel ratio in shivanya and payal varieties under refrigerator conditions. . The pooled data of treatment T3 Chitosan (0.75%) + Aloevera (1.5%) + Mint leave juice (1%) and T4 Chitosan (0.75%) + Aloevera (2.5%) + Mint leave juice (1%) also had higher pulp-peel ratio in garima and alok varieties but shivanya and payal varieties had more effect. Control treatment had more pulp peel ratio as compared to treated produce.

It had been procured that the shivanya and payal varieties showed more pulp peel ratio whereas the varieties alok and garima defined less pulp peel ratio. This may be because the pulp peel ratio related to sugar concentration in the tissues of produce. The increase in sugar concentration in the pulp maintained the fruit consistency. The pulp-peel content in produce deteriorated by microbes with an increase in storage days. The pulp-peel ratio was maintained by covering produce with a good outer layer that protects the produce from outer obstacles (Xylia *et al.*, 2021). The pulp-peel ratio was maintained due to the layer of chitosan + aloe vera + mint as coating material. Chitosan acts as a barrier against the outer environment and avoids any microbes' proliferation and retained the sugar and other soluble content of produce. These results defined that the control treatment had more loss of pulp-peel ratio. Similar findings are defined by Goudarzi *et al.*, (2022) and Xylia *et al.*, (2021).

Table 4.25(a): Effect of different treatments on pulp peel ratio at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Pulp peel ratio													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.330	6.067	5.660	5.497	5.043	4.113	5.452	6.330	6.087	5.647	5.510	5.057	4.127	5.459
T1	6.327	6.187	5.763	5.570	5.147	4.233	5.538	6.327	6.193	5.783	5.587	5.160	4.247	5.549
T2	6.333	6.207	5.807	5.603	5.130	4.237	5.553	6.330	6.223	5.820	5.623	5.143	4.250	5.565
T3	6.327	6.203	5.797	5.587	5.163	4.270	5.558	6.327	6.223	5.807	5.597	5.173	4.277	5.567
T4	6.330	6.223	5.880	5.637	5.180	4.287	5.589	6.330	6.260	5.893	5.677	5.203	4.313	5.613
T5	6.330	6.113	5.710	5.530	5.087	4.157	5.488	6.330	6.127	5.723	5.553	5.100	4.173	5.501
T6	6.330	6.177	5.763	5.573	5.113	4.213	5.528	6.330	6.193	5.780	5.587	5.137	4.223	5.542
Mean	6.330	6.168	5.769	5.571	5.123	4.216		6.329	6.187	5.779	5.590	5.139	4.230	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.012	0.006	0.004	0.000			Factor (Treatments)	0.011	0.006	0.004	0.000		
	Factor (Days)	0.011	0.006	0.004	0.000			Factor (Days)	0.011	0.005	0.004	0.000		
	Factor (T × D)	0.029	0.015	0.010	0.000			Factor (T × D)	0.028	0.014	0.010	0.000		

Table 4.25(b): Effect of different treatments on pulp peel ratio at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Pulp peel ratio													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.330	6.047	5.593	5.487	5.033	4.083	5.429	6.330	6.017	5.577	5.447	5.013	4.023	5.401
T1	6.327	6.130	5.697	5.493	5.103	4.207	5.493	6.330	6.110	5.670	5.463	5.123	4.183	5.480
T2	6.330	6.163	5.773	5.583	5.117	4.193	5.527	6.330	6.113	5.737	5.547	5.083	4.170	5.497
T3	6.327	6.183	5.763	5.517	5.123	4.217	5.522	6.330	6.133	5.740	5.483	5.103	4.153	5.491
T4	6.330	6.197	5.787	5.607	5.160	4.270	5.558	6.330	6.143	5.730	5.550	5.127	4.190	5.512
T5	6.330	6.093	5.687	5.517	5.053	4.107	5.464	6.330	6.050	5.643	5.473	5.017	4.107	5.437
T6	6.330	6.133	5.750	5.553	5.117	4.197	5.513	6.330	6.107	5.697	5.517	5.093	4.160	5.484
Mean	6.329	6.135	5.721	5.537	5.101	4.182		6.330	6.096	5.685	5.497	5.080	4.141	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.012	0.006	0.004	0.000			Factor (Treat ments)	0.009	0.005	0.003	0.000		
	Factor (Days)	0.011	0.005	0.004	0.000			Factor (Days)	0.009	0.004	0.003	0.000		
	Factor (T × D)	0.029	0.014	0.010	0.000			Factor (T × D)	0.023	0.012	0.008	0.000		

Table 4.25(c): Effect of different treatments on pulp peel ratio at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Pulp peel ratio													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.330	6.067	5.660	5.497	5.043	4.113	5.452	6.330	6.087	5.647	5.510	5.057	4.127	5.459
T1	6.327	6.187	5.763	5.570	5.147	4.233	5.538	6.327	6.193	5.783	5.587	5.160	4.247	5.549
T2	6.333	6.207	5.807	5.603	5.130	4.237	5.553	6.330	6.223	5.820	5.623	5.143	4.250	5.565
T3	6.327	6.203	5.797	5.587	5.163	4.270	5.558	6.327	6.223	5.807	5.597	5.173	4.277	5.567
T4	6.330	6.223	5.880	5.637	5.180	4.287	5.589	6.330	6.260	5.893	5.677	5.203	4.313	5.613
T5	6.330	6.113	5.710	5.530	5.087	4.157	5.488	6.330	6.127	5.723	5.553	5.100	4.173	5.501
T6	6.330	6.177	5.763	5.573	5.113	4.213	5.528	6.330	6.193	5.780	5.587	5.137	4.223	5.542
Mean	6.330	6.168	5.769	5.571	5.123	4.216		6.329	6.187	5.779	5.590	5.139	4.230	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.012	0.006	0.004	0.000			Factor (Treat ments)	0.011	0.006	0.004	0.000		
	Factor (Days)	0.011	0.006	0.004	0.000			Factor (Days)	0.011	0.005	0.004	0.000		
	Factor (T × D)	0.029	0.015	0.010	0.000			Factor (T × D)	0.028	0.014	0.010	0.000		

Table 4.24(d): Effect of different treatments on pulp peel ratio stored at 0, 2, 4, 6, 8, 10 days in different varieties of sponge gourd alongwith their interaction between treatments and days during 2021-2022.

Treatments	Pulp peel ratio													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.330	6.047	5.593	5.487	5.033	4.083	5.429	6.330	6.017	5.577	5.447	5.013	4.023	5.401
T1	6.327	6.130	5.697	5.493	5.103	4.207	5.493	6.330	6.110	5.670	5.463	5.123	4.183	5.480
T2	6.330	6.163	5.773	5.583	5.117	4.193	5.527	6.330	6.113	5.737	5.547	5.083	4.170	5.497
T3	6.327	6.183	5.763	5.517	5.123	4.217	5.522	6.330	6.133	5.740	5.483	5.103	4.153	5.491
T4	6.330	6.197	5.787	5.607	5.160	4.270	5.558	6.330	6.143	5.730	5.550	5.127	4.190	5.512
T5	6.330	6.093	5.687	5.517	5.053	4.107	5.464	6.330	6.050	5.643	5.473	5.017	4.107	5.437
T6	6.330	6.133	5.750	5.553	5.117	4.197	5.513	6.330	6.107	5.697	5.517	5.093	4.160	5.484
Mean	6.329	6.135	5.721	5.537	5.101	4.182		6.330	6.096	5.685	5.497	5.080	4.141	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.012	0.006	0.004	0.000			Factor (Treat ments)	0.009	0.005	0.003	0.000		
	Factor (Days)	0.011	0.005	0.004	0.000			Factor (Days)	0.009	0.004	0.003	0.000		
	Factor (T × D)	0.029	0.014	0.010	0.000			Factor (T × D)	0.023	0.012	0.008	0.000		

Table 4.25(e) : Average effect of different treatments on Pulp peel ratio after 10 days storage in different varieties of sponge gourd.

Treatments	Pulp peel ratio											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	5.452	5.439	5.445	5.459	5.453	5.456	5.429	6.454	5.941	5.401	6.463	5.932
T1	5.538	5.507	5.522	5.549	5.532	5.540	5.493	5.487	5.490	5.480	5.524	5.502
T2	5.553	5.543	5.548	5.565	5.546	5.555	5.527	5.424	5.475	5.497	5.464	5.480
T3	5.558	5.541	5.549	5.567	5.567	5.567	5.522	5.355	5.438	5.491	5.392	5.441
T4	5.589	5.586	5.587	5.613	5.604	5.608	5.558	5.317	5.437	5.512	5.345	5.428
T5	5.488	5.484	5.486	5.501	5.498	5.499	5.464	5.597	5.530	5.437	5.635	5.536
T6	5.528	5.540	5.534	5.542	5.539	5.540	5.513	5.550	5.531	5.484	5.576	5.530
CD (p≤0.05)	0.029	0.030	0.029	0.028	0.025	0.026	0.029	0.034	0.036	0.023	0.051	0.037

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

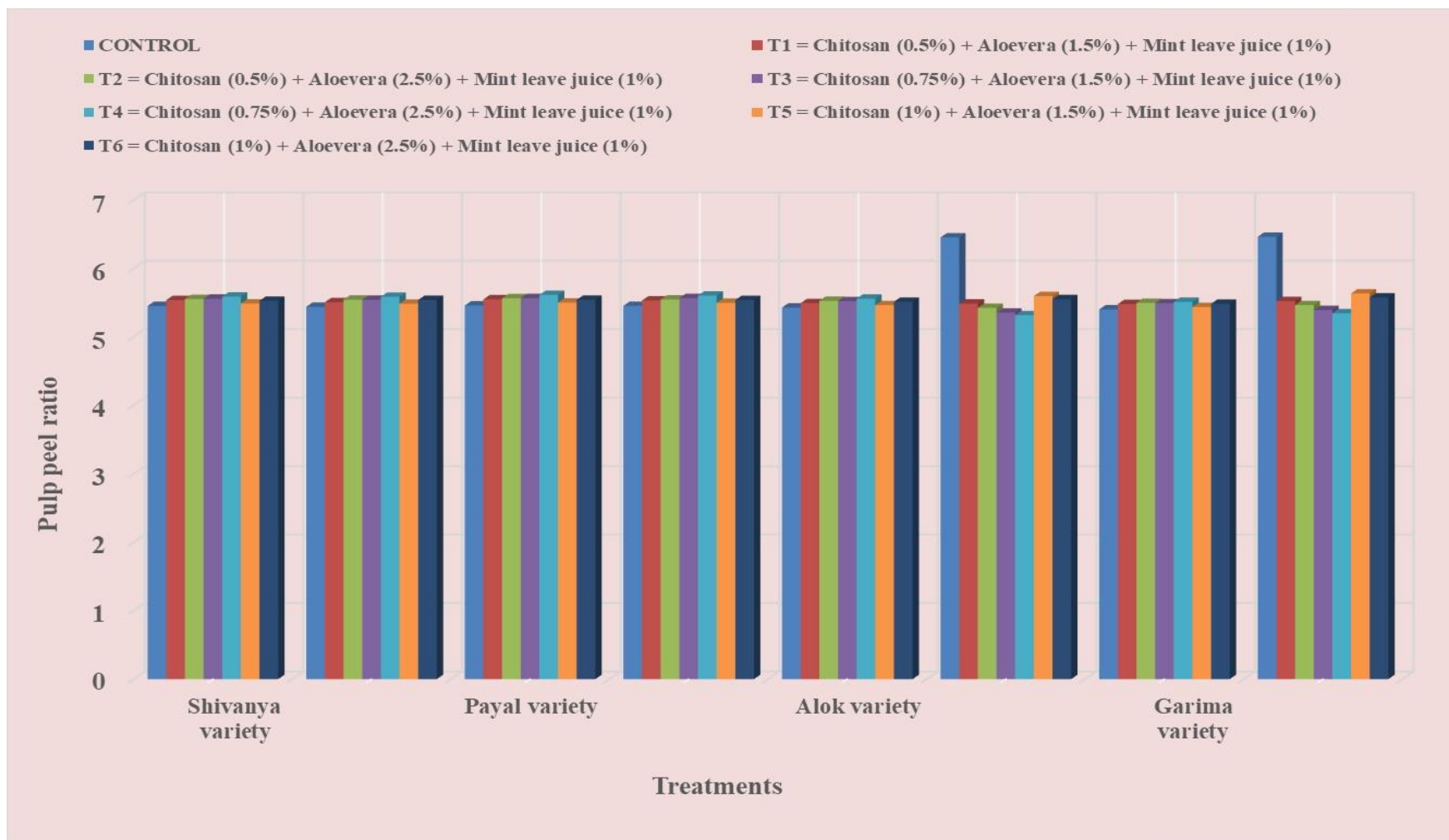


Figure 25: Effect of different treatments on Pulp peel ratio after 10 days storage in different varieties of sponge gourd.

4.4 Quality Parameters

4.4.1 pH

The pH of weight in luffa was presented in Table 4.26 (e) illustrate that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 26. Firstly in the year 2021 it had been seen that shivanya and payal varieties had less decrease in pH in T4 (6.204) and (6.233) as compared to alok and garima. Similarly, in 2022 data shivanya and payal varieties had less pH loss in T4 (6.178) and (6.247) as compared to alok and garima varieties. The effect of different varieties of luffa defined that shivanya and payal varieties defined less decrease in pH whereas the varieties of alok and garima defined high decrease in pH content. The treatment control showed more decrease in pH content and treatment T3 Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%) had less decrease in pH and considered as best treatment and same effect was defined by T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) treatment.

With an increase in storage days, the pH of the vegetable starts decreasing. The decrease in pH causes loss of transpiration and evaporation from the produce content. The decrease in pH causes the produce to lose physical weight and the proliferation of microbes starts. Chitosan coating had a great impact on produce and maintains the barrier on produce and avoiding the proliferation of microbes and other extra matter. Aloe vera addition act as extra protection to the produce and provides an effective physical barrier to avoid more respiration and transpiration losses during storage (Aboryia *et al.*, 2022). These results depicted that the control treatment had more decrease in pH as compared to the other treatments. The addition of mint also adds flavor to the coating and provides a good barrier to the outer environment. The addition of 1 % chitosan causes the same decrease in pH as like control treatment and there is no space for produce to respire and have enough moisture. Similar findings are defined by Naeem *et al.*, (2019) and Aboryia *et al.*, (2022).

Table 4.26(a): Effect of different treatments on pH at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	pH													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	5.237	5.527	6.180	6.403	6.530	6.697	6.096	5.237	5.563	6.223	6.430	6.560	6.730	6.124
T1	5.240	5.597	6.243	6.450	6.670	6.767	6.161	5.237	5.633	6.273	6.477	6.707	6.797	6.187
T2	5.243	5.553	6.263	6.483	6.667	6.800	6.168	5.243	5.630	6.297	6.520	6.703	6.840	6.206
T3	5.240	5.620	6.273	6.483	6.687	6.833	6.189	5.240	5.660	6.340	6.510	6.717	6.857	6.221
T4	5.243	5.647	6.273	6.503	6.703	6.857	6.204	5.243	5.673	6.317	6.543	6.740	6.880	6.233
T5	5.240	5.530	6.203	6.430	6.583	6.727	6.119	5.240	5.553	6.240	6.467	6.617	6.757	6.146
T6	5.237	5.543	6.240	6.467	6.633	6.773	6.149	5.237	5.580	6.287	6.503	6.670	6.800	6.179
Mean	5.240	5.574	6.240	6.460	6.639	6.779		5.240	5.613	6.282	6.493	6.673	6.809	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.021	0.011	0.007	0.000			Factor (Treat ments)	0.022	0.011	0.008	0.000		
	Factor (Days)	0.020	0.010	0.007	0.000			Factor (Days)	0.020	0.010	0.007	0.000		
	Factor (T × D)	0.052	0.026	0.018	0.015			Factor (T × D)	0.053	0.027	0.019	0.024		

Table 4.26(b): Effect of different treatments on pH at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	pH													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	5.237	5.493	6.170	6.420	6.543	6.713	6.096	5.243	5.497	6.140	6.373	6.497	6.667	6.069
T1	5.240	5.477	6.153	6.390	6.527	6.683	6.078	5.240	5.490	6.167	6.407	6.547	6.697	6.091
T2	5.243	5.480	6.127	6.367	6.517	6.657	6.065	5.237	5.510	6.183	6.453	6.560	6.723	6.111
T3	5.237	5.533	6.207	6.420	6.617	6.763	6.129	5.237	5.580	6.230	6.453	6.647	6.803	6.158
T4	5.243	5.607	6.237	6.463	6.667	6.813	6.172	5.243	5.620	6.250	6.477	6.680	6.830	6.183
T5	5.243	5.517	6.180	6.430	6.597	6.763	6.122	5.243	5.527	6.193	6.440	6.610	6.773	6.131
T6	5.237	5.567	6.217	6.440	6.633	6.787	6.147	5.237	5.547	6.220	6.430	6.637	6.783	6.142
Mean	5.240	5.525	6.184	6.419	6.586	6.740		5.240	5.539	6.198	6.433	6.597	6.754	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.017	0.008	0.006	0.000			Factor (Treat ments)	0.020	0.010	0.007	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.018	0.009	0.006	0.000		
	Factor (T × D)	0.041	0.021	0.015	0.000			Factor (T × D)	0.048	0.024	0.018	0.002		

Table 4.26(c): Effect of different treatments on pH at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	pH													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	5.237	5.527	6.180	6.403	6.530	6.697	6.096	5.237	5.563	6.223	6.430	6.560	6.730	6.124
T1	5.240	5.597	6.243	6.450	6.670	6.767	6.161	5.237	5.633	6.273	6.477	6.707	6.797	6.187
T2	5.243	5.553	6.263	6.483	6.667	6.800	6.168	5.243	5.630	6.297	6.520	6.703	6.840	6.206
T3	5.240	5.620	6.273	6.483	6.687	6.833	6.189	5.240	5.660	6.340	6.510	6.717	6.857	6.221
T4	5.243	5.647	6.273	6.503	6.703	6.857	6.204	5.243	5.673	6.317	6.543	6.740	6.880	6.233
T5	5.240	5.530	6.203	6.430	6.583	6.727	6.119	5.240	5.553	6.240	6.467	6.617	6.757	6.146
T6	5.237	5.543	6.240	6.467	6.633	6.773	6.149	5.237	5.580	6.287	6.503	6.670	6.800	6.179
Mean	5.240	5.574	6.240	6.460	6.639	6.779		5.240	5.613	6.282	6.493	6.673	6.809	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.021	0.011	0.007	0.000			Factor (Treatments)	0.022	0.011	0.008	0.000		
	Factor (Days)	0.020	0.010	0.007	0.000			Factor (Days)	0.020	0.010	0.007	0.000		
	Factor (T × D)	0.052	0.026	0.018	0.015			Factor (T × D)	0.053	0.027	0.019	0.024		

Table 4.26(d): Effect of different treatments on pH at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	pH													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	5.237	5.493	6.170	6.420	6.543	6.713	6.096	5.243	5.497	6.140	6.373	6.497	6.667	6.069
T1	5.240	5.477	6.153	6.390	6.527	6.683	6.078	5.240	5.490	6.167	6.407	6.547	6.697	6.091
T2	5.243	5.480	6.127	6.367	6.517	6.657	6.065	5.237	5.510	6.183	6.453	6.560	6.723	6.111
T3	5.237	5.533	6.207	6.420	6.617	6.763	6.129	5.237	5.580	6.230	6.453	6.647	6.803	6.158
T4	5.243	5.607	6.237	6.463	6.667	6.813	6.172	5.243	5.620	6.250	6.477	6.680	6.830	6.183
T5	5.243	5.517	6.180	6.430	6.597	6.763	6.122	5.243	5.527	6.193	6.440	6.610	6.773	6.131
T6	5.237	5.567	6.217	6.440	6.633	6.787	6.147	5.237	5.547	6.220	6.430	6.637	6.783	6.142
Mean	5.240	5.525	6.184	6.419	6.586	6.740		5.240	5.539	6.198	6.433	6.597	6.754	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.017	0.008	0.006	0.000			Factor (Treat ments)	0.020	0.010	0.007	0.000		
	Factor (Days)	0.016	0.008	0.006	0.000			Factor (Days)	0.018	0.009	0.006	0.000		
	Factor (T × D)	0.041	0.021	0.015	0.000			Factor (T × D)	0.048	0.024	0.018	0.002		

Table 4.26 (e): Effect of different treatments on pH after 10 days storage in different varieties of sponge gourd.

Treatments	pH											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	6.096	6.085	6.090	6.124	6.079	6.101	6.096	6.043	6.069	6.069	6.033	6.051
T1	6.161	6.125	6.143	6.187	6.141	6.164	6.078	6.031	6.054	6.091	6.039	6.065
T2	6.168	6.131	6.149	6.206	6.172	6.189	6.065	6.036	6.050	6.111	6.068	6.089
T3	6.189	6.178	6.183	6.221	6.228	6.224	6.129	6.109	6.119	6.158	6.128	6.143
T4	6.204	6.178	6.191	6.233	6.247	6.240	6.172	6.143	6.157	6.183	6.161	6.172
T5	6.119	6.103	6.111	6.146	6.152	6.149	6.122	6.112	6.117	6.131	6.131	6.131
T6	6.149	6.160	6.154	6.179	6.164	6.171	6.147	6.119	6.133	6.142	6.119	6.130
CD (p≤0.05)	0.052	0.031	0.041	0.053	0.041	0.047	0.041	0.027	0.034	0.048	0.035	0.041

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

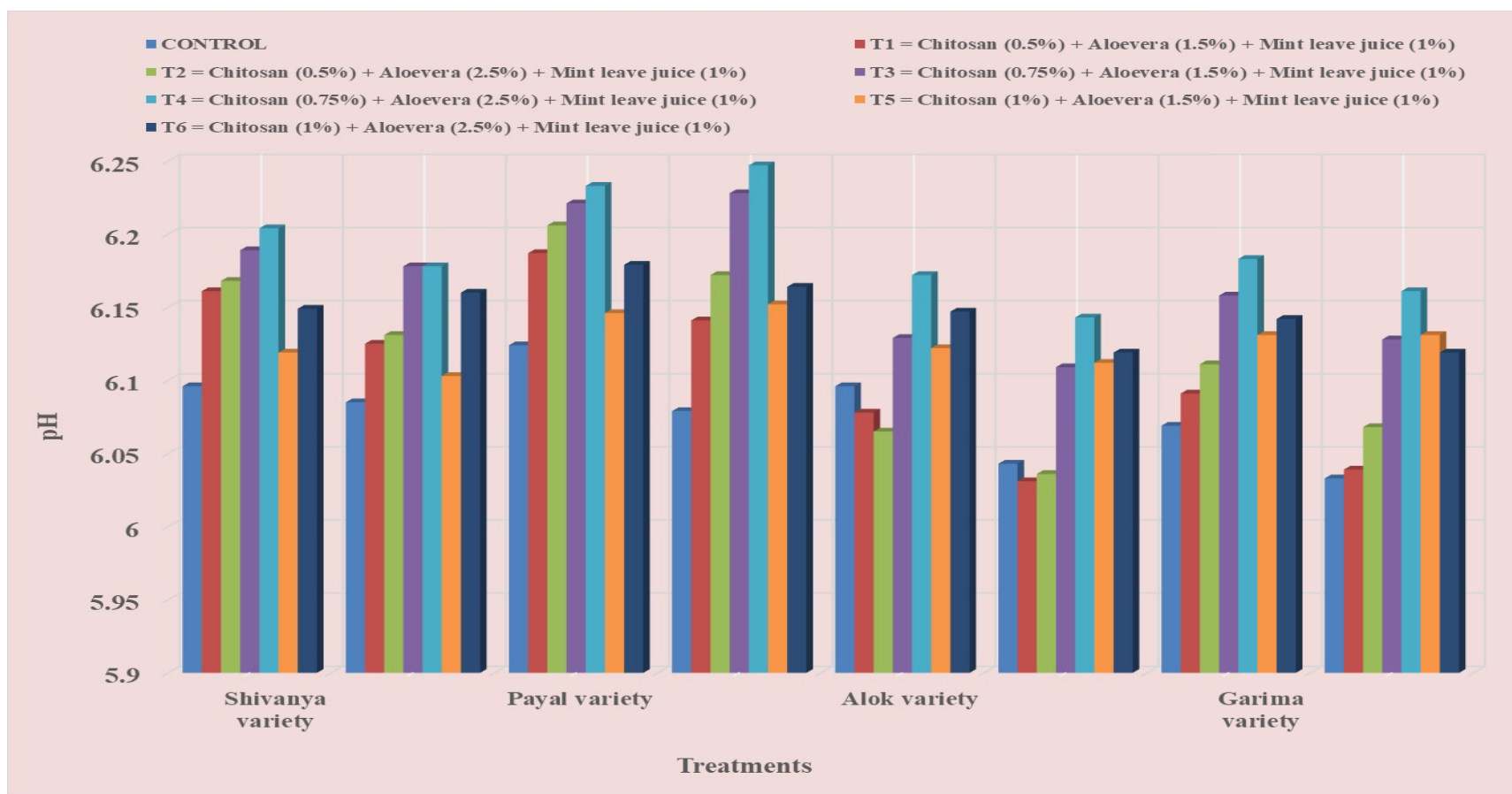


Figure 26: Effect of different treatments on pH after 10 days storage in different varieties of sponge gourd.

4.4.2 TSS

The TSS in luffa was presented in Table 4.27(e) explain that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 27. Firstly in the year 2021 it had been seen that shivanya and payal varieties had less loss in TSS in T4 as 5.883°Brix & 5.916°Brix when compared to alok and garima. Similarly, in 2022 data shivanya and payal varieties had less TSS loss in T4 5.987°Brix & 5.906°Brix as compared to other varieties. The effect of different varieties of luffa defined that shivanya and payal varieties defined less loss in TSS whereas the varieties of alok and garima defined high loss in TSS content. The treatments T3 and T4 shows less loss in total soluble solids as compared to other treatments. The control fruits with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa.

The TSS of produce increases with an increase in storage days and then decreases. The total soluble solids of luffa increase because of the conversion of compounds into starches and physiological loss in weight. The transpiration and respiration during storage cause luffa to lose weight and content soluble solids. The coated vegetable had less TSS loss as protective coating suppresses the degradation and avoids respiration at peak, hence using present metabolites in fruit. The chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of the produce. The effect of different varieties of luffa defined that shivanya and payal varieties defined less decrease in TSS whereas the varieties of alok and garima defined high decrease in TSS content. Chitosan coating had a great impact on produce and maintains the barrier on produce and avoiding the proliferation of microbes and other extra matter. Aloe vera addition act as extra protection to the produce and provides an effective physical barrier to avoid more respiration and transpiration losses during storage (Aboryia *et al.*, 2022). The addition of mint also adds flavor to the coating and provides a good barrier to the outer environment and maintains the soluble content of the produce inside. The addition of 1 % chitosan causes the same decrease in TSS as like control treatment and there is no space for produce to respire and have enough moisture. Similar findings are suggested by Aboryia *et al.*, (2022) and Xylia *et al.*, (2021).

Table 4.27(a): Effect of different treatments on TSS (°B) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	TSS(°B)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.137	6.167	6.200	6.090	6.077	5.730	6.067	6.137	6.177	6.220	6.100	6.093	5.730	6.076
T1	6.137	6.140	6.183	6.070	6.043	5.560	6.022	6.137	6.167	6.200	6.083	6.093	5.583	6.044
T2	6.137	6.123	6.163	6.040	6.023	5.537	6.004	6.137	6.137	6.177	6.050	6.050	5.560	6.018
T3	6.137	6.103	6.147	6.023	6.013	5.507	5.988	6.137	6.113	6.157	6.040	6.033	5.527	6.001
T4	6.137	6.087	6.127	5.867	5.587	5.493	5.883	6.137	6.097	6.137	5.880	5.733	5.510	5.916
T5	6.137	6.133	6.143	6.053	6.023	5.553	6.007	6.137	6.147	6.157	6.080	6.057	5.577	6.026
T6	6.137	6.097	6.117	5.873	5.727	5.527	5.913	6.137	6.113	6.130	6.037	5.737	5.540	5.949
Mean	6.137	6.121	6.154	6.002	5.928	5.558		6.137	6.136	6.168	6.039	5.971	5.575	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.052	0.026	0.019	0.000			Factor (Treat ments)	0.052	0.026	0.018	0.000		
	Factor (Days)	0.049	0.024	0.017	0.000			Factor (Days)	0.048	0.024	0.017	0.000		
	Factor (T × D)	0.128	0.064	0.046	0.000			Factor (T × D)	0.127	0.064	0.045	0.004		

Table 4.27(b): Effect of different treatments on TSS (°B) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	TSS (°Brix)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.137	6.193	6.247	6.127	6.110	5.753	6.094	6.137	6.223	6.297	6.163	6.137	5.777	6.122
T1	6.137	6.177	6.210	6.107	6.103	5.600	6.056	6.137	6.200	6.227	6.130	6.117	5.630	6.073
T2	6.137	6.167	6.200	6.073	6.100	5.587	6.044	6.137	6.187	6.223	6.090	6.117	5.603	6.059
T3	6.137	6.137	6.173	6.077	6.093	5.550	6.028	6.137	6.157	6.190	6.097	6.090	5.577	6.041
T4	6.137	6.113	6.147	6.033	5.743	5.547	5.953	6.137	6.137	6.167	6.067	5.913	5.593	6.002
T5	6.137	6.163	6.170	6.110	6.103	5.610	6.049	6.137	6.190	6.180	6.127	6.077	5.633	6.057
T6	6.137	6.130	6.147	6.077	6.067	5.587	6.024	6.137	6.170	6.167	6.110	6.097	5.617	6.049
Mean	6.137	6.154	6.185	6.086	6.046	5.605		6.137	6.180	6.207	6.112	6.078	5.633	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.036	0.018	0.013	0.000			Factor (Treatments)	0.030	0.015	0.011	0.000		
	Factor (Days)	0.034	0.017	0.012	0.000			Factor (Days)	0.028	0.014	0.010	0.000		
	Factor (T × D)	0.089	0.045	0.032	0.000			Factor (T × D)	0.074	0.037	0.026	0.015		

Table 4.27(c): Effect of different treatments on TSS (°B) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	TSS (°B)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.137	6.167	6.200	6.090	6.077	5.730	6.067	6.137	6.177	6.220	6.100	6.093	5.730	6.076
T1	6.137	6.140	6.183	6.070	6.043	5.560	6.022	6.137	6.167	6.200	6.083	6.093	5.583	6.044
T2	6.137	6.123	6.163	6.040	6.023	5.537	6.004	6.137	6.137	6.177	6.050	6.050	5.560	6.018
T3	6.137	6.103	6.147	6.023	6.013	5.507	5.988	6.137	6.113	6.157	6.040	6.033	5.527	6.001
T4	6.137	6.087	6.127	5.867	5.587	5.493	5.883	6.137	6.097	6.137	5.880	5.733	5.510	5.916
T5	6.137	6.133	6.143	6.053	6.023	5.553	6.007	6.137	6.147	6.157	6.080	6.057	5.577	6.026
T6	6.137	6.097	6.117	5.873	5.727	5.527	5.913	6.137	6.113	6.130	6.037	5.737	5.540	5.949
Mean	6.137	6.121	6.154	6.002	5.928	5.558		6.137	6.136	6.168	6.039	5.971	5.575	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.052	0.026	0.019	0.000			Factor (Treatments)	0.052	0.026	0.018	0.000		
	Factor (Days)	0.049	0.024	0.017	0.000			Factor (Days)	0.048	0.024	0.017	0.000		
	Factor (T × D)	0.128	0.064	0.046	0.000			Factor (T × D)	0.127	0.064	0.045	0.004		

Table 4.27(d): Effect of different treatments on TSS (°B) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	TSS (°B)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	6.137	6.193	6.247	6.127	6.110	5.753	6.094	6.137	6.223	6.297	6.163	6.137	5.777	6.122
T1	6.137	6.177	6.210	6.107	6.103	5.600	6.056	6.137	6.200	6.227	6.130	6.117	5.630	6.073
T2	6.137	6.167	6.200	6.073	6.100	5.587	6.044	6.137	6.187	6.223	6.090	6.117	5.603	6.059
T3	6.137	6.137	6.173	6.077	6.093	5.550	6.028	6.137	6.157	6.190	6.097	6.090	5.577	6.041
T4	6.137	6.113	6.147	6.033	5.743	5.547	5.953	6.137	6.137	6.167	6.067	5.913	5.593	6.002
T5	6.137	6.163	6.170	6.110	6.103	5.610	6.049	6.137	6.190	6.180	6.127	6.077	5.633	6.057
T6	6.137	6.130	6.147	6.077	6.067	5.587	6.024	6.137	6.170	6.167	6.110	6.097	5.617	6.049
Mean	6.137	6.154	6.185	6.086	6.046	5.605		6.137	6.180	6.207	6.112	6.078	5.633	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.036	0.018	0.013	0.000			Factor (Treat ments)	0.030	0.015	0.011	0.000		
	Factor (Days)	0.034	0.017	0.012	0.000			Factor (Days)	0.028	0.014	0.010	0.000		
	Factor (T × D)	0.089	0.045	0.032	0.000			Factor (T × D)	0.074	0.037	0.026	0.015		

Table 4.27(e): Effect of different treatments on TSS after 10 days storage in different varieties of sponge gourd.

Treatments	TSS (°B)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	6.067	6.064	6.065	6.076	6.063	6.069	6.094	6.079	6.086	6.122	6.076	6.099
T1	6.022	6.047	6.034	6.044	6.037	6.040	6.056	6.057	6.056	6.073	6.048	6.060
T2	6.004	6.020	6.012	6.018	6.011	6.014	6.044	6.040	6.042	6.059	6.032	6.045
T3	5.988	5.996	5.992	6.001	5.988	5.994	6.028	6.014	6.021	6.041	6.002	6.021
T4	5.883	5.987	5.935	5.916	5.906	5.911	5.953	5.999	5.976	6.002	5.973	5.987
T5	6.007	6.011	6.009	6.026	6.009	6.017	6.049	6.043	6.046	6.057	6.025	6.041
T6	5.913	5.974	5.943	5.949	5.963	5.956	6.024	6.022	6.023	6.049	6.009	6.029
CD (p≤0.05)	0.128	0.065	0.096	0.127	0.111	0.119	0.089	0.019	0.054	0.074	0.064	0.069

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

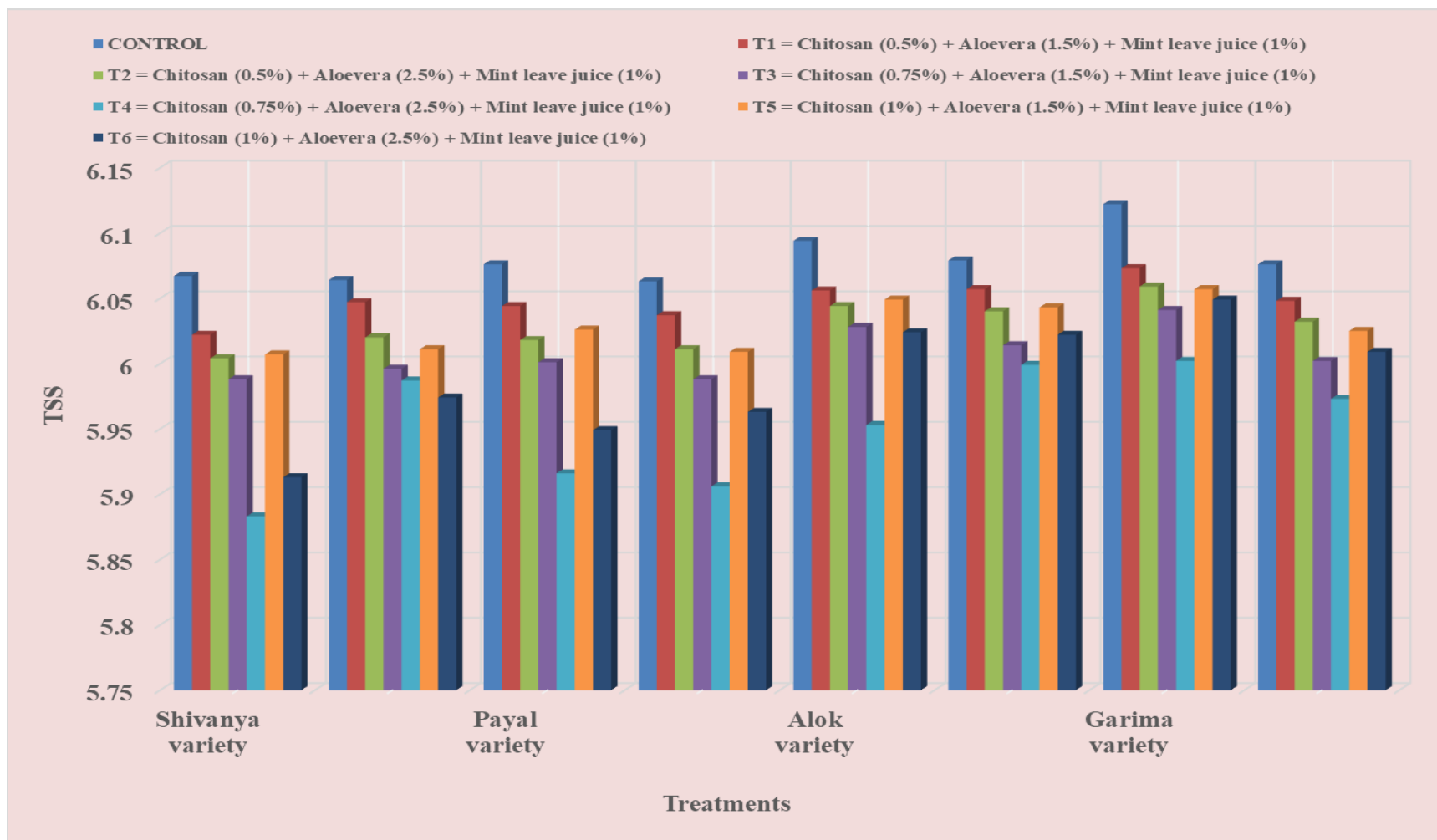


Figure 27: Effect of different treatments on TSS after 10 days storage in different varieties of sponge gourd.

4.4.3 Titratable acidity (%)

The titratable acidity in luffa was presented in Table 4.28(e) specify that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 28. Firstly in the year 2021 it had been evaluated that shivanya and payal had less loss in acidity in T4 exhibits 0.509% & 0.509% while compared to alok and garima. Likewise, in 2022 data shivanya and payal varieties had less loss in titratable acidity of 0.513% & 0.499% as compared to others. The effect of different varieties of luffa explicated that shivanya and payal varieties showed less acidity loss whereas the varieties of alok and garima defined high loss in acidity. The produce coated with T3 and T4 retained more titratable acidity.

The titratable acidity of produce decreases with an increase in storage days. The produce treated with coatings retained acidity as compared to coated ones. The control ones had more loss due to respiration, and transpiration losses during the storage of luffa vegetables. The slow transformation of acids into sugars during ripening retained more titratable acidity. The varieties shivanya and payal depicted less loss of titratable acidity whereas the varieties alok and garima explained the more loss of titratable acidity. The transpiration and respiration during storage cause produce to lose weight and titratable acidity (Xylia *et al.*, 2021). The control ones with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa. The chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of the produce. The coating of chitosan, aloe vera, and mint provides a surface layer and also avoids the microbial attack. The results depicted that the control treatment had more decrease in acidity content as compared to the other treatments. A similar approach was suggested by Li *et al.*, (2019), Aboryia *et al.*, (2022), and Xylia *et al.*, (2021).

Table 4.28(a): Effect of different treatments on Titratable acidity (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Titratable acidity (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.617	0.570	0.433	0.333	0.280	0.173	0.401	0.613	0.550	0.413	0.317	0.233	0.153	0.380
T1	0.623	0.603	0.543	0.457	0.340	0.273	0.473	0.613	0.593	0.567	0.473	0.367	0.263	0.479
T2	0.617	0.607	0.557	0.497	0.377	0.313	0.494	0.613	0.600	0.577	0.503	0.393	0.307	0.499
T3	0.623	0.607	0.557	0.467	0.353	0.293	0.483	0.613	0.597	0.577	0.473	0.373	0.273	0.484
T4	0.623	0.617	0.567	0.517	0.397	0.337	0.509	0.613	0.607	0.583	0.517	0.410	0.323	0.509
T5	0.623	0.583	0.497	0.430	0.380	0.250	0.461	0.613	0.573	0.487	0.457	0.383	0.243	0.459
T6	0.623	0.567	0.507	0.460	0.403	0.287	0.474	0.613	0.553	0.483	0.447	0.393	0.300	0.465
Mean	0.621	0.593	0.523	0.451	0.361	0.275		0.613	0.582	0.527	0.455	0.365	0.266	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.011	0.005	0.004	0.000			Factor (Treatments)	0.010	0.005	0.003	0.000		
	Factor (Days)	0.010	0.005	0.004	0.000			Factor (Days)	0.009	0.004	0.003	0.000		
	Factor (T × D)	0.026	0.013	0.009	0.000			Factor (T × D)	0.024	0.012	0.008	0.000		

Table 4.28(b): Effect of different treatments on Titratable acidity (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Titratable acidity (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.610	0.487	0.387	0.270	0.207	0.130	0.348	0.617	0.470	0.377	0.230	0.173	0.143	0.335
T1	0.603	0.513	0.433	0.323	0.250	0.137	0.377	0.613	0.507	0.423	0.270	0.197	0.157	0.361
T2	0.603	0.533	0.460	0.347	0.273	0.160	0.396	0.613	0.513	0.447	0.290	0.213	0.180	0.376
T3	0.610	0.527	0.447	0.337	0.260	0.147	0.388	0.613	0.523	0.453	0.287	0.213	0.173	0.377
T4	0.603	0.550	0.473	0.357	0.283	0.167	0.406	0.613	0.530	0.463	0.297	0.230	0.183	0.386
T5	0.603	0.513	0.413	0.313	0.220	0.143	0.368	0.613	0.497	0.427	0.230	0.200	0.163	0.355
T6	0.603	0.517	0.413	0.333	0.243	0.150	0.377	0.613	0.493	0.433	0.237	0.217	0.153	0.358
Mean	0.605	0.520	0.432	0.326	0.248	0.148		0.614	0.505	0.432	0.263	0.206	0.165	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.008	0.004	0.003	0.000			Factor (Treat ments)	0.013	0.006	0.005	0.000		
	Factor (Days)	0.007	0.004	0.003	0.000			Factor (Days)	0.012	0.006	0.004	0.000		
	Factor (T × D)	0.020	0.010	0.007	0.000			Factor (T × D)	N/A	0.016	0.011	0.114		

Table 4.28(c): Effect of different treatments on Titratable acidity (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Titratable acidity (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.617	0.570	0.433	0.333	0.280	0.173	0.401	0.613	0.550	0.413	0.317	0.233	0.153	0.380
T1	0.623	0.603	0.543	0.457	0.340	0.273	0.473	0.613	0.593	0.567	0.473	0.367	0.263	0.479
T2	0.617	0.607	0.557	0.497	0.377	0.313	0.494	0.613	0.600	0.577	0.503	0.393	0.307	0.499
T3	0.623	0.607	0.557	0.467	0.353	0.293	0.483	0.613	0.597	0.577	0.473	0.373	0.273	0.484
T4	0.623	0.617	0.567	0.517	0.397	0.337	0.509	0.613	0.607	0.583	0.517	0.410	0.323	0.509
T5	0.623	0.583	0.497	0.430	0.380	0.250	0.461	0.613	0.573	0.487	0.457	0.383	0.243	0.459
T6	0.623	0.567	0.507	0.460	0.403	0.287	0.474	0.613	0.553	0.483	0.447	0.393	0.300	0.465
Mean	0.621	0.593	0.523	0.451	0.361	0.275		0.613	0.582	0.527	0.455	0.365	0.266	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.011	0.005	0.004	0.000			Factor (Treatme nts)	0.010	0.005	0.003	0.000		
	Factor (Days)	0.010	0.005	0.004	0.000			Factor (Days)	0.009	0.004	0.003	0.000		
	Factor (T × D)	0.026	0.013	0.009	0.000			Factor (T × D)	0.024	0.012	0.008	0.000		

Table 4.28(d): Effect of different treatments on Titratable acidity (%) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Titratable acidity (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	0.610	0.487	0.387	0.270	0.207	0.130	0.348	0.617	0.470	0.377	0.230	0.173	0.143	0.335
T1	0.603	0.513	0.433	0.323	0.250	0.137	0.377	0.613	0.507	0.423	0.270	0.197	0.157	0.361
T2	0.603	0.533	0.460	0.347	0.273	0.160	0.396	0.613	0.513	0.447	0.290	0.213	0.180	0.376
T3	0.610	0.527	0.447	0.337	0.260	0.147	0.388	0.613	0.523	0.453	0.287	0.213	0.173	0.377
T4	0.603	0.550	0.473	0.357	0.283	0.167	0.406	0.613	0.530	0.463	0.297	0.230	0.183	0.386
T5	0.603	0.513	0.413	0.313	0.220	0.143	0.368	0.613	0.497	0.427	0.230	0.200	0.163	0.355
T6	0.603	0.517	0.413	0.333	0.243	0.150	0.377	0.613	0.493	0.433	0.237	0.217	0.153	0.358
Mean	0.605	0.520	0.432	0.326	0.248	0.148		0.614	0.505	0.432	0.263	0.206	0.165	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.008	0.004	0.003	0.000			Factor (Treat ments)	0.013	0.006	0.005	0.000		
	Factor (Days)	0.007	0.004	0.003	0.000			Factor (Days)	0.012	0.006	0.004	0.000		
	Factor (T × D)	0.020	0.010	0.007	0.000			Factor (T × D)	N/A	0.016	0.011	0.114		

Table 4.28(e): Effect of different treatments on Titratable acidity after 10 days storage in different varieties of sponge gourd.

Treatments	Titratable acidity (%)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	0.401	0.404	0.402	0.380	0.396	0.388	0.348	0.368	0.358	0.335	0.360	0.347
T1	0.473	0.481	0.477	0.479	0.472	0.475	0.377	0.450	0.413	0.361	0.440	0.400
T2	0.494	0.503	0.498	0.499	0.491	0.495	0.396	0.472	0.434	0.376	0.452	0.414
T3	0.483	0.488	0.485	0.484	0.468	0.476	0.388	0.452	0.420	0.377	0.442	0.409
T4	0.509	0.513	0.511	0.509	0.499	0.504	0.406	0.476	0.441	0.386	0.457	0.421
T5	0.461	0.454	0.457	0.459	0.446	0.452	0.368	0.431	0.399	0.355	0.416	0.385
T6	0.474	0.467	0.470	0.465	0.465	0.465	0.377	0.449	0.413	0.358	0.434	0.396
CD (p≤0.05)	0.026	0.019	0.022	0.024	0.018	0.021	0.020	0.018	0.019	N/A	0.017	0.017

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

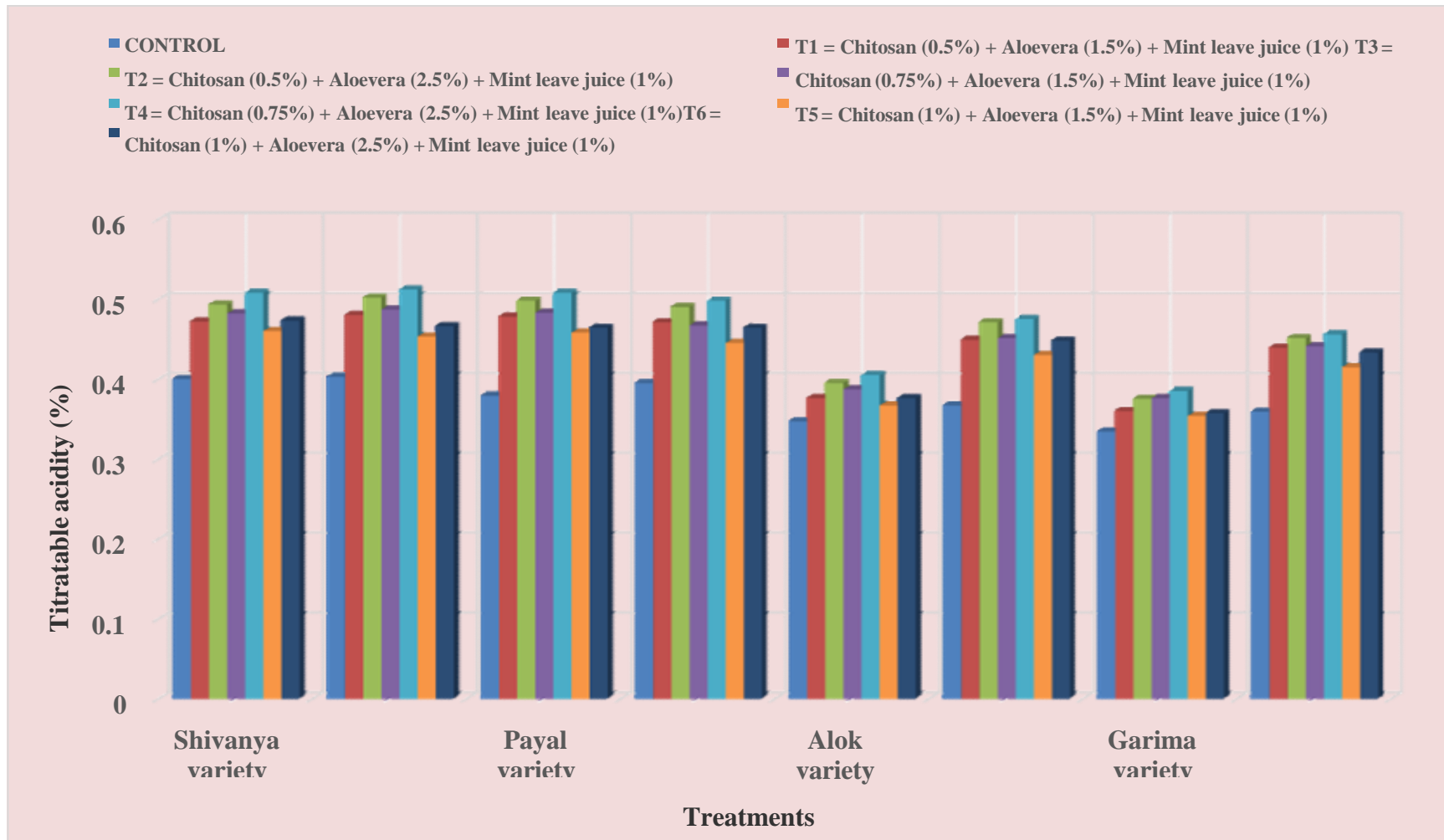


Figure 28: Effect of different treatments on Titratable acidity after 10 days storage in different varieties of sponge gourd.

4.4.4 Ascorbic acid (mg/100 g FW)

The ascorbic acid in luffa was presented in Table 4.29(e) described that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 29. Firstly in the year 2021 it had been studied that shivanya and payal varieties had less loss in ascorbic acid in T4 29.38 mg/100g and 29.53 mg/100g as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties had less loss in ascorbic acid in T4 29.20 mg/100g and 29.45 mg/100g as compared to alok and garima varieties. The treatments T3 and T4 defined a high amount of ascorbic acid as compared to other treatments. The control fruits with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa.

Ascorbic acid gives vitamin C content to the body and is used as a dietary supplement when the presence of ascorbic acid is not enough in the diet. The ascorbic acid of produce decreases with an increase in storage days. The control fruits had more loss due to respiration and transpiration losses during the storage of luffa vegetables. The varieties shivanya and payal depicted less loss of ascorbic acid whereas the varieties alok and garima depicted more loss of ascorbic acid. The transpiration and respiration during storage cause produce to lose weight and ascorbic acid. The incorporation of chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of produce from microbes. The coating of chitosan, aloe vera, and mint provides a surface layer and also avoids the microbial attack. The presence of more ascorbic acid in the produce is good for health and it provides vitamin C content to the body. The results depicted that the control treatment had more decrease in ascorbic acid content as compared to the other treatments. Similar findings are detailed by Chuenchom *et al.*, (2021) and Li *et al.*, (2019).

Table 4.29(a): Effect of different treatments on ascorbic acid (mg/100 g FW) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Ascorbic acid (mg/100 g FW)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	35.233	32.500	28.600	22.367	18.800	16.933	25.739	35.233	32.767	28.200	23.220	18.633	16.667	25.787
T1	35.233	34.733	33.500	28.467	22.967	19.133	29.006	35.233	34.900	33.433	28.367	22.967	19.233	29.022
T2	35.233	34.967	33.867	29.033	23.433	19.000	29.256	35.133	38.000	34.100	29.100	23.767	19.433	29.922
T3	35.233	34.900	33.600	28.767	23.733	19.000	29.206	35.233	35.133	33.733	24.033	23.867	19.200	28.533
T4	35.233	35.267	33.800	29.000	23.833	19.200	29.389	35.233	35.600	33.900	29.133	24.000	19.333	29.533
T5	35.233	33.067	31.867	28.233	21.867	18.133	28.067	35.233	33.600	32.500	28.867	22.733	18.500	28.572
T6	35.233	33.267	32.467	28.800	22.333	18.600	28.450	35.233	33.433	32.800	28.900	23.000	19.133	28.750
Mean	35.233	34.100	32.529	27.810	22.424	18.571		35.219	34.776	32.667	27.374	22.710	18.786	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.214	0.107	0.076	0.000			Factor (Treat ments)	0.425	0.213	0.151	0.000		
	Factor (Days)	0.198	0.099	0.070	0.000			Factor (Days)	0.394	0.198	0.140	0.000		
	Factor (T × D)	0.524	0.263	0.186	0.000			Factor (T × D)	1.041	0.523	0.370	0.000		

Table 4.29(b): Effect of different treatments on ascorbic acid (mg/100 g FW) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Ascorbic acid (mg/100 g FW)													
	Alok variety													
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	35.233	31.533	23.033	18.300	15.067	14.200	22.894	35.233	31.633	23.533	18.833	15.400	14.733	23.228
T1	35.233	32.933	28.400	26.633	20.200	16.933	26.722	35.233	33.533	28.700	26.867	20.933	17.033	27.050
T2	35.133	33.700	28.900	26.833	21.400	17.100	27.178	35.133	33.333	29.367	26.867	22.267	17.500	27.411
T3	35.233	34.000	29.233	26.967	21.833	17.167	27.406	35.233	34.167	29.467	27.333	21.967	17.333	27.583
T4	35.233	34.433	29.533	27.233	22.567	17.567	27.761	35.233	34.233	29.467	27.533	22.900	17.633	27.833
T5	35.133	31.600	27.800	26.933	20.933	15.567	26.328	35.233	31.867	28.033	27.167	21.233	15.800	26.556
T6	35.233	30.200	27.233	26.300	20.567	15.367	25.817	35.233	30.667	27.500	26.833	21.033	15.867	26.189
Mean	35.205	32.629	27.733	25.600	20.367	16.271		35.219	32.776	28.010	25.919	20.819	16.557	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.501	0.251	0.178	0.000			Factor (Treat ments)	0.501	0.251	0.178	0.000		
	Factor (Days)	0.464	0.233	0.165	0.000			Factor (Days)	0.463	0.233	0.164	0.000		
	Factor (T × D)	1.227	0.616	0.436	0.000			Factor (T × D)	1.226	0.615	0.435	0.000		

Table 4.29(c): Effect of different treatments on ascorbic acid (mg/100 g FW) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Ascorbic acid (mg/100 g FW)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	35.233	32.500	28.600	22.367	18.800	16.933	25.739	35.233	32.767	28.200	23.220	18.633	16.667	25.787
T1	35.233	34.733	33.500	28.467	22.967	19.133	29.006	35.233	34.900	33.433	28.367	22.967	19.233	29.022
T2	35.233	34.967	33.867	29.033	23.433	19.000	29.256	35.133	38.000	34.100	29.100	23.767	19.433	29.922
T3	35.233	34.900	33.600	28.767	23.733	19.000	29.206	35.233	35.133	33.733	24.033	23.867	19.200	28.533
T4	35.233	35.267	33.800	29.000	23.833	19.200	29.389	35.233	35.600	33.900	29.133	24.000	19.333	29.533
T5	35.233	33.067	31.867	28.233	21.867	18.133	28.067	35.233	33.600	32.500	28.867	22.733	18.500	28.572
T6	35.233	33.267	32.467	28.800	22.333	18.600	28.450	35.233	33.433	32.800	28.900	23.000	19.133	28.750
Mean	35.233	34.100	32.529	27.810	22.424	18.571		35.219	34.776	32.667	27.374	22.710	18.786	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
	Factor (Treat ments)	0.214	0.107	0.076	0.000			Factor (Treat ments)	0.425	0.213	0.151	0.000		
	Factor (Days)	0.198	0.099	0.070	0.000			Factor (Days)	0.394	0.198	0.140	0.000		
	Factor (T × D)	0.524	0.263	0.186	0.000			Factor (T × D)	1.041	0.523	0.370	0.000		

Table 4.29(d): Effect of different treatments on ascorbic acid (mg/100 g FW) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Ascorbic acid (mg/100 g FW)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	35.233	31.533	23.033	18.300	15.067	14.200	22.894	35.233	31.633	23.533	18.833	15.400	14.733	23.228
T1	35.233	32.933	28.400	26.633	20.200	16.933	26.722	35.233	33.533	28.700	26.867	20.933	17.033	27.050
T2	35.133	33.700	28.900	26.833	21.400	17.100	27.178	35.133	33.333	29.367	26.867	22.267	17.500	27.411
T3	35.233	34.000	29.233	26.967	21.833	17.167	27.406	35.233	34.167	29.467	27.333	21.967	17.333	27.583
T4	35.233	34.433	29.533	27.233	22.567	17.567	27.761	35.233	34.233	29.467	27.533	22.900	17.633	27.833
T5	35.133	31.600	27.800	26.933	20.933	15.567	26.328	35.233	31.867	28.033	27.167	21.233	15.800	26.556
T6	35.233	30.200	27.233	26.300	20.567	15.367	25.817	35.233	30.667	27.500	26.833	21.033	15.867	26.189
Mean	35.205	32.629	27.733	25.600	20.367	16.271		35.219	32.776	28.010	25.919	20.819	16.557	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.501	0.251	0.178	0.000			Factor (Treat ments)	0.501	0.251	0.178	0.000		
	Factor (Days)	0.464	0.233	0.165	0.000			Factor (Days)	0.463	0.233	0.164	0.000		
	Factor (T × D)	1.227	0.616	0.436	0.000			Factor (T × D)	1.226	0.615	0.435	0.000		

Table 4.29(e): Effect of different treatments on Ascorbic acid after 10 days storage in different varieties of sponge gourd.

Treatments	Ascorbic acid (mg/100 g FW)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	25.739	24.608	25.17	25.787	25.234	25.510	22.894	22.267	22.580	23.228	22.033	22.630
T1	29.006	28.069	28.537	29.022	28.609	28.815	26.722	26.039	26.380	27.050	25.584	26.317
T2	29.256	29.218	29.237	29.922	29.503	29.712	27.178	26.794	26.986	27.411	26.067	26.739
T3	29.206	28.504	28.855	28.533	28.602	28.567	27.406	26.239	26.822	27.583	25.594	26.588
T4	29.389	29.208	29.298	29.533	29.454	29.493	27.761	26.328	27.044	27.833	25.767	26.800
T5	28.067	28.044	28.055	28.572	29.048	28.810	26.328	25.271	25.799	26.556	24.828	25.692
T6	28.450	28.457	28.453	28.750	29.067	28.908	25.817	25.107	25.462	26.189	24.498	25.343
CD (p≤0.05)	0.524	1.081	0.802	1.041	0.891	0.966	1.227	1.293	1.260	1.226	1.254	1.240

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

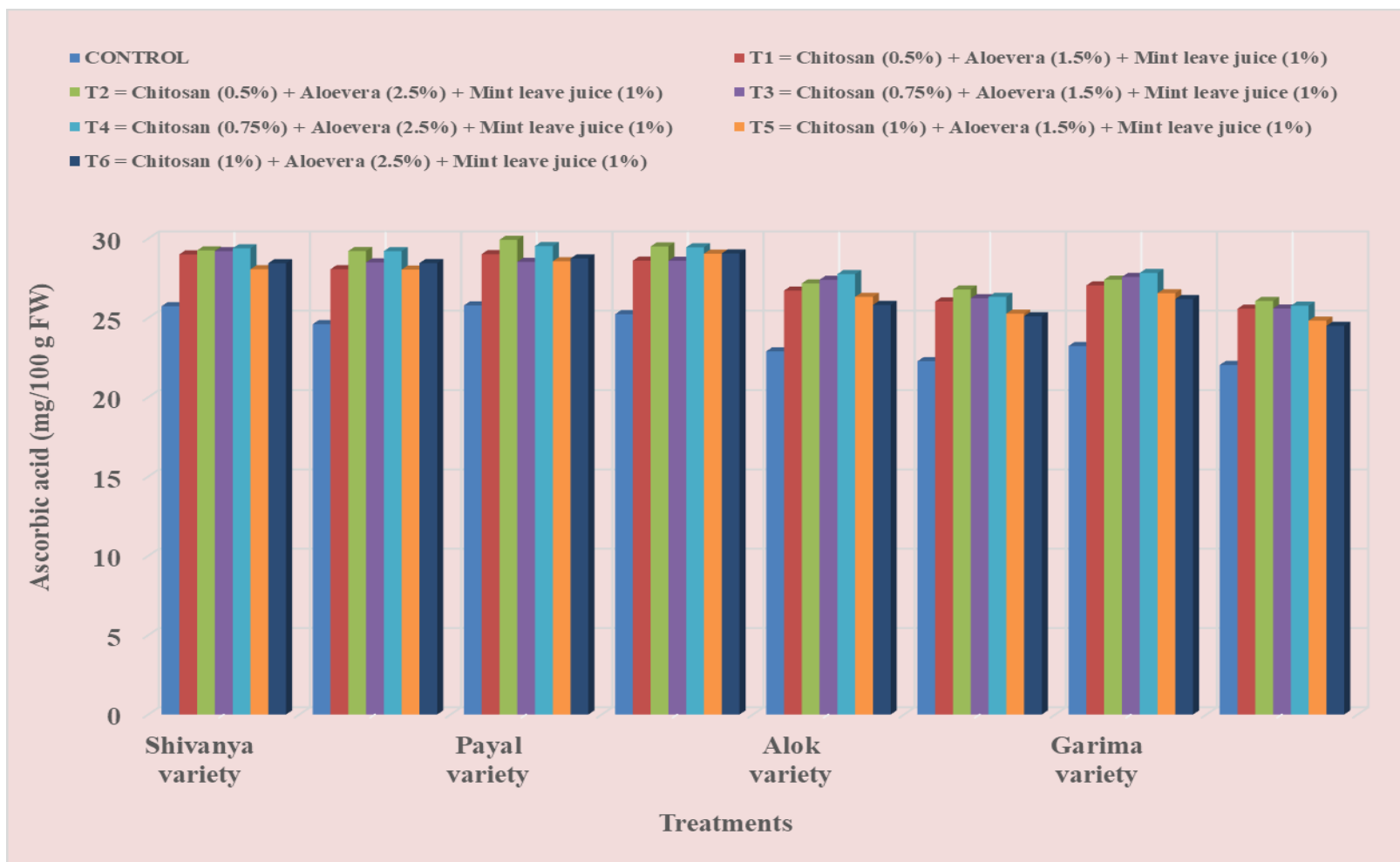


Figure 29: Effect of different treatments on Ascorbic acid after 10 days storage in different varieties of sponge gourd.

4.4.5 TSS:Acid ratio

The TSS:Acid ratio in luffa was presented in Table 4.30(e) detailed that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 30. Firstly in the year 2021 it had been studied that shivanya and payal varieties had less loss in TSS:Acid ratio in T4 12.05 and 12.17 as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties had less loss in TSS:Acid ratio in T4 12.05 and 12.16 as compared to alok and garima varieties. The treatment control showed more decrease in TSS:Acid ratio and treatment T3 Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%) had less decrease in TSS:Acid ratio and is best treatment and same effect was defined by T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) treatment.

The TSS: Acid ratio of produce decreases with an increase in storage days. Mainly the TSS: Acid ratio of two years of pooled data was determined by the values originating from TSS and titratable acidity parameters. The produce coated with T3 and T4 retained more TSS: Acid ratio. The control ones had more loss due to respiration and transpiration losses during the storage of luffa vegetables. The varieties shivanya and payal depicted less loss of TSS:Acid ratio whereas the varieties alok and garima depicted the more loss. The treatments T3 and T4 defined a high amount of TSS: Acid as compared to other treatments. The production of chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of produce from microbes (Han *et al.*, 2014). The results depicted that the control treatment had more decrease in TSS:Acid ratio as compared to the other treatments. These findings are proved by literature reviewers Zhang *et al.*, (2020) and Han *et al.*, (2014).

Table 4.30(a): Effect of different treatments on TSS:Acid ratio at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	TSS:Acid ratio													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	9.953	10.817	14.303	18.317	21.717	33.223	18.055	10.003	11.227	15.053	19.263	26.153	37.593	19.882
T1	9.843	10.173	11.387	13.313	17.780	20.340	13.806	10.003	10.367	10.937	12.853	16.623	21.207	13.665
T2	9.947	10.090	11.083	12.170	15.983	17.683	12.826	10.003	10.223	10.713	12.030	15.380	18.157	12.751
T3	9.843	10.060	11.040	12.927	17.027	18.773	13.278	10.003	10.243	10.673	12.773	16.167	20.220	13.347
T4	9.843	9.867	10.807	11.393	14.107	16.313	12.055	10.003	10.050	10.517	11.373	14.047	17.040	12.172
T5	9.843	10.513	12.380	14.077	15.853	22.383	14.175	10.003	10.727	12.670	13.313	15.797	22.977	14.248
T6	9.843	10.760	12.113	12.773	14.220	19.420	13.188	10.003	11.047	12.693	13.517	14.607	18.553	13.403
Mean	9.874	10.326	11.873	13.567	16.670	21.162		10.003	10.555	11.894	13.589	16.968	22.250	
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	0.611	0.307	0.220	0.000				Factor (Treatments)	0.622	0.312	0.221	0.000		
Factor (Days)	0.566	0.284	0.202	0.000				Factor (Days)	0.576	0.289	0.204	0.000		
Factor (T × D)	1.497	0.751	0.539	0.000				Factor (T × D)	1.524	0.765	0.541	0.000		

Table 4.30(b): Effect of different treatments on TSS:Acid ratio at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	TSS:Acid ratio													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.057	12.753	16.187	22.707	29.830	44.423	22.659	9.947	13.240	16.823	26.827	35.510	40.363	23.785
T1	10.170	12.043	14.327	18.887	24.437	41.020	20.147	10.000	12.293	14.707	22.857	31.117	35.613	21.098
T2	10.170	11.567	13.477	17.520	22.317	34.913	18.327	10.000	12.087	13.930	21.013	28.850	31.187	19.511
T3	10.057	11.363	13.817	18.050	23.457	37.880	19.104	10.000	11.803	12.613	21.270	28.553	32.190	19.405
T4	10.170	11.110	12.983	16.913	20.280	33.307	17.461	10.000	11.610	13.310	20.450	26.080	30.527	18.663
T5	10.170	12.007	14.927	19.517	27.893	39.180	20.616	10.000	12.517	14.480	26.663	30.433	34.510	21.434
T6	10.170	11.860	14.880	18.243	24.940	38.240	19.722	10.000	12.670	14.230	25.823	28.150	36.657	21.255
Mean	10.138	11.815	14.371	18.834	24.736	38.423		9.992	12.317	14.299	23.558	29.813	34.435	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significa nce			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatme nts)	0.795	0.399	0.282	0.000			Factor (Treat ments)	0.813	0.408	0.289	0.000		
	Factor (Days)	0.736	0.370	0.261	0.000			Factor (Days)	0.753	0.378	0.267	0.000		
	Factor (T × D)	1.948	0.978	0.691	0.000			Factor (T × D)	1.992	1.000	0.707	0.000		

Table 4.30(c): Effect of different treatments on TSS:Acid ratio at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	TSS:Acid ratio														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	9.953	10.817	14.303	18.317	21.717	33.223	18.055	10.003	11.227	15.053	19.263	26.153	37.593	19.882	
T1	9.843	10.173	11.387	13.313	17.780	20.340	13.806	10.003	10.367	10.937	12.853	16.623	21.207	13.665	
T2	9.947	10.090	11.083	12.170	15.983	17.683	12.826	10.003	10.223	10.713	12.030	15.380	18.157	12.751	
T3	9.843	10.060	11.040	12.927	17.027	18.773	13.278	10.003	10.243	10.673	12.773	16.167	20.220	13.347	
T4	9.843	9.867	10.807	11.393	14.107	16.313	12.055	10.003	10.050	10.517	11.373	14.047	17.040	12.172	
T5	9.843	10.513	12.380	14.077	15.853	22.383	14.175	10.003	10.727	12.670	13.313	15.797	22.977	14.248	
T6	9.843	10.760	12.113	12.773	14.220	19.420	13.188	10.003	11.047	12.693	13.517	14.607	18.553	13.403	
Mean	9.874	10.326	11.873	13.567	16.670	21.162		10.003	10.555	11.894	13.589	16.968	22.250		
	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance					CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			
Factor (Treatments)	0.611	0.307	0.220	0.000					0.622	0.312	0.221	0.000			
Factor (Days)	0.566	0.284	0.202	0.000					0.576	0.289	0.204	0.000			
Factor (T × D)	1.497	0.751	0.539	0.000					1.524	0.765	0.541	0.000			

Table 4.30(d): Effect of different treatments on TSS:Acid ratio at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	TSS:Acid ratio													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.057	12.753	16.187	22.707	29.830	44.423	22.659	9.947	13.240	16.823	26.827	35.510	40.363	23.785
T1	10.170	12.043	14.327	18.887	24.437	41.020	20.147	10.000	12.293	14.707	22.857	31.117	35.613	21.098
T2	10.170	11.567	13.477	17.520	22.317	34.913	18.327	10.000	12.087	13.930	21.013	28.850	31.187	19.511
T3	10.057	11.363	13.817	18.050	23.457	37.880	19.104	10.000	11.803	12.613	21.270	28.553	32.190	19.405
T4	10.170	11.110	12.983	16.913	20.280	33.307	17.461	10.000	11.610	13.310	20.450	26.080	30.527	18.663
T5	10.170	12.007	14.927	19.517	27.893	39.180	20.616	10.000	12.517	14.480	26.663	30.433	34.510	21.434
T6	10.170	11.860	14.880	18.243	24.940	38.240	19.722	10.000	12.670	14.230	25.823	28.150	36.657	21.255
Mean	10.138	11.815	14.371	18.834	24.736	38.423		9.992	12.317	14.299	23.558	29.813	34.435	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.795	0.399	0.282	0.000			Factor (Treat ments)	0.813	0.408	0.289	0.000		
	Factor (Days)	0.736	0.370	0.261	0.000			Factor (Days)	0.753	0.378	0.267	0.000		
	Factor (T × D)	1.948	0.978	0.691	0.000			Factor (T × D)	1.992	1.000	0.707	0.000		

Table 4.30(e): Effect of different treatments on TSS:Acid ratio after 10 days storage in different varieties of sponge gourd.

Treatments	TSS:Acid ratio											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	18.055	18.059	18.057	19.882	19.879	19.880	22.659	22.653	22.656	23.785	23.782	23.783
T1	13.806	13.809	13.807	13.665	13.661	13.663	20.147	20.142	20.144	21.098	21.095	21.096
T2	12.826	12.834	12.83	12.751	12.747	12.749	18.327	18.322	18.324	19.511	19.506	19.508
T3	13.278	13.274	13.276	13.347	13.342	13.344	19.104	19.101	19.102	19.405	19.401	19.403
T4	12.055	12.059	12.057	12.172	12.167	12.169	17.461	17.457	17.459	18.663	18.661	18.662
T5	14.175	14.171	14.173	14.248	14.241	14.244	20.616	20.612	20.614	21.434	21.432	21.433
T6	13.188	13.182	13.185	13.403	13.401	13.402	19.722	19.720	19.721	21.255	21.253	21.254
CD (p≤0.05)	1.497	1.492	1.494	1.524	1.521	1.522	1.948	1.942	1.945	1.992	1.991	1.991

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ =Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

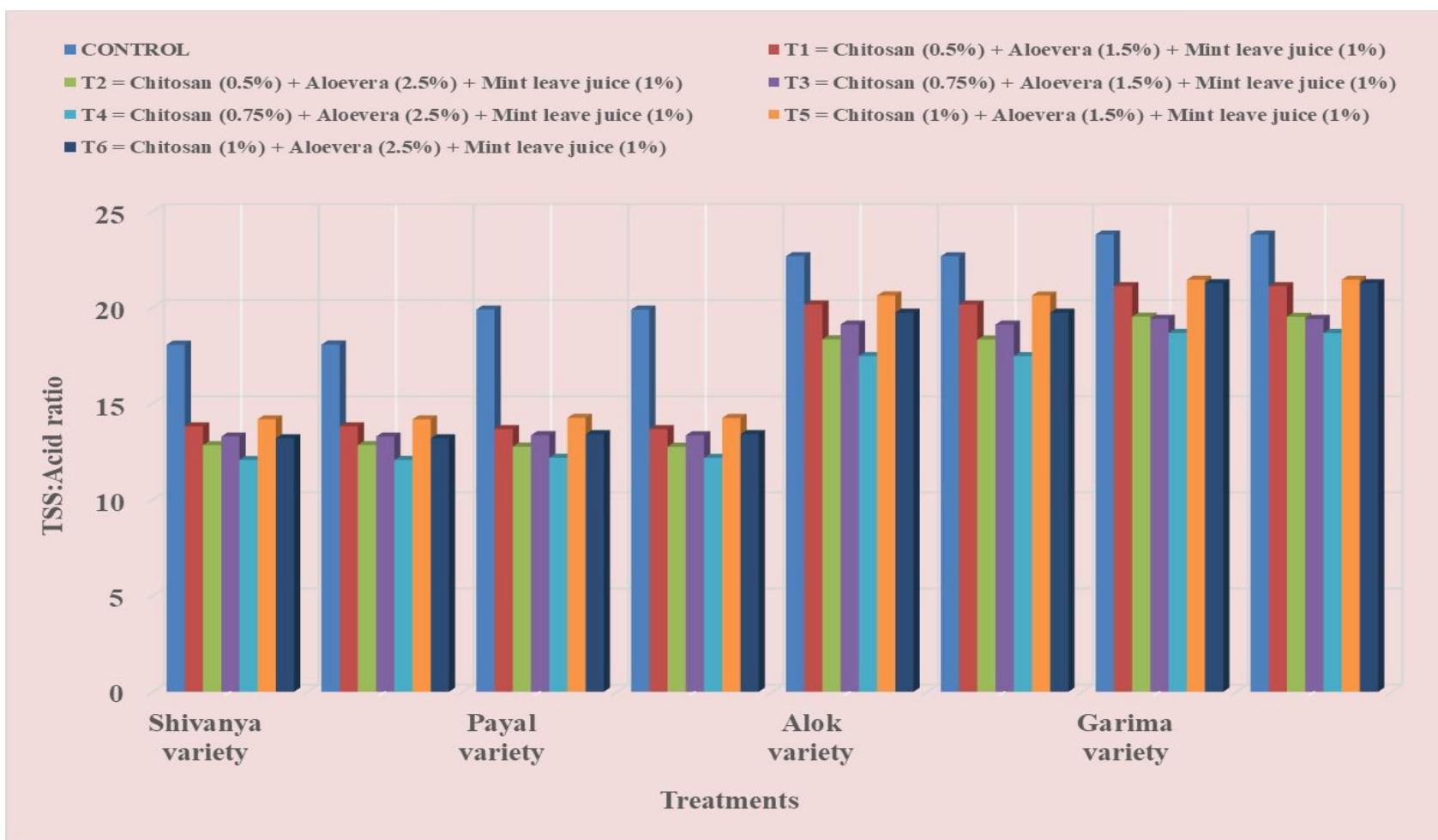


Figure 30: Effect of different treatments on TSS:Acid ratio after 10 days storage in different varieties of sponge gourd

4.4.6 Fruit length (cm)

The fruit length in luffa was presented in Table 4.31(e) outline that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 31. Firstly in the year 2021 it had been studied that shivanya and payal varieties had high amount of fruit length in T4 (10.11 cm) and (10.12 cm) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the fruit length in T4 10.13 cm and 10.09 cm as compared to alok and garima varieties. The produce coated with T3 and T4 retained more fruit length. The control ones had more loss due to respiration and transpiration losses during the storage of luffa vegetables.

The fruit length of luffa vegetables varies with the application of different treatments. With the increase in the number of days, shelf life and produce length start decreasing. The fruit length of produce decreases with an increase in storage days. The varieties shivanya and payal depicted less loss in fruit length whereas the varieties alok and garima depicted more loss in fruit length. The transpiration and respiration during storage cause produce to lose weight and fruit length. The treatments T3 and T4 defined a high amount of fruit length as compared to other treatments. The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa. The incorporation of chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of produce from microbes. The coating prepared from chitosan, aloe vera, and mint has significant behavior on vegetables and provides a good barrier with atmosphere to avoid more loss in fruit length with increasing storage days. A similar investigation was given by Ogunyemi *et al.*, (2020) and Lim, (2012).

Table 4.31(a): Effect of different treatments on fruit length (cm) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Fruit length (cm)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.530	9.867	9.560	9.230	9.127	8.950	9.544	10.537	9.870	9.570	9.240	9.137	8.967	9.553
T1	10.530	10.340	10.137	9.957	9.863	9.710	10.089	10.533	10.350	10.140	9.973	9.873	9.733	10.101
T2	10.547	10.363	10.160	9.970	9.870	9.737	10.108	10.520	10.353	10.167	9.977	9.877	9.747	10.107
T3	10.437	10.377	10.190	9.973	9.877	9.747	10.100	10.523	10.357	10.200	9.983	9.883	9.753	10.117
T4	10.433	10.413	10.213	9.977	9.887	9.757	10.113	10.550	10.370	10.207	9.987	9.890	9.763	10.128
T5	10.373	10.307	10.203	9.963	9.850	9.700	10.066	10.540	10.270	10.183	9.943	9.837	9.690	10.077
T6	10.450	10.330	10.210	9.970	9.857	9.713	10.088	10.547	10.310	10.187	9.967	9.863	9.710	10.097
Mean	10.471	10.285	10.096	9.863	9.761	9.616		10.536	10.269	10.093	9.867	9.766	9.623	
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	0.017	0.008	0.006	0.000				Factor (Treatments)	0.013	0.007	0.005	0.000		
Factor (Days)	0.015	0.008	0.005	0.000				Factor (Days)	0.012	0.006	0.004	0.000		
Factor (T × D)	0.041	0.021	0.015	0.000				Factor (T × D)	0.032	0.016	0.012	0.000		

Table 4.31(b): Effect of different treatments on fruit length (cm) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Fruit length (cm)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.530	9.540	9.427	9.197	9.097	8.930	9.453	10.523	9.550	9.447	9.203	9.107	8.937	9.461
T1	10.533	9.863	9.657	9.480	9.343	9.197	9.679	10.513	9.870	9.667	9.500	9.360	9.200	9.685
T2	10.537	9.883	9.677	9.510	9.397	9.213	9.703	10.520	9.883	9.680	9.503	9.373	9.207	9.694
T3	10.513	9.913	9.710	9.530	9.417	9.233	9.719	10.527	9.903	9.717	9.523	9.410	9.253	9.722
T4	10.533	9.937	9.737	9.550	9.440	9.247	9.741	10.513	9.910	9.723	9.527	9.450	9.257	9.730
T5	10.517	9.880	9.713	9.513	9.400	9.217	9.707	10.513	9.867	9.710	9.527	9.413	9.227	9.709
T6	10.527	9.900	9.720	9.523	9.413	9.230	9.719	10.517	9.900	9.720	9.537	9.417	9.237	9.721
Mean	10.527	9.845	9.663	9.472	9.358	9.181		10.518	9.840	9.666	9.474	9.361	9.188	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.013	0.006	0.005	0.000			Factor (Treat ments)	0.013	0.006	0.004	0.000		
	Factor (Days)	0.012	0.006	0.004	0.000			Factor (Days)	0.012	0.006	0.004	0.000		
	Factor (T × D)	0.031	0.016	0.011	0.000			Factor (T × D)	0.031	0.016	0.011	0.000		

Table 4.31(c): Effect of different treatments on fruit length (cm) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Fruit length (cm)														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	10.390	9.800	9.487	9.193	9.113	8.920	9.484	10.357	9.827	9.467	9.187	9.107	8.913	9.476	
T1	10.407	10.300	10.143	9.913	9.827	9.667	10.043	10.377	10.277	10.117	9.897	9.813	9.640	10.020	
T2	10.407	10.347	10.153	9.940	9.830	9.737	10.069	10.403	10.313	10.130	9.923	9.823	9.717	10.052	
T3	10.400	10.387	10.223	10.013	9.887	9.797	10.118	10.400	10.340	10.197	9.963	9.863	9.767	10.088	
T4	10.403	10.400	10.237	10.017	9.910	9.813	10.130	10.400	10.350	10.210	9.943	9.867	9.773	10.091	
T5	10.417	10.343	10.233	9.937	9.823	9.673	10.071	10.410	10.277	10.150	9.920	9.813	9.650	10.037	
T6	10.420	10.387	10.253	9.953	9.837	9.723	10.096	10.407	10.343	10.180	9.937	9.817	9.687	10.062	
Mean	10.406	10.280	10.104	9.852	9.747	9.619		10.393	10.247	10.064	9.824	9.729	9.592		
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance			
Factor (Treatments)	0.017	0.009	0.006	0.000				Factor (Treatments)	0.011	0.006	0.004	0.000			
Factor (Days)	0.016	0.008	0.006	0.000				Factor (Days)	0.010	0.005	0.004	0.000			
Factor (T × D)	0.042	0.021	0.015	0.000				Factor (T × D)	0.028	0.014	0.010	0.000			

Table 4.31(d): Effect of different treatments on fruit length (cm) at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Fruit length (cm)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.367	9.507	9.413	9.177	9.070	8.867	9.400	10.347	9.527	9.423	9.193	9.113	8.883	9.414
T1	10.397	9.827	9.627	9.403	9.300	9.127	9.613	10.397	9.840	9.660	9.473	9.333	9.143	9.641
T2	10.390	9.843	9.643	9.443	9.347	9.160	9.638	10.410	9.873	9.663	9.470	9.383	9.190	9.665
T3	10.370	9.870	9.670	9.493	9.397	9.197	9.666	10.397	9.880	9.700	9.493	9.427	9.233	9.688
T4	10.347	9.903	9.693	9.517	9.417	9.223	9.683	10.403	9.890	9.710	9.507	9.427	9.237	9.696
T5	10.370	9.847	9.710	9.493	9.380	9.187	9.664	10.400	9.873	9.743	9.557	9.420	9.193	9.698
T6	10.390	9.873	9.723	9.510	9.397	9.207	9.683	10.387	9.900	9.767	9.573	9.453	9.267	9.724
Mean	10.376	9.810	9.640	9.434	9.330	9.138		10.391	9.826	9.667	9.467	9.365	9.164	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.012	0.006	0.004	0.000			Factor (Treat ments)	0.011	0.006	0.004	0.000		
	Factor (Days)	0.011	0.006	0.004	0.000			Factor (Days)	0.010	0.005	0.004	0.000		
	Factor (T × D)	0.029	0.015	0.010	0.000			Factor (T × D)	0.027	0.013	0.010	0.000		

Table 4.31(e): Effect of different treatments on fruit length after 10 days storage in different varieties of sponge gourd.

Treatments	Fruit length (cm)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	9.544	9.484	9.514	9.553	9.476	9.514	9.453	9.400	9.426	9.461	9.414	9.437
T1	10.089	10.043	10.066	10.101	10.020	10.060	9.679	9.613	9.646	9.685	9.641	9.663
T2	10.108	10.069	10.088	10.107	10.052	10.079	9.703	9.638	9.670	9.694	9.665	9.679
T3	10.100	10.118	10.109	10.117	10.088	10.102	9.719	9.666	9.692	9.722	9.688	9.705
T4	10.113	10.130	10.121	10.128	10.091	10.109	9.741	9.683	9.712	9.730	9.696	9.713
T5	10.066	10.071	10.068	10.077	10.037	10.057	9.707	9.664	9.685	9.709	9.698	9.703
T6	10.088	10.096	10.092	10.097	10.062	10.079	9.719	9.683	9.701	9.721	9.724	9.722
CD (p≤0.05)	0.041	0.042	0.041	0.032	0.028	0.030	0.031	0.029	0.030	0.031	0.027	0.029

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

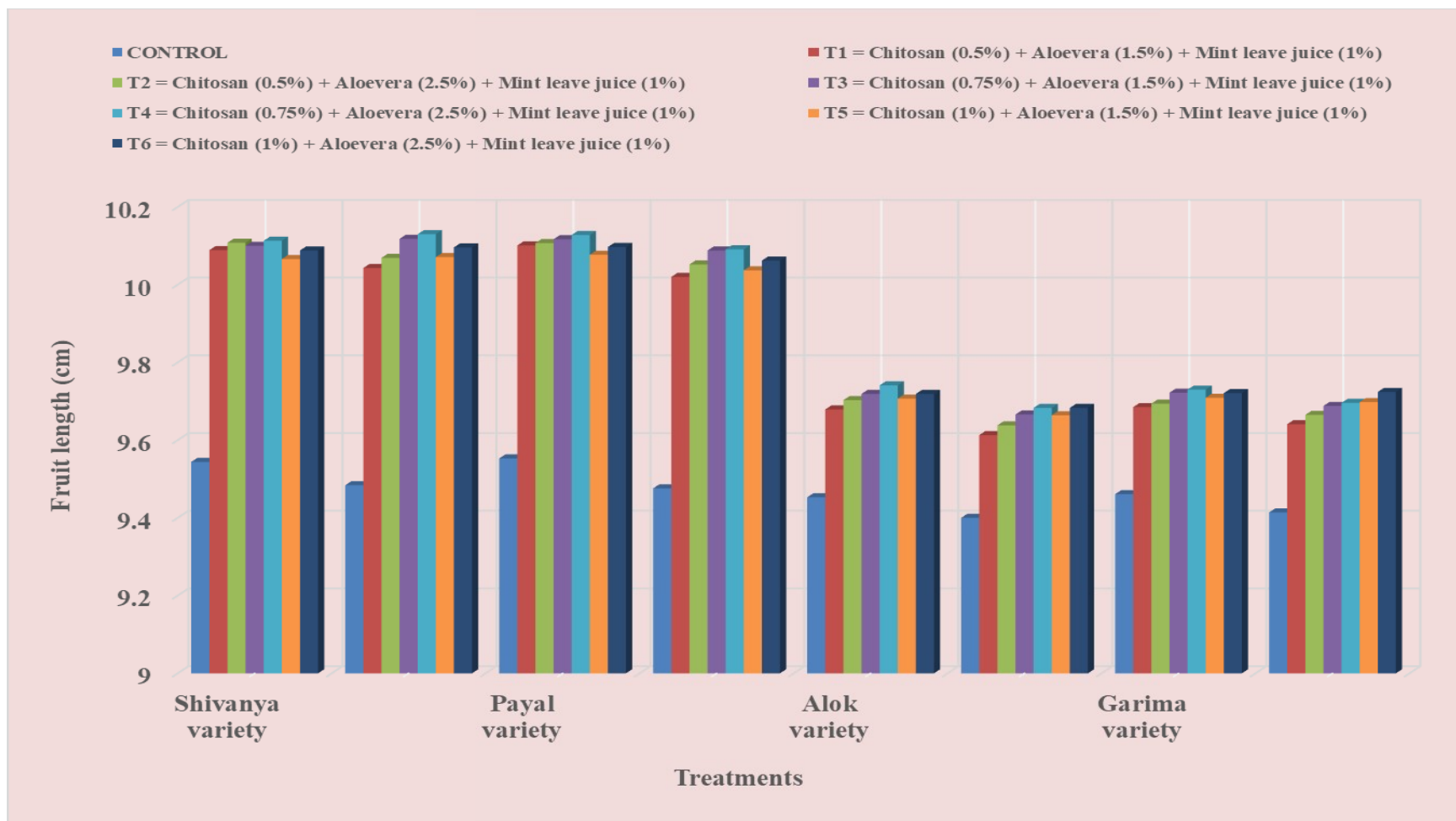


Figure 31: Effect of different treatments on fruit length(cm) after 10 days storage in different varieties of sponge gourd.

4.4.7 Fruit weight (g)

The fruit weight in luffa was presented in Table 4.32(e) portray that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 32. Firstly in the year 2021 it had been studied that shivanya and payal varieties had less decrease of fruit weight in T4 (113.18 g) and (113.70 g) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the fruit weight in T4 (113.04 g) and (113.72g) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more fruit weight. The treatment control showed more decrease in fruit weight and treatment T3 Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%) had less decrease in fruit weight and is best treatment and same effect was defined by T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) treatment.

The fruit weight of luffa vegetables varies with the application of different treatments. With the increase in the number of days, shelf life and produce length start decreasing. The fruit weight of produce decreases with an increase in storage days. The control ones had more loss due to respiration, and transpiration losses during the storage of luffa vegetables. The varieties shivanya and payal depicted less loss of fruit length whereas the varieties alok and garima depicted more loss of fruit weight. The transpiration and respiration during storage cause produce to lose weight and fruit length (Lim, 2012). The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa. The incorporation of chitosan, Aloe vera, and mint coatings slow down the respiration rate and protect the surface of produce from microbes. The coating prepared from chitosan, aloe vera, and mint has significant behavior on vegetables and provides a good barrier with atmosphere to avoid more loss in fruit weight with increasing storage days. A similar investigation was suggested by Ogunyemi *et al.*, (2020) and Lim, (2012).

Table 4.32(a): Effect of different treatments on fruit weight (g) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Fruit weight (g)														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	122.833	111.333	98.667	94.933	90.033	76.800	99.100	125.433	113.133	100.067	97.367	91.800	80.607	101.401	
T1	122.833	121.700	117.200	112.667	102.800	93.667	111.811	123.367	121.967	117.833	113.067	105.133	95.233	112.767	
T2	122.743	122.533	117.500	113.167	103.167	94.923	112.339	123.167	123.033	118.300	113.500	103.500	95.413	112.819	
T3	123.967	123.933	117.200	113.233	103.533	95.200	112.844	123.033	122.667	119.033	114.067	104.067	95.657	113.087	
T4	124.333	124.300	117.367	113.500	104.067	95.533	113.183	122.767	122.733	119.667	115.900	105.167	95.983	113.703	
T5	123.033	122.267	116.200	112.000	102.433	93.067	111.500	122.033	120.467	117.467	116.067	105.167	92.373	112.262	
T6	89.067	88.433	116.100	112.433	102.367	93.333	100.289	122.240	121.033	117.833	116.067	106.133	93.213	112.753	
Mean	118.401	116.357	114.319	110.276	101.200	91.789		123.149	120.719	115.743	112.291	102.995	92.640		
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance			
Factor (Treatments)	8.773	4.404	3.114	0.000				Factor (Treatments)	0.485	0.244	0.172	0.000			
Factor (Days)	8.122	4.077	2.883	0.000				Factor (Days)	0.449	0.226	0.160	0.000			
Factor (T × D)	N/A	10.787	7.627	0.572				Factor (T × D)	1.189	0.597	0.422	0.000			

Table 4.32(b): Effect of different treatments on fruit weight (g) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Fruit weight (cm)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	124.133	108.433	93.067	88.100	81.433	74.810	94.996	123.833	108.067	93.400	88.400	83.233	75.167	95.350
T1	124.167	116.500	110.833	100.567	89.647	82.500	104.036	123.000	114.500	112.967	100.467	89.777	83.667	104.063
T2	122.533	117.733	112.633	101.267	91.743	83.467	104.896	121.100	115.967	116.233	102.300	91.623	83.167	105.065
T3	122.767	118.133	113.033	102.567	93.567	86.867	106.156	122.067	118.033	113.200	103.500	93.067	86.633	106.083
T4	123.133	118.533	114.000	104.033	94.167	88.300	107.028	122.467	117.633	114.200	105.000	94.167	87.990	106.910
T5	122.000	112.967	102.800	92.767	90.367	82.800	100.617	120.200	112.367	104.167	94.200	90.900	83.833	100.944
T6	122.767	113.667	103.833	93.467	89.967	83.500	101.200	121.067	113.800	104.900	94.200	90.133	84.467	101.428
Mean	123.071	115.138	107.171	97.538	90.127	83.178		121.962	114.338	108.438	98.295	90.414	83.560	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	1.063	0.534	0.377	0.000			Factor (Treatments)	1.213	0.609	0.430	0.000		
	Factor (Days)	0.984	0.494	0.349	0.000			Factor (Days)	1.123	0.564	0.398	0.000		
	Factor (T × D)	2.604	1.307	0.924	0.000			Factor (T × D)	2.970	1.491	1.054	0.000		

Table 4.32(c): Effect of different treatments on fruit weight (g) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Fruit weight (g)														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	119.217	110.967	97.727	93.973	86.510	75.370	97.294	121.367	111.800	103.653	96.207	89.023	80.897	100.491	
T1	120.257	118.620	114.360	111.687	100.633	92.000	109.593	119.733	119.653	116.987	110.980	102.647	93.977	110.663	
T2	119.340	120.000	116.623	114.690	102.000	93.733	111.064	121.833	121.033	118.200	115.700	104.000	96.333	112.850	
T3	122.007	121.117	117.723	115.993	103.667	94.763	112.545	122.667	121.167	119.307	116.867	106.033	96.677	113.786	
T4	122.943	120.800	117.673	116.633	104.933	95.267	113.042	119.467	122.200	120.133	117.633	105.933	97.000	113.728	
T5	121.700	119.000	116.600	114.400	103.767	94.167	111.606	120.500	121.367	118.067	116.967	106.400	96.150	113.242	
T6	122.233	120.400	117.333	115.333	104.867	94.567	112.456	121.367	121.400	118.633	116.933	107.100	96.700	113.689	
Mean	121.100	118.701	114.006	111.816	100.911	91.410		120.991	119.803	116.426	113.041	103.020	93.962		
	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance					CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			
Factor (Treatments)	0.672	0.337	0.239	0.000				Factor (Treat ments)	0.871	0.437	0.309	0.000			
Factor (Days)	0.622	0.312	0.221	0.000				Factor (Days)	0.807	0.405	0.286	0.000			
Factor (T × D)	1.647	0.827	0.584	0.572				Factor (T × D)	2.135	1.071	0.758	0.000			

Table 4.32(d): Effect of different treatments on fruit weight (g) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Fruit weight (cm)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	122.367	105.933	94.167	86.067	80.367	74.600	93.917	121.500	106.933	96.000	89.467	84.267	77.433	95.933
T1	121.033	114.667	110.900	98.133	85.780	81.833	102.058	120.600	116.333	113.867	99.567	88.700	84.253	103.887
T2	120.600	115.900	112.267	98.933	89.967	82.167	103.306	121.100	116.733	115.233	101.900	94.933	86.267	106.028
T3	121.833	116.767	112.200	100.500	92.567	84.567	104.739	120.567	116.933	115.967	104.533	96.333	87.433	106.961
T4	121.500	117.267	114.200	102.100	93.833	86.267	105.861	121.933	117.467	116.233	106.167	97.600	88.433	107.972
T5	120.900	113.233	103.833	98.433	91.333	84.267	102.000	121.000	114.200	105.133	98.500	93.100	85.300	102.872
T6	121.600	114.567	105.900	98.333	92.100	87.367	103.311	120.233	115.267	106.700	98.633	93.400	88.000	103.706
Mean	121.405	114.048	107.638	97.500	89.421	83.010		120.991	114.838	109.876	99.824	92.619	85.303	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.899	0.451	0.319	0.000			Factor (Treatments)	0.846	0.424	0.300	0.000		
	Factor (Days)	0.832	0.418	0.295	0.000			Factor (Days)	0.783	0.393	0.278	0.000		
	Factor (T × D)	2.202	1.105	0.782	0.000			Factor (T × D)	2.071	1.040	0.735	0.000		

Table 4.32(e): Effect of different treatments on fruit weight after 10 days storage in different varieties of sponge gourd.

Treatments	Fruit weight (g)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	99.100	97.294	98.197	101.401	100.491	100.946	94.996	93.917	94.456	95.350	95.933	95.641
T1	111.811	109.593	110.702	112.767	110.663	111.715	104.036	102.058	103.047	104.063	103.887	103.975
T2	112.339	111.064	111.701	112.819	112.850	112.834	104.896	103.306	104.101	105.065	106.028	105.546
T3	112.844	112.545	112.694	113.087	113.786	113.436	106.156	104.739	105.447	106.083	106.961	106.522
T4	113.183	113.042	113.112	113.703	113.728	113.715	107.028	105.861	106.444	106.910	107.972	107.441
T5	111.500	111.606	111.553	112.262	113.242	112.752	100.617	102.000	101.308	100.944	102.872	101.908
T6	100.289	112.456	106.372	112.753	113.689	113.221	101.200	103.311	102.255	101.428	103.706	102.567
CD (p≤0.05)	N/A	1.647	1.647	1.189	2.135	1.662	2.604	2.202	2.403	2.970	2.071	2.520

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

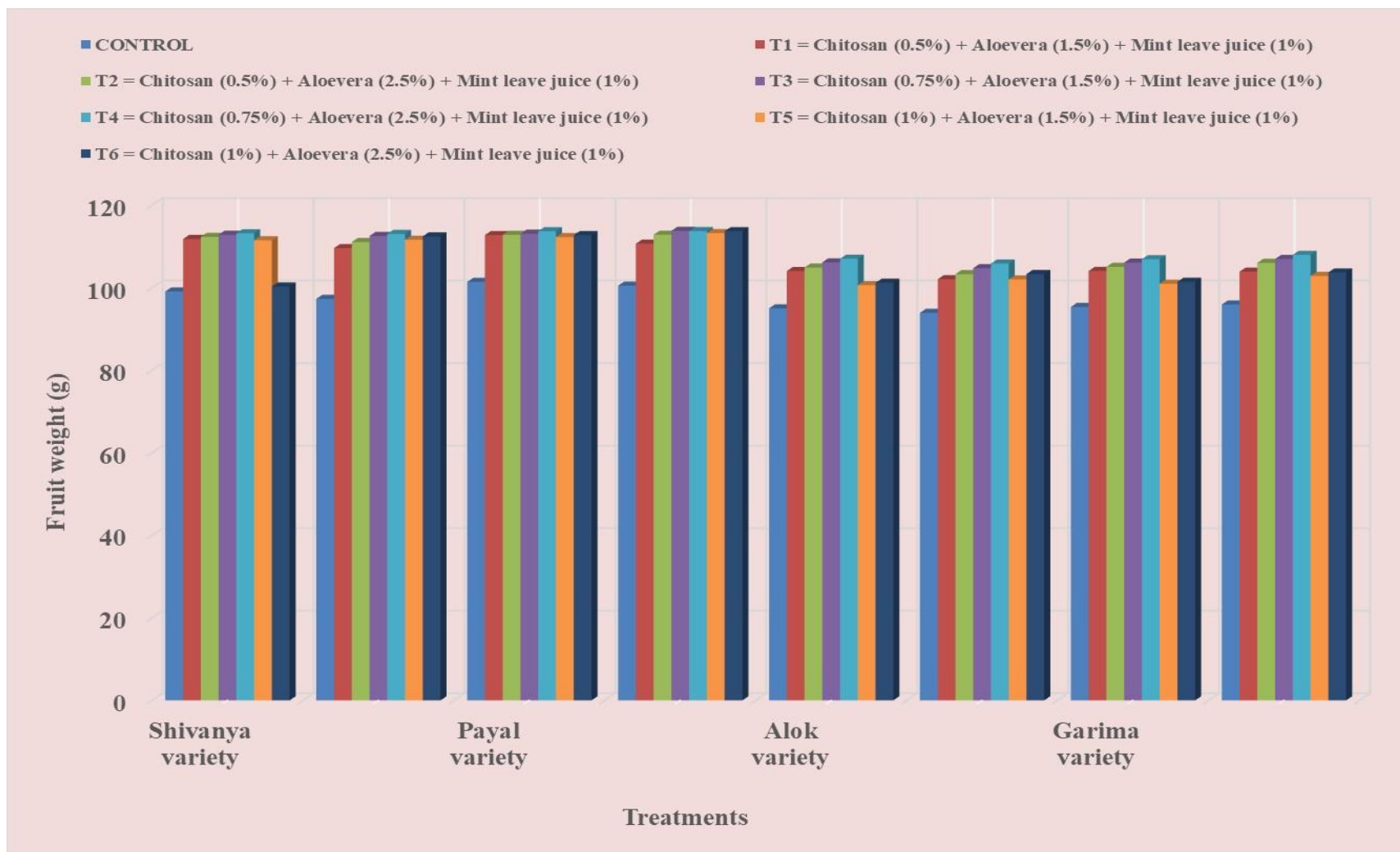


Figure 32: Effect of different treatments on fruit weight after 10 days storage in different varieties of sponge gourd.

4.4.8 Overall acceptability

The overall acceptability in luffa was presented in Table 4.33(e) explicate that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed. Firstly in the year 2021 it had been studied that shivanya and payal varieties had good overall acceptability in T4 (6.63) and (6.70) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the overall acceptability in T4 (7.03) and (7.08) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more overall acceptability.

Sensory quality is a criterion for determining the overall acceptability of any food or food product by the consumers. The quality and nutritional attributes of food depend upon its sensory quality (Han *et al.*, 2014). The 9-point hedonic scale was used to record the marks suggested by judges about the sample. The sensory score was varied with different treatments on luffa vegetables as shown in Figure 33. The control treatment had fewer scores as compared to other treatments. The produce with treatments T3 and T4 suggested the best overall acceptability as compared to other treatments. Mainly the overall acceptability was decreased with an increase in storage days. The application of the right coating provides good shelf life and quality maintenance to the produce. The control produce had lower acceptability scoring and varieties shivanya and payal had good scoring as compared to alok and garima varieties in the refrigerator conditions. The coating prepared from chitosan, aloe vera, and mint has significant behavior on vegetables and provides a good barrier to the atmosphere with increasing storage days. This detailing was similar to Gedam and Dongre, (2016) and Han *et al.*, (2014).

Table 4.33(a): Effect of different treatments on Overall acceptability at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Overall acceptability														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	8.333	8.400	7.367	6.500	5.367	4.167	6.689	8.667	8.533	7.533	6.600	5.533	4.267	6.856	
T1	8.667	8.567	7.433	6.733	5.700	4.600	6.950	8.333	8.667	7.567	6.733	5.833	4.633	6.961	
T2	8.333	8.700	7.567	6.733	5.767	4.667	6.961	8.667	8.733	7.733	6.833	5.867	4.767	7.100	
T3	8.667	8.833	7.667	6.767	5.800	4.833	7.094	8.333	8.800	7.867	6.867	5.900	4.867	7.106	
T4	8.333	8.300	7.300	6.267	5.367	4.267	6.639	8.667	8.233	7.300	6.367	5.367	4.267	6.700	
T5	8.667	8.367	7.533	6.400	5.433	4.367	6.794	8.333	8.367	7.500	6.533	5.467	4.433	6.772	
T6	8.667	8.233	7.300	6.233	5.233	4.267	6.656	8.333	8.233	7.300	6.300	5.233	4.267	6.611	
Mean	8.524	8.486	7.452	6.519	5.524	4.452		8.476	8.510	7.543	6.605	5.600	4.500		
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance			
Factor (Treatments)	0.166	0.083	0.059	0.000					0.164	0.083	0.058	0.000			
Factor (Days)	0.154	0.077	0.055	0.000					0.152	0.076	0.054	0.000			
Factor (T × D)	N/A	0.204	0.144	0.828					N/A	0.202	0.143	0.597			

Table 4.33(b): Effect of different treatments on Overall acceptability at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Overall acceptability													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	8.667	7.267	6.067	5.267	4.967	4.067	6.050	8.333	7.167	6.067	5.200	4.833	4.000	5.933
T1	8.667	7.567	6.500	5.567	5.167	4.167	6.272	8.667	7.500	6.333	5.333	5.333	4.133	6.217
T2	8.667	7.667	6.667	5.667	5.267	4.267	6.367	8.667	7.600	6.433	5.433	5.333	4.200	6.278
T3	8.667	7.767	6.767	5.700	5.367	4.367	6.439	8.667	7.667	6.500	5.567	5.500	4.333	6.372
T4	8.667	7.433	6.367	5.333	5.333	4.133	6.211	8.667	7.200	6.167	5.233	5.067	4.033	6.061
T5	8.667	7.467	6.500	5.433	5.267	4.267	6.267	8.667	7.333	6.233	5.333	5.233	4.133	6.156
T6	8.667	7.367	6.267	5.267	5.167	4.133	6.144	8.667	7.233	6.167	5.133	5.033	3.900	6.022
Mean	8.667	7.505	6.448	5.462	5.219	4.200		8.619	7.386	6.271	5.319	5.190	4.105	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.177	0.089	0.063	0.000			Factor (Treat ments)	0.167	0.084	0.059	0.000		
	Factor (Days)	0.164	0.082	0.058	0.000			Factor (Days)	0.155	0.078	0.055	0.000		
	Factor (T × D)	N/A	0.218	0.154	0.997			Factor (T × D)	N/A	0.205	0.145	0.999		

Table 4.33(c): Effect of different treatments on Overall acceptability at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Overall acceptability														
	Shivanya variety							Payal variety							
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean	
CONTROL	8.333	8.400	7.533	6.567	5.400	4.067	6.717	8.333	8.433	7.600	6.667	5.600	4.167	6.800	
T1	8.000	8.500	7.600	6.733	5.633	4.267	6.789	8.333	8.667	7.700	6.833	5.767	4.333	6.939	
T2	8.667	8.633	7.633	6.800	5.667	4.333	6.956	8.333	8.800	7.867	6.900	5.800	4.467	7.028	
T3	8.667	8.733	7.800	6.833	5.800	4.633	7.078	8.333	8.867	7.933	6.967	5.867	4.767	7.122	
T4	8.667	8.700	7.733	6.767	5.767	4.567	7.033	8.667	8.733	7.833	6.833	5.833	4.633	7.089	
T5	8.333	8.333	7.367	6.333	5.467	4.433	6.711	8.667	8.433	7.633	6.533	5.567	4.533	6.894	
T6	8.000	8.267	7.267	6.167	5.233	4.233	6.528	8.667	8.333	7.433	6.267	5.367	4.467	6.756	
Mean	8.381	8.510	7.562	6.600	5.567	4.362		8.476	8.610	7.714	6.714	5.686	4.481		
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance			
Factor (Treatments)	0.205	0.103	0.073	0.000				Factor (Treatments)	0.166	0.084	0.059	0.000			
Factor (Days)	0.189	0.095	0.067	0.000				Factor (Days)	0.154	0.077	0.055	0.000			
Factor (T × D)	N/A	0.205	0.178	0.992				Factor (T × D)	N/A	0.205	0.145	0.322			

Table 4.33(d): Effect of different treatments on Overall acceptability at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Overall acceptability													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	8.667	7.400	5.933	5.300	4.767	3.933	6.000	8.000	7.333	5.867	5.167	4.567	3.800	5.789
T1	8.667	7.633	6.500	5.500	5.067	4.133	6.250	8.333	7.400	6.233	5.233	5.033	4.033	6.044
T2	8.333	7.833	6.767	5.633	5.267	4.300	6.356	8.333	7.467	6.233	5.333	5.167	4.233	6.128
T3	8.333	7.867	6.833	5.767	5.400	4.367	6.428	8.667	7.567	6.567	5.633	5.433	4.267	6.356
T4	8.667	7.567	6.433	5.500	5.267	4.200	6.272	8.333	7.633	6.500	5.467	5.200	4.200	6.222
T5	8.333	7.567	6.333	5.333	5.167	4.133	6.144	8.667	7.500	6.167	5.233	5.167	4.000	6.122
T6	8.667	7.333	6.167	5.200	5.033	4.033	6.072	8.667	7.333	6.133	5.133	4.967	3.767	6.000
Mean	8.524	7.600	6.424	5.462	5.138	4.157		8.429	7.462	6.243	5.314	5.076	4.043	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.186	0.093	0.066	0.000			Factor (Treat ments)	0.186	0.093	0.066	0.000		
	Factor (Days)	0.172	0.087	0.061	0.000			Factor (Days)	0.172	0.087	0.061	0.000		
	Factor (T × D)	N/A	0.229	0.229	0.997			Factor (T × D)	N/A	0.229	0.162	0.902		

Table 4.33 (e): Effect of different treatments on Overall acceptability after 10 days storage in different varieties of sponge gourd.

Treatments	Overall acceptability											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	6.689	6.717	6.703	6.856	6.800	6.828	6.050	6.000	6.025	5.933	5.789	5.86
T1	6.950	6.789	6.869	6.961	6.939	6.950	6.272	6.250	6.261	6.217	6.044	6.130
T2	6.961	6.956	6.958	7.100	7.028	7.064	6.367	6.356	6.361	6.278	6.128	6.203
T3	7.094	7.078	7.086	7.106	7.122	7.114	6.439	6.428	6.433	6.372	6.356	6.364
T4	6.639	7.033	6.836	6.700	7.089	6.894	6.211	6.272	6.241	6.061	6.222	6.141
T5	6.794	6.711	6.752	6.772	6.894	6.833	6.267	6.144	6.205	6.156	6.122	6.139
T6	6.656	6.528	6.592	6.611	6.756	6.683	6.144	6.072	6.108	6.022	6.000	6.011
CD (p≤0.05)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ =Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

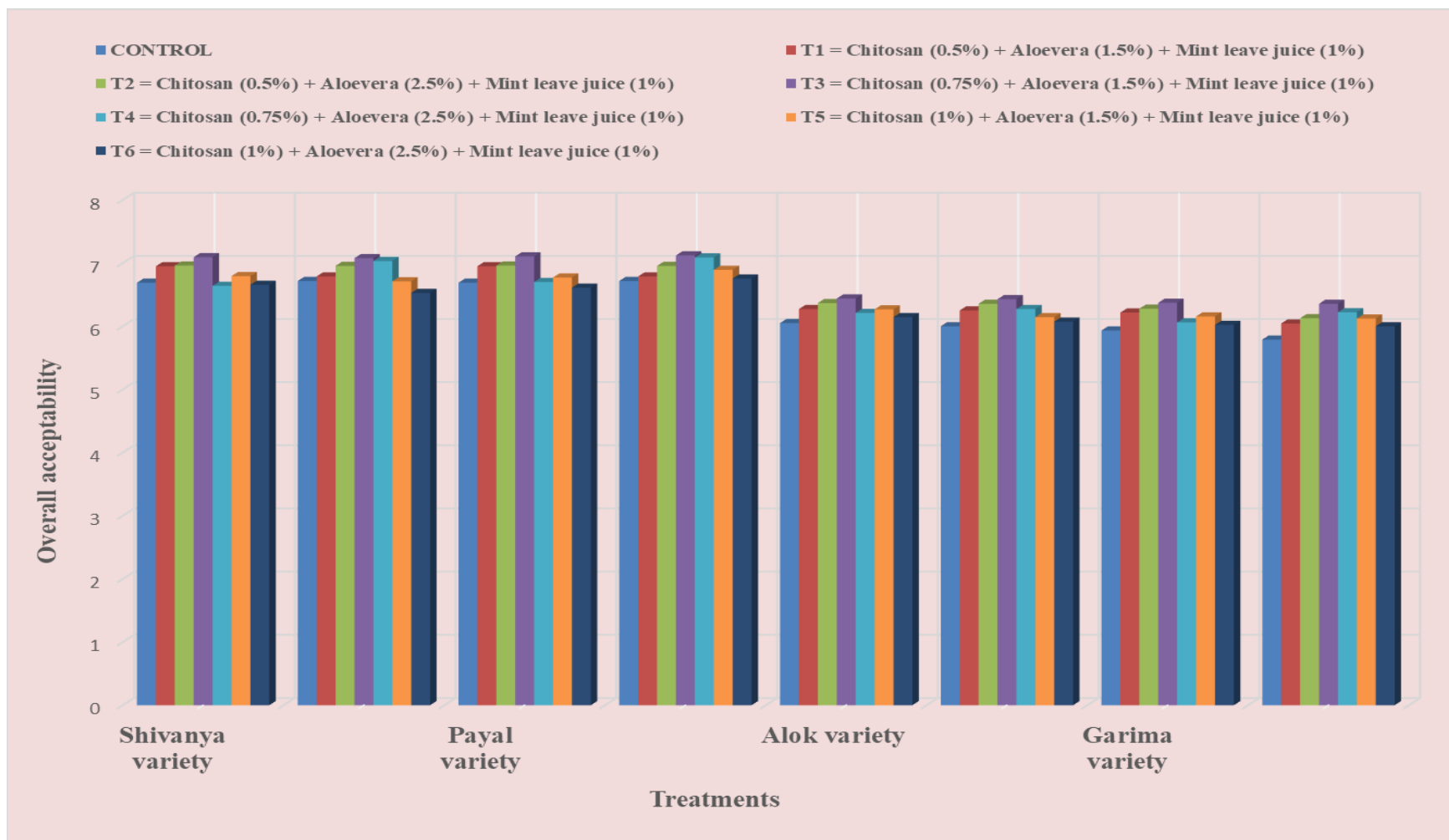


Figure 33: Effect of different treatments on Overall acceptability after 10 days storage in different varieties of sponge gourd.

4.5 Biochemical parameter

4.5.1 Phenols (mg/100g FW)

The phenols in luffa were presented in Table 4.34(e) described that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 34. Firstly in the year 2021 it had been studied that shivanya and payal varieties had less decrease in phenolic content in T4 (385.64 mg/100g) and (384.86 mg/100g) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the phenolic content in T4 (380.21 mg/g) and (380.72 mg/g) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more phenols. The treatments T3 and T4 defined a high amount of phenols as compared to other treatments. The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa.

Total phenol content (TPC) activity is the amount of phenolic content in the samples. The produce coated with T3 and T4 retained more phenols. The control ones had more loss due to respiration and transpiration losses during the storage of luffa vegetables. The varieties Shivanya and Payal depicted less loss of phenols whereas the varieties Alok and Garima depicted more loss of phenol content. The transpiration and respiration during storage cause produce to loss of phenolic amount. The coating prepared from chitosan, aloe vera, and mint has significant behavior on vegetables and provides a good barrier with atmosphere to avoid more loss in phenolics with increasing storage days. According to Kerch, (2015), the decrement in phenolic compounds after the storage is likely due to the break-up of cell structure as the fruit perishes. As Seedao *et al.*, (2018) reported, it is possible that chitosan coating created a semi-permeable barrier on the fruit surface that restricted gas exchange, reduced water loss, and delayed ripening and senescence by modifying the endogenous CO₂, O₂, ethylene, and ultimately reduce the oxygen supply for enzymatic oxidation of phenolics. The incorporation of chitosan with aloe vera and mint maintained higher contents of total phenols, and similar results were reported by Seedao *et al.*, (2018) and Kerch, (2015).

Table 4.34(a): Effect of different treatments on phenols at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Phenols (mg/100g FW)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	421.907	388.033	378.033	355.300	332.867	323.300	366.573	421.907	388.567	378.700	356.100	333.600	323.800	367.112
T1	421.907	400.267	387.400	375.100	364.033	354.733	383.907	421.907	400.800	387.800	375.900	365.100	356.500	384.668
T2	421.907	400.767	388.167	376.867	365.933	355.300	384.823	421.907	400.800	388.867	377.467	367.267	356.400	385.451
T3	421.907	400.867	389.167	377.300	366.500	355.800	385.257	421.907	404.567	389.533	377.900	367.400	356.500	386.301
T4	421.907	401.033	389.500	377.767	367.300	356.333	385.640	421.907	401.400	389.833	370.967	367.800	357.267	384.862
T5	421.907	388.033	387.600	376.600	365.433	354.367	382.323	421.907	389.467	387.867	376.767	365.700	354.733	382.740
T6	421.907	388.400	387.967	376.900	365.967	354.933	382.679	421.907	388.733	388.500	377.367	367.100	355.733	383.223
Mean	421.907	395.343	386.833	373.691	361.148	350.681		421.907	396.333	387.300	373.210	361.995	351.562	
	CD (p≤ 0.05)	SE (d)	SE (m)	Significance					CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	4.016	2.016	1.425	0.000				Factor (Treatments)	4.508	2.263	1.600	0.000		
Factor (Days)	3.178	1.866	1.320	0.000				Factor (Days)	4.174	2.095	1.481	0.000		
Factor (T × D)	9.836	4.937	3.491	0.000				Factor (T × D)	11.04	5.543	3.919	0.003		

Table 4.34(b): Effect of different treatments on phenols at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Phenols (mg/100g FW)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	421.907	381.600	373.167	350.067	327.500	319.000	362.207	421.907	381.667	373.767	350.533	328.467	319.133	362.579
T1	421.907	388.533	376.833	360.100	354.567	347.933	374.979	421.907	388.633	375.167	359.400	355.067	347.567	374.623
T2	421.907	389.467	378.667	361.667	355.033	348.500	375.873	421.907	389.000	378.667	361.933	356.100	348.700	376.051
T3	421.907	389.633	379.333	367.167	355.533	349.100	377.112	421.907	388.900	378.867	367.833	355.500	349.167	377.029
T4	421.907	389.800	379.667	367.700	355.867	349.433	377.396	421.907	389.867	379.700	367.733	356.667	349.800	377.612
T5	421.907	383.400	374.867	365.067	353.533	343.067	373.640	421.907	383.200	373.400	363.000	353.033	343.333	372.979
T6	421.907	384.133	376.233	366.367	355.900	344.833	374.896	421.907	383.833	374.167	364.000	353.367	344.200	373.579
Mean	421.907	386.652	376.967	362.591	351.133	343.124		421.907	386.443	376.248	362.062	351.171	343.129	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treatments)	0.923	0.463	0.328	0.000			Factor (Treatments)	0.884	0.444	0.314	0.000		
	Factor (Days)	0.855	0.429	0.303	0.000			Factor (Days)	0.819	0.411	0.291	0.000		
	Factor (T × D)	2.261	1.135	0.803	0.000			Factor (T × D)	2.166	1.087	0.769	0.000		

Table 4.34(c): Effect of different treatments on phenols at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Phenols (mg/100g FW)															
	Shivanya variety							Payal variety								
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean		
CONTROL	398.643	387.167	376.567	353.133	332.200	324.167	361.980	398.643	388.333	377.900	354.867	332.900	325.133	362.963		
T1	398.643	393.133	385.200	372.867	362.867	353.200	377.652	398.643	394.300	386.167	374.667	364.300	354.033	378.685		
T2	398.643	396.933	386.300	374.967	364.333	354.200	379.229	398.643	397.300	387.133	376.367	365.367	355.233	380.007		
T3	398.643	395.900	386.933	374.567	363.900	353.467	378.902	398.643	397.367	388.300	376.333	365.033	355.167	380.141		
T4	398.643	397.200	387.933	375.900	365.767	355.833	380.213	398.643	398.200	388.400	376.733	366.167	356.200	380.724		
T5	398.643	389.267	385.967	374.200	367.533	357.133	378.791	398.643	390.633	387.400	375.200	366.833	356.767	379.246		
T6	398.643	390.633	387.633	376.033	367.433	358.233	379.768	398.643	391.467	388.200	377.133	367.433	357.067	379.991		
Mean	398.643	392.891	385.219	371.667	360.576	350.891		398.643	393.943	386.214	373.043	361.148	351.372			
	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance					CD (p≤0.05)	SE (d)	SE (m)	Signifi cance				
Factor (Treatments)	0.537	0.270	0.191	0.000					Factor (Treat ments)	0.529	0.265	0.188	0.000			
Factor (Days)	0.497	0.250	0.176	0.000					Factor (Days)	0.489	0.264	0.174	0.000			
Factor (T × D)	1.315	0.660	0.467	0.000					Factor (T × D)	1.295	0.650	0.460	0.003			

Table 4.34(d): Effect of different treatments on phenols at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Phenols (mg/100g FW)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	398.643	383.533	374.167	352.867	329.833	322.200	360.207	398.643	385.167	375.800	353.933	332.133	322.533	361.368
T1	398.643	392.067	383.100	371.467	362.367	353.167	376.802	398.643	393.167	384.267	372.433	363.233	353.967	377.618
T2	398.643	393.867	384.833	372.867	363.333	354.467	378.002	398.643	394.467	385.567	373.367	362.900	355.133	378.346
T3	398.643	392.833	383.800	371.767	362.167	354.200	377.235	398.643	393.100	383.967	372.233	363.100	354.933	377.663
T4	398.643	394.200	385.633	373.200	363.233	355.000	378.318	398.643	395.200	385.967	373.700	363.600	355.533	378.774
T5	398.643	386.133	384.600	376.967	365.200	354.633	377.696	398.643	387.000	385.500	376.767	363.933	353.933	377.630
T6	398.643	388.233	385.533	377.533	366.067	356.100	378.685	398.643	388.267	386.433	378.600	365.333	355.133	378.735
Mean	398.643	390.124	383.095	370.952	358.886	349.967		398.643	390.910	383.929	371.576	359.176	350.167	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.472	0.237	0.167	0.000			Factor (Treatments)	0.413	0.207	0.147	0.000		
	Factor (Days)	0.437	0.219	0.155	0.000			Factor (Days)	0.382	0.192	0.136	0.000		
	Factor (T × D)	1.155	0.580	0.410	0.000			Factor (T × D)	1.011	0.508	0.359	0.000		

Table 4.34(e): Effect of different treatments on phenols after 10 days storage in different varieties of sponge gourd.

Treatments	Phenols (mg/100g FW)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	366.573	361.980	364.276	367.112	362.963	365.037	362.207	360.207	361.207	362.579	361.368	361.973
T1	383.907	377.652	380.779	384.668	378.685	381.676	374.979	376.802	375.890	374.623	377.618	376.120
T2	384.823	379.229	382.026	385.451	380.007	382.729	375.873	378.002	376.937	376.051	378.346	377.198
T3	385.257	378.902	382.079	386.301	380.141	383.221	377.112	377.235	377.173	377.029	377.663	377.346
T4	385.640	380.213	382.926	384.862	380.724	382.793	377.396	378.318	377.857	377.612	378.774	378.193
T5	382.323	378.791	380.557	382.740	379.246	380.993	373.640	377.696	375.668	372.979	377.630	375.304
T6	382.679	379.768	381.223	383.223	379.991	381.607	374.896	378.685	376.790	373.579	378.735	376.157
CD (p≤0.05)	9.836	1.315	5.575	11.04	1.295	6.167	2.261	1.155	1.708	2.166	1.011	1.588

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ = Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan(1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

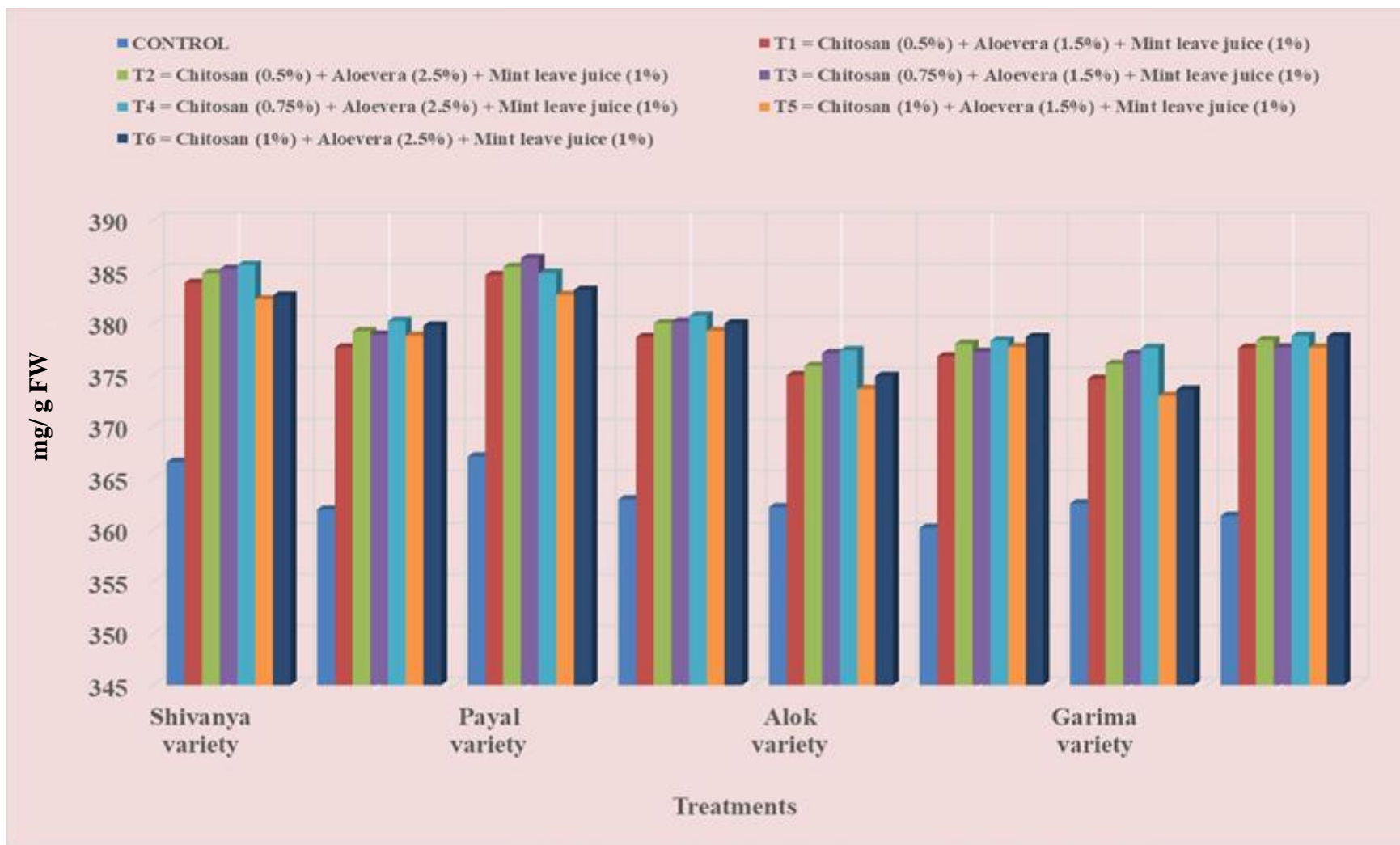


Figure 34: Effect of different treatments on phenols after 10 days storage in different varieties of sponge gourd.

4.5.2 DPPH (%)

The DPPH in luffa was presented in Table 4.35(e) depicts that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 35. Firstly in the year 2021 it had been studied that shivanya and payal varieties had less decrease in antioxidant activity in T4 (32.58 %) and (32.68 %) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the DPPH in T4 (32.40 %) and (32.98 %) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more DPPH. The treatments T3 and T4 defined a high amount of antioxidants as compared to other treatments. The treatment control showed more decrease in antioxidant amount and treatment T3 Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%) had less decrease in DPPH and is best treatment and same effect was defined by T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) treatment.

The DPPH radical scavenging activity is generally quantified in terms of the inhibition percentage of the pre-formed free radical by antioxidants. The produce coated with T3 and T4 retained more DPPH scavenging activity. The control ones had more loss due to respiration, and transpiration losses during the storage of luffa vegetables. The transpiration and respiration during storage cause produce to lose the antioxidants. The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa. The coating prepared from chitosan, aloe vera, and mint has significant behavior on vegetables and provides a good barrier with atmosphere to avoid more loss in antioxidants with increasing storage days. Thus, the antioxidant effect of chitosan is reinforced by the incorporation of aloe vera and mint. These results are in agreement with those of Zhang *et al.*, (2020) and Lim, (2012).

Table 4.35(a): Effect of different treatments on DPPH at 0, 2, 4, 6, 8, 10 days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	DPPH (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	43.697	36.933	33.267	23.400	20.300	16.933	29.088	43.697	37.667	33.467	24.100	20.633	17.033	29.433
T1	43.697	39.367	36.900	28.333	21.600	18.600	31.416	43.697	39.800	37.100	28.667	22.033	18.833	31.688
T2	43.697	39.700	37.500	29.400	22.933	18.800	32.005	43.697	39.800	37.567	29.533	23.133	19.000	32.122
T3	43.697	39.833	38.033	29.733	23.600	19.200	32.349	43.697	39.867	38.600	29.800	23.700	19.367	32.505
T4	43.697	40.000	38.600	29.867	24.033	19.300	32.583	43.697	40.067	38.733	29.933	24.267	19.433	32.688
T5	43.697	39.067	33.867	26.567	20.033	16.867	30.016	43.697	39.000	33.933	26.800	21.633	17.100	30.361
T6	43.697	39.300	34.233	26.933	20.067	17.100	30.222	43.697	39.333	34.667	27.233	20.433	17.500	30.477
Mean	43.697	39.171	36.057	27.748	21.795	18.114		43.697	39.362	36.295	28.010	22.262	18.324	
	CD (p≤0.05)	SE (d)	SE (m)	Significance					CD (p≤0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	0.542	0.272	0.192	0.000				Factor (Treatments)	0.669	0.336	0.238	0.000		
Factor (Days)	0.502	0.252	0.178	0.000				Factor (Days)	0.620	0.311	0.220	0.000		
Factor (T × D)	1.328	0.666	0.471	0.000				Factor (T × D)	1.639	0.823	0.582	0.000		

Table 4.35(b):Effect of different treatments on DPPH at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	DPPH (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	43.697	32.400	28.033	22.433	18.900	14.633	26.683	43.697	32.833	28.933	22.833	19.367	15.067	27.122
T1	43.697	33.300	29.067	23.267	19.633	16.033	27.499	43.697	33.233	29.267	23.600	19.700	16.267	27.627
T2	43.697	33.500	29.533	23.833	19.733	16.400	27.783	43.697	33.633	29.800	24.100	19.967	16.700	27.983
T3	43.697	33.967	29.967	23.867	20.100	16.533	28.022	43.697	34.100	30.200	23.933	20.200	16.500	28.105
T4	43.697	34.600	30.333	24.367	19.967	16.933	28.316	43.697	34.933	30.833	24.500	20.067	17.267	28.549
T5	43.697	32.000	28.333	21.767	19.167	15.933	26.816	43.697	33.233	29.033	22.267	19.433	16.367	27.338
T6	43.697	32.200	28.800	21.933	19.300	16.133	27.011	43.697	32.533	29.000	22.133	19.567	16.333	27.211
Mean	43.697	33.138	29.152	23.067	19.543	16.086		43.697	33.500	29.581	23.338	19.757	16.357	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.386	0.194	0.137	0.000			Factor (Treat ments)	0.382	0.165	0.117	0.000		
	Factor (Days)	0.357	0.179	0.127	0.000			Factor (Days)	0.304	0.153	0.108	0.000		
	Factor (T × D)	0.945	0.474	0.336	0.012			Factor (T × D)	0.804	0.404	0.286	0.001		

Table 4.35(c):Effect of different treatments on DPPH at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	DPPH (%)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	41.657	35.067	32.000	22.100	19.400	15.733	27.659	41.657	35.900	33.733	24.267	19.800	15.900	28.543
T1	41.657	37.033	35.667	26.800	19.367	18.467	29.832	41.657	38.433	36.900	28.467	21.433	18.900	30.965
T2	41.657	38.100	37.167	29.067	21.833	18.867	31.115	41.657	39.133	37.267	29.600	22.867	18.867	31.565
T3	41.657	38.567	37.800	29.533	24.033	19.233	31.804	41.657	39.067	38.133	29.633	24.833	19.500	32.137
T4	41.657	39.967	38.867	29.767	24.633	19.567	32.409	41.657	40.700	39.200	31.000	25.733	19.633	32.987
T5	41.657	39.500	34.800	26.900	20.233	17.067	30.026	41.657	39.667	35.267	27.200	21.133	17.367	30.382
T6	41.657	39.333	34.633	26.733	20.767	17.333	30.076	41.657	39.633	34.900	27.367	21.167	17.933	30.443
Mean	41.657	38.224	35.848	27.271	21.467	18.038		41.657	38.933	36.486	28.219	22.424	18.300	
	CD (p≤0.05)	SE (d)	SE (m)	Significance				CD (p≤0.05)	SE (d)	SE (m)	Significance			
Factor (Treatments)	0.454	0.228	0.161	0.000				Factor (Treatments)	0.493	0.207	0.175	0.000		
Factor (Days)	0.420	0.211	0.149	0.000				Factor (Days)	0.456	0.229	0.162	0.000		
Factor (T × D)	1.112	0.558	0.395	0.000				Factor (T × D)	1.207	0.606	0.428	0.000		

Table 4.35(d): Effect of different treatments on DPPH at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	DPPH (%)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	41.657	32.200	28.133	21.867	18.900	14.800	26.259	41.657	32.700	28.700	22.267	19.167	15.367	26.643
T1	41.657	32.600	29.200	23.867	19.833	16.700	27.309	41.657	33.400	29.733	24.133	19.967	17.067	27.659
T2	41.657	33.633	29.733	24.100	20.233	16.867	27.704	41.657	33.833	29.967	24.200	20.433	17.133	27.871
T3	41.657	33.933	30.033	24.333	20.400	17.000	27.893	41.657	34.367	30.233	24.400	20.500	17.400	28.093
T4	41.657	34.367	30.300	24.500	20.433	17.367	28.104	41.657	34.567	31.000	24.600	20.533	17.733	28.348
T5	41.657	32.257	28.200	22.187	18.800	16.267	26.561	41.657	32.867	29.267	22.367	18.967	16.433	26.926
T6	41.657	31.833	27.933	21.867	18.900	15.900	26.348	41.657	32.467	28.650	22.033	18.900	16.067	26.629
Mean	41.657	32.975	29.076	23.246	19.643	16.414		41.657	33.457	29.650	23.429	19.781	16.743	
	Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance			Factors	CD (p≤ 0.05)	SE (d)	SE (m)	Signifi cance		
	Factor (Treat ments)	0.368	0.185	0.131	0.000			Factor (Treat ments)	0.379	0.190	0.134	0.000		
	Factor (Days)	0.341	0.171	0.121	0.000			Factor (Days)	0.351	0.176	0.125	0.000		
	Factor (T × D)	0.901	0.452	0.320	0.002			Factor (T × D)	0.928	0.466	0.329	0.032		

Table 4.35 (e): Effect of different treatments on DPPH after 10 days storage in different varieties of sponge gourd.

Treatments	DPPH (%)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	29.088	27.659	28.373	29.433	28.543	28.988	26.683	26.259	26.471	27.122	26.643	26.882
T1	31.416	29.832	30.624	31.688	30.965	31.326	27.499	27.309	27.404	27.627	27.659	27.643
T2	32.005	31.115	31.560	32.122	31.565	31.843	27.783	27.704	27.743	27.983	27.871	27.927
T3	32.349	31.804	32.076	32.505	32.137	32.321	28.022	27.893	27.957	28.105	28.093	28.099
T4	32.583	32.409	32.496	32.688	32.987	32.837	28.316	28.104	28.210	28.549	28.348	28.448
T5	30.016	30.026	30.021	30.361	30.382	30.371	26.816	26.561	26.688	27.338	26.926	27.132
T6	30.222	30.076	30.149	30.477	30.443	30.460	27.011	26.348	26.679	27.211	26.629	26.920
CD (p≤0.05)	1.328	1.112	1.220	1.639	1.207	1.423	0.945	0.901	0.923	0.804	0.928	0.866

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ =Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%) + Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

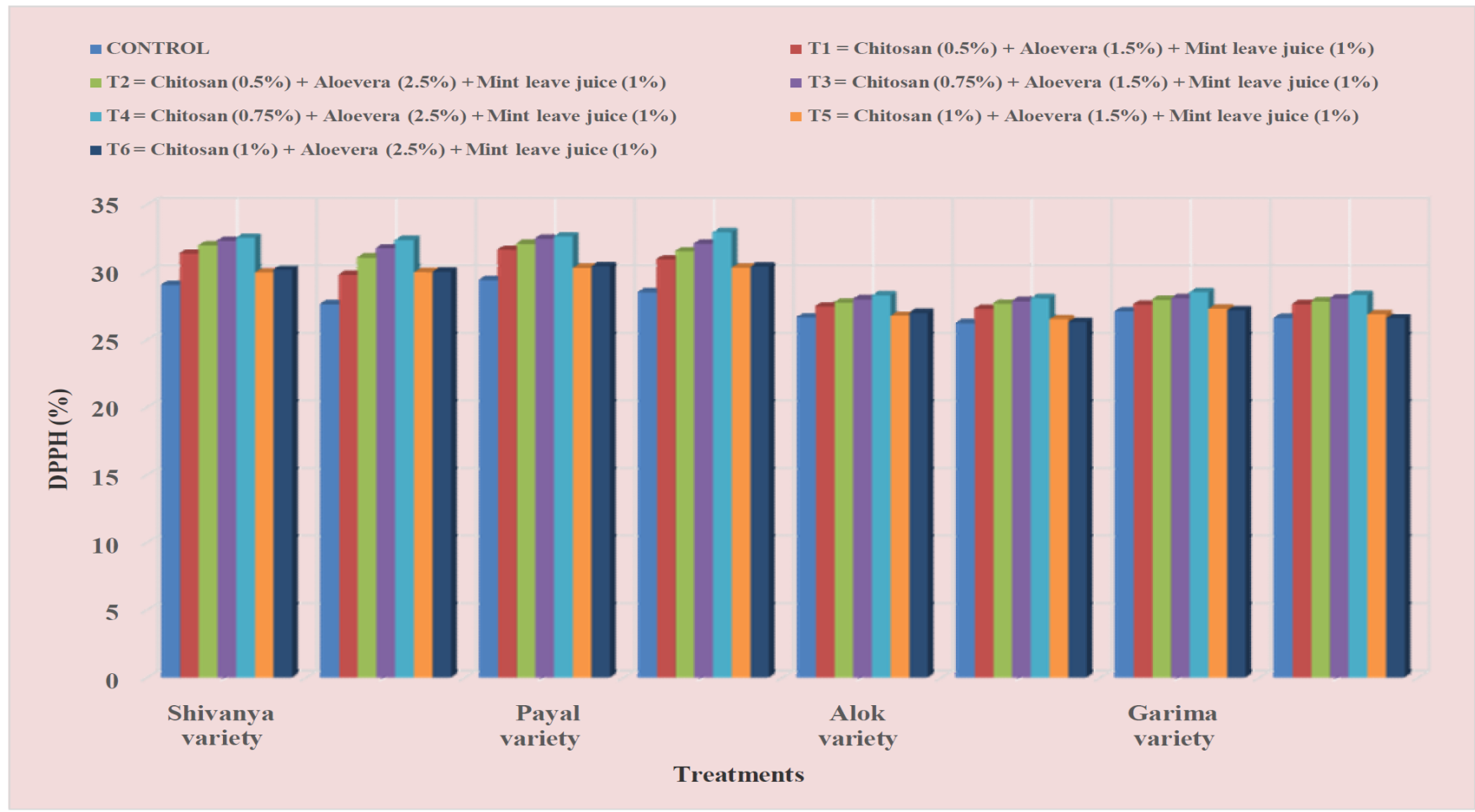


Figure 35: Effect of different treatments on DPPH after 10 days storage in different varieties of sponge gourd.

4.5.3 Firmness (Kg/cm²)

The firmness in luffa was presented in Table 4.36(e) illustrate that different varieties had significant variation in the year of 2021-2022. The effect of 4 different varieties including shivanya, payal, alok, and garima data were observed and were presented in Figure 36. Firstly in the year 2021 it had been studied that shivanya and payal varieties had retained more firmness in T4 (10.20 kg/cm²) and (10.21 kg/cm²) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the firmness in T4 (9.51 kg/cm²) and (953 kg/cm²) as compared to alok and garima varieties. The treatments T3 and T4 defined a high amount of firmness as compared to other treatments. The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa.

The firmness of the produce defined the fruit ripening. The firmness of produce decreases with an increase in storage days. Control treatment defined more firmness and loss of all soluble content of produce and ultimately produces starts decreasing weight with storage time. The produce coated with T3 and T4 retained more firmness. The control ones had more loss due to respiration and transpiration losses during the storage of luffa vegetables. The varieties shivanya and payal depicted less loss of firmness whereas the varieties alok and garima depicted more loss of firmness. The transpiration and respiration during storage cause produce to decrease the firmness. The treatment control showed more decrease in firmness and treatment T3 Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%) had less decrease in firmness and is best treatment and same effect was defined by T4 Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%) treatment. The incorporation of chitosan with aloe vera and mint maintained the firmness of the produce for a longer duration. Similar findings are suggested by Naeem *et al.*, (2019) and Han *et al.*, (2014).

Table 4.36(a): Effect of different treatments on Firmness (Kg/cm²) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Firmness (Kg/cm ²)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	11.227	10.350	8.267	7.347	6.537	4.550	8.046	11.227	10.360	8.277	7.357	6.557	4.573	8.058
T1	11.227	10.870	10.553	9.880	9.537	8.770	10.139	11.227	10.887	10.567	9.890	9.557	8.787	10.152
T2	11.227	10.880	10.623	9.900	9.573	8.817	10.170	11.227	10.900	10.637	9.910	9.587	8.830	10.182
T3	11.227	10.923	10.663	9.933	9.587	8.840	10.196	11.227	10.933	10.673	9.943	9.600	8.847	10.204
T4	11.227	10.937	10.677	9.943	9.607	8.860	10.208	11.227	10.947	10.683	9.953	9.617	8.877	10.217
T5	11.227	10.950	10.683	9.957	9.630	8.873	10.220	11.227	10.967	10.710	9.963	9.667	8.887	10.237
T6	11.227	10.963	10.710	9.963	9.637	8.883	10.231	11.227	10.970	10.730	9.977	9.633	8.887	10.237
Mean	11.227	10.839	10.311	9.560	9.158	8.228		11.227	10.852	10.325	9.570	9.174	8.241	
	CD (p≤ 0.05)	SE (d)	SE (m)	Significance					CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	0.011	0.006	0.004	0.000				Factor (Treatments)	0.010	0.005	0.003	0.000		
Factor (Days)	0.010	0.005	0.004	0.000				Factor (Days)	0.009	0.004	0.003	0.000		
Factor (T × D)	0.028	0.014	0.010	0.000				Factor (T × D)	0.024	0.012	0.008	0.000		

Table 4.36(b): Effect of different treatments on Firmness (Kg/cm²) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2020-2021.

Treatments	Firmness (Kg/cm ²)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	11.227	10.323	8.193	7.243	6.583	4.583	8.026	11.227	10.303	8.167	7.217	6.517	4.530	7.993
T1	11.227	10.823	10.523	9.833	9.523	8.733	10.111	11.227	10.813	10.503	9.810	9.490	8.710	10.092
T2	11.227	10.850	10.623	9.857	9.530	8.787	10.146	11.227	10.823	10.613	9.823	9.523	8.767	10.129
T3	11.227	10.873	10.630	9.897	9.577	8.797	10.167	11.227	10.837	10.620	9.860	9.560	8.770	10.146
T4	11.227	10.923	10.623	9.930	9.587	8.840	10.188	11.227	10.887	10.600	9.923	9.573	8.827	10.173
T5	11.227	10.923	10.683	9.930	9.623	8.837	10.204	11.227	10.893	10.637	9.903	9.597	8.823	10.180
T6	11.227	10.930	10.717	9.923	9.583	8.830	10.202	11.227	10.900	10.707	9.893	9.587	8.820	10.189
Mean	11.227	10.807	10.285	9.516	9.144	8.201		11.227	10.780	10.264	9.490	9.121	8.178	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.012	0.006	0.004	0.000			Factor (Treatments)	0.014	0.007	0.005	0.000		
	Factor (Days)	0.011	0.006	0.004	0.000			Factor (Days)	0.013	0.007	0.005	0.000		
	Factor (T × D)	0.029	0.015	0.010	0.000			Factor (T × D)	0.035	0.014	0.013	0.000		

Table 4.36(c): Effect of different treatments on Firmness (Kg/cm²) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Firmness (Kg/cm ²)													
	Shivanya variety							Payal variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.530	10.190	8.203	7.393	6.347	4.510	7.862	10.530	10.197	8.210	7.410	6.370	4.550	7.878
T1	10.530	10.497	9.730	9.127	8.767	8.137	9.464	10.530	10.500	9.747	9.140	8.777	8.147	9.473
T2	10.530	10.507	9.757	9.157	8.780	8.147	9.479	10.530	10.510	9.783	9.173	8.810	8.167	9.496
T3	10.530	10.510	9.800	9.187	8.800	8.170	9.499	10.530	10.513	9.820	9.200	8.820	8.200	9.514
T4	10.530	10.513	9.817	9.213	8.823	8.210	9.518	10.530	10.520	9.847	9.227	8.850	8.223	9.533
T5	10.530	10.520	9.837	9.237	8.857	8.223	9.534	10.530	10.523	9.850	9.253	8.873	8.233	9.544
T6	10.530	10.523	9.847	9.247	8.867	8.233	9.541	10.530	10.527	9.857	9.257	8.883	8.247	9.550
Mean	10.530	10.466	9.570	8.937	8.463	7.661		10.530	10.470	9.588	8.951	8.483	7.681	
	CD (p≤ 0.05)	SE (d)	SE (m)	Significance					CD (p≤ 0.05)	SE (d)	SE (m)	Significance		
Factor (Treatments)	0.193	0.097	0.068	0.000				Factor (Treatments)	0.193	0.097	0.069	0.000		
Factor (Days)	0.178	0.090	0.063	0.000				Factor (Days)	0.179	0.090	0.064	0.000		
Factor (T × D)	0.472	0.237	0.167	0.000				Factor (T × D)	0.474	0.238	0.168	0.000		

Table 4.36(d): Effect of different treatments on Firmness (Kg/cm²) at 0, 2, 4, 6, 8, 10days of storage in different varieties of sponge gourd and their interaction among treatments and days during 2021-2022.

Treatments	Firmness (Kg/cm ²)													
	Alok variety							Garima variety						
	0 days	2 days	4 days	6 days	8 days	10 days	Mean	0 days	2 days	4 days	6 days	8 days	10 days	Mean
CONTROL	10.530	10.133	8.187	7.337	6.307	4.503	7.833	10.530	10.143	8.193	7.363	6.330	4.517	7.846
T1	10.530	10.170	9.700	9.113	8.723	8.113	9.392	10.530	10.183	9.720	9.137	8.753	8.127	9.408
T2	10.530	10.190	9.717	9.137	8.760	8.127	9.410	10.530	10.193	9.727	9.153	8.780	8.133	9.419
T3	10.530	10.193	9.727	9.150	8.767	8.153	9.420	10.530	10.197	9.747	9.163	8.777	8.157	9.428
T4	10.530	10.200	9.727	9.160	8.783	8.167	9.428	10.530	10.200	9.747	9.167	8.800	8.180	9.437
T5	10.530	10.203	9.737	9.167	8.800	8.177	9.436	10.530	10.203	9.753	9.177	8.813	8.203	9.447
T6	10.530	10.207	9.757	9.177	8.827	8.187	9.447	10.530	10.207	9.773	9.187	8.837	8.404	9.489
Mean	10.530	10.185	9.507	8.891	8.424	7.632		10.530	10.190	9.523	8.907	8.441	7.674	
	Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance			Factors	CD (p≤0.05)	SE (d)	SE (m)	Significance		
	Factor (Treatments)	0.143	0.072	0.051	0.000			Factor (Treatments)	0.148	0.074	0.053	0.000		
	Factor (Days)	0.133	0.067	0.047	0.000			Factor (Days)	0.137	0.069	0.049	0.000		
	Factor (T × D)	0.351	0.176	0.125	0.000			Factor (T × D)	0.363	0.182	0.129	0.000		

Table 4.36: Effect of different treatments on firmness after 10 days storage in different varieties of sponge gourd.

Treatments	Firmness (Kg/cm ²)											
	Shivanya variety			Payal variety			Alok variety			Garima variety		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
CONTROL	8.046	7.862	7.954	8.058	7.878	7.968	8.026	7.833	7.929	7.993	4.517	6.255
T1	10.139	9.464	9.801	10.152	9.473	9.812	10.111	9.392	9.751	10.092	8.127	9.109
T2	10.170	9.479	9.824	10.182	9.496	9.839	10.146	9.410	9.778	10.129	9.419	9.774
T3	10.196	9.499	9.847	10.204	9.514	9.859	10.167	9.420	9.793	10.146	9.428	9.787
T4	10.208	9.518	9.863	10.217	9.533	9.875	10.188	9.428	9.808	10.173	9.437	9.805
T5	10.220	9.534	9.877	10.237	9.544	9.890	10.204	9.436	9.820	10.180	9.447	9.813
T6	10.231	9.541	9.886	10.237	9.550	9.893	10.202	9.447	9.824	10.189	9.489	9.839
CD p≤0.05)	0.028	0.472	0.250	0.024	0.474	0.249	0.029	0.351	0.190	0.035	0.363	0.199

*T₀=Control; T₁ = Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave juice (1%); T₂ = Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave juice (1%); T₃ =Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave juice (1%); T₄ = Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave juice (1%); T₅ = Chitosan (1%)+ Aloe vera (1.5%) + Mint leave juice (1%); T₆ = Chitosan (1%) + Aloe vera (2.5%) + Mint leave juice (1%)

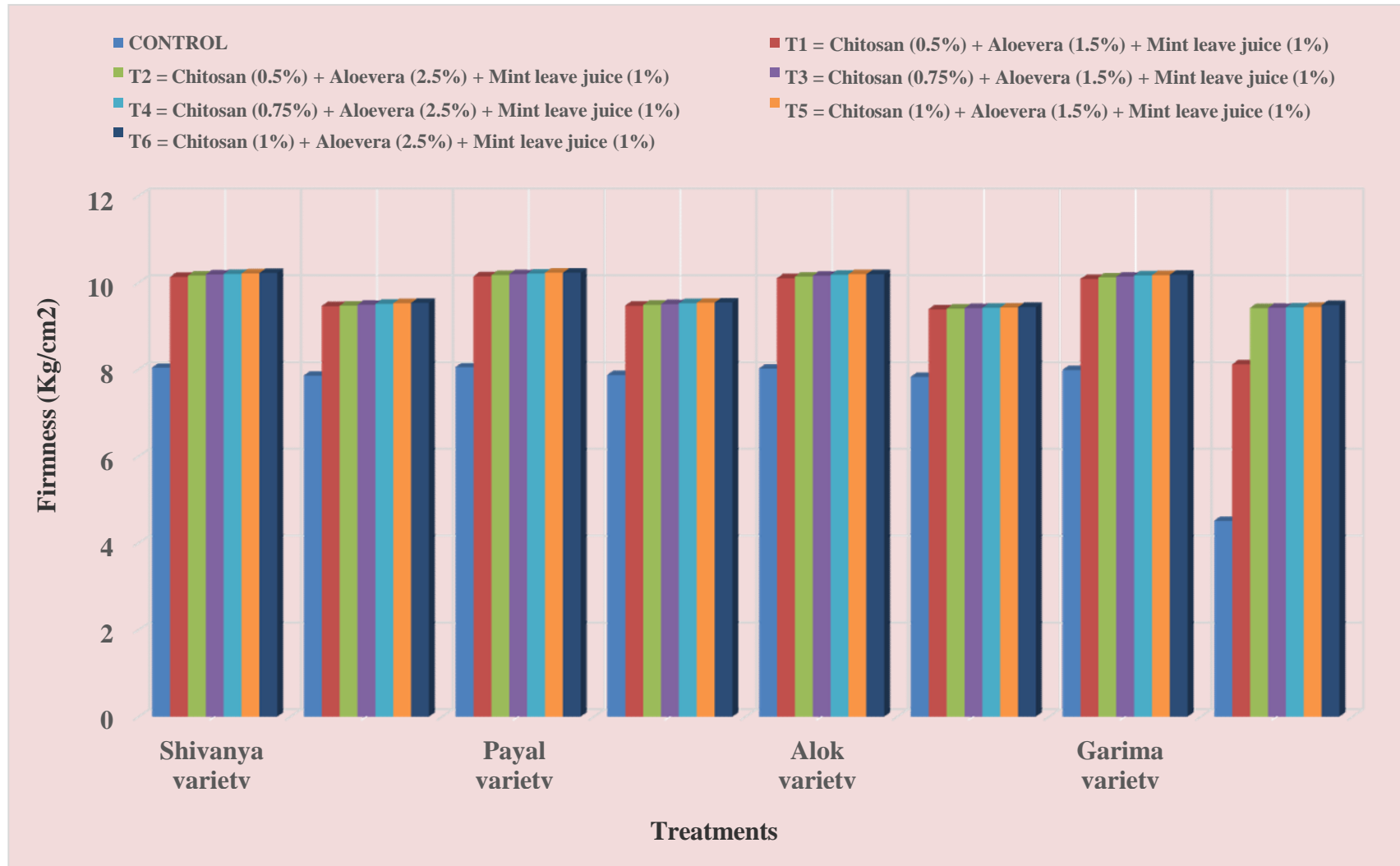


Figure 36: Effect of different treatments on firmness after 10 days storage in different varieties of sponge gourd

Experiment no. 3: Study of development of value-added product pasta prepared from sponge gourd.

4.6 Cooking quality analysis of Pasta:

4.6.1 Cooking loss (g/100g)

Cooking loss of pasta prepared from luffa vegetables was determined in the Table 4.37 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 37. The maximum cooking loss was shown in T6 treatment of Payal variety (6.85 g/100g) followed by T6 treatment of Shivanya (6.83 g/100g). While, the minimum cooking loss was found in T7 treatment of Shivanya variety (4.88 g/100g) followed by T7 treatment of Payal variety (4.89 g/100g). The pasta was prepared by the addition of wheat flour + semolina + sponge gourd pulp with different concentrations. The cooking loss is to determine the quality of pasta and the amount of water lost during the cooking of pasta is calculated as cooking loss (Ganesh *et al.*, 2022). The more loss of water is defined as not good of pasta preparation. Pasta needs to have good texture, firmness, and stickiness to be defined as good value-added pasta. The addition of semolina defined good taste to pasta and sponge gourd pulp gives little sweet taste. Similar results are defined by Devi and Geethanjali, (2017) and Ganesh *et al.*, (2022).

4.37: Effect of cooking loss on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Cooking loss g/100g	
	Shivanya	Payal
T ₀	6.43	6.47
T ₁	6.48	6.50
T ₂	6.56	6.56
T ₃	6.64	6.65
T ₄	5.30	5.35
T ₅	6.76	6.77
T ₆	6.83	6.85
T ₇	4.88	4.89
T ₈	6.76	6.80
T ₉	6.75	6.77
CD (p≤0.05)	0.10	0.10

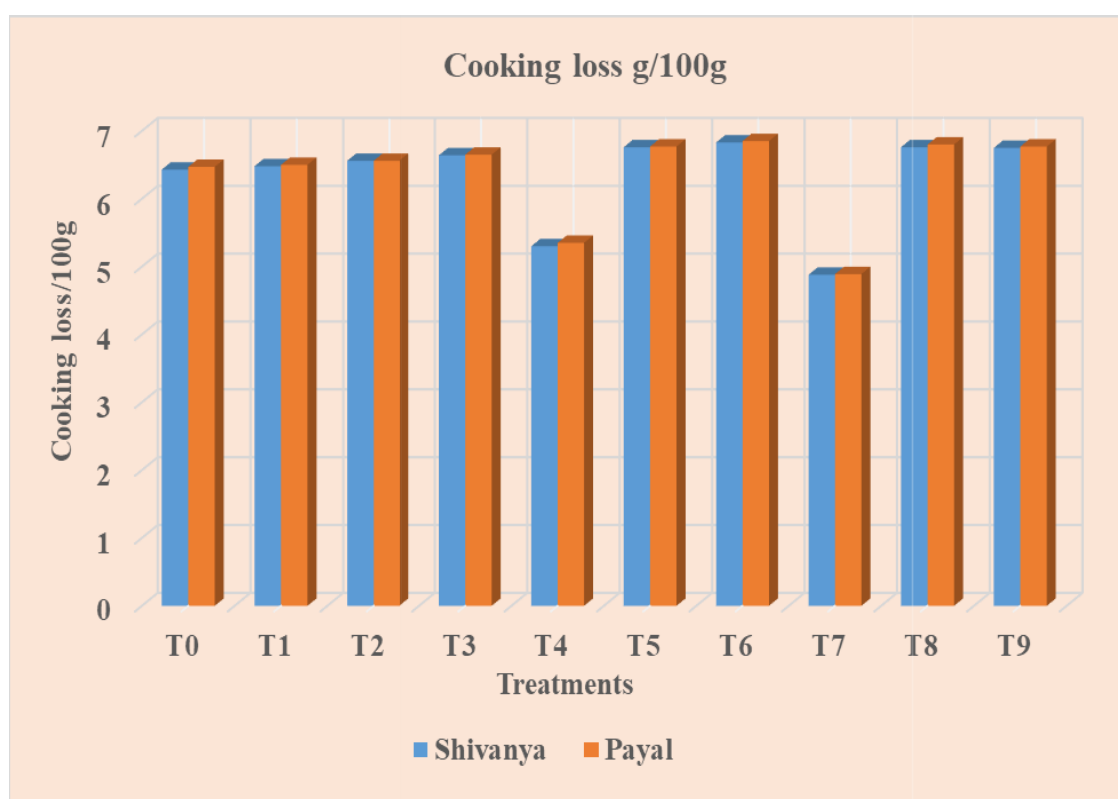


Figure 37: Effect of cooking loss on value added pasta from two different varieties of *Luffa cylindrica* L.

4.6.2 Water absorption (%)

Water absorption of pasta prepared from luffa vegetables was determined in the Table 4.38 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 38. The maximum water absorption was shown in T2 treatment of shivanya variety (178.67 %) followed by T2 treatment of payal (175.50 %). While, the minimum water absorption was found in T7 treatment of payal variety (165.27 %) followed by T7 treatment of shivanya variety (166.67%). The pasta was prepared by the addition of wheat flour + semolina + sponge gourd pulp with different concentrations. The water absorption of pasta is mainly affected by damaged starch, physical properties of pasta, and protein content. The water absorption of pasta depends upon flour weight. Good quality pasta needs to have a short cooking time with less loss of solids (Ganesh *et al.*, 2022). The absorption of water by pasta is determined by its quality during cooking. The more loss of water absorption is defined as not good pasta preparation. Similar findings are determined by Wang *et al.*, (2021) and Wadhwa *et al.*, (2015).

Table 4.38: Effect of water absorption on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Water absorption (%)	
	Shivanya	Payal
T0	182.33	182.87
T1	177.90	175.57
T2	178.67	175.50
T3	177.63	174.13
T4	169.50	167.73
T5	176.37	175.03
T6	175.80	175.10
T7	166.67	165.27
T8	176.07	175.57
T9	175.90	176.17
CD (p≤0.05)	1.04	1.50

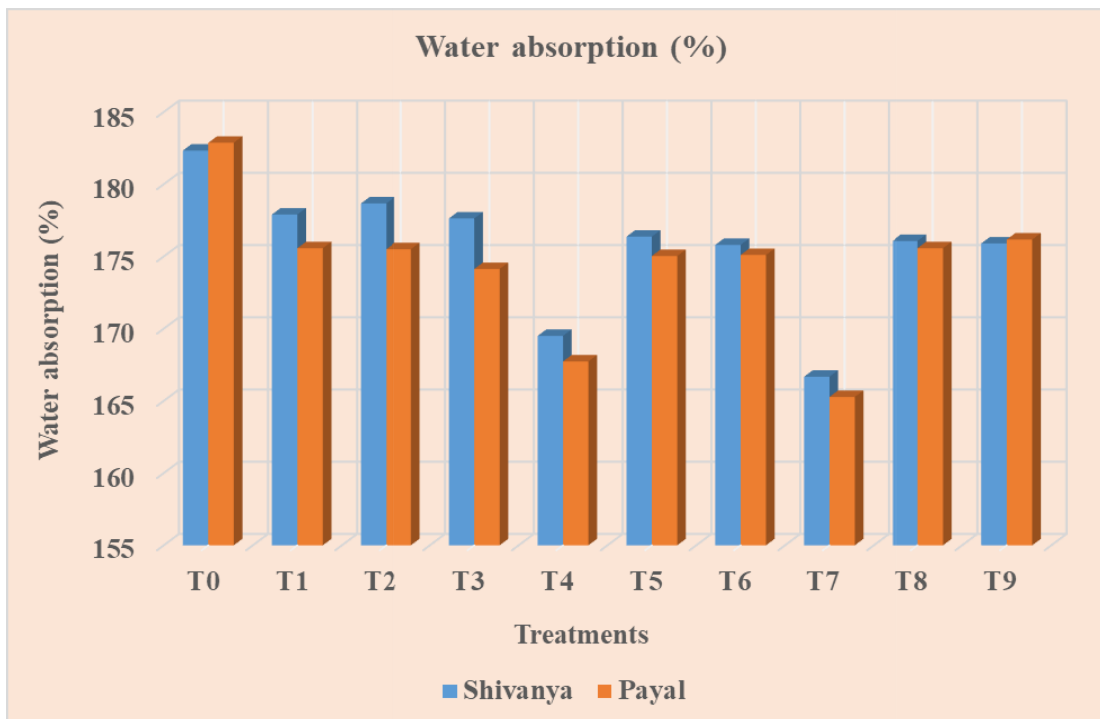


Figure 38: Effect of water absorption on value added pasta from two different varieties of *Luffa cylindrica* L.

4.6.3 Swelling Index (%)

Swelling index of pasta prepared from luffa vegetables was determined in the Table 4.39 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 39. The maximum swelling index was shown in T2 treatment of shivanya variety (1.73 %) followed by T2 treatment of payal (1.67 %). While, the minimum swelling index was found in T4 treatment of payal variety (1.50 %) followed by T4 treatment of shivanya variety (1.50 %). The swelling index of pasta defined the amount of water absorbed by the starch and proteins present in pasta during cooking which is used for starch gelatinization and protein hydration. The swelling index of pasta prepared from luffa vegetables was determined in the given study. The pasta was prepared by the addition of wheat flour + semolina + sponge gourd pulp with different concentrations. The swelling index is directly proportional to the amount of water absorbed by the pasta and is affected by properties such as damaged starch, protein content, and properties of starch. The swelling index and water absorption of pasta mainly depend upon the flour weight (Wang *et al.*, 2021). The more the weight of

flour the more amounts it can absorb and swell the pasta prepared. The T4 treatment has a less swelling index as compared to T7 of shivanya and payal varieties. A similar record was defined by Wang *et al.*,(2021) and Wadhwa *et al.*, (2015).

Table 4.39: Effect of swelling index on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Swelling index (%)	
	Shivanya	Payal
T0	1.97	2.00
T1	1.70	1.73
T2	1.73	1.67
T3	1.67	1.77
T4	1.50	1.50
T5	1.63	1.67
T6	1.67	1.67
T7	1.53	1.43
T8	1.67	1.70
T9	1.73	1.67
CD ($p \leq 0.05$)	0.18	0.19

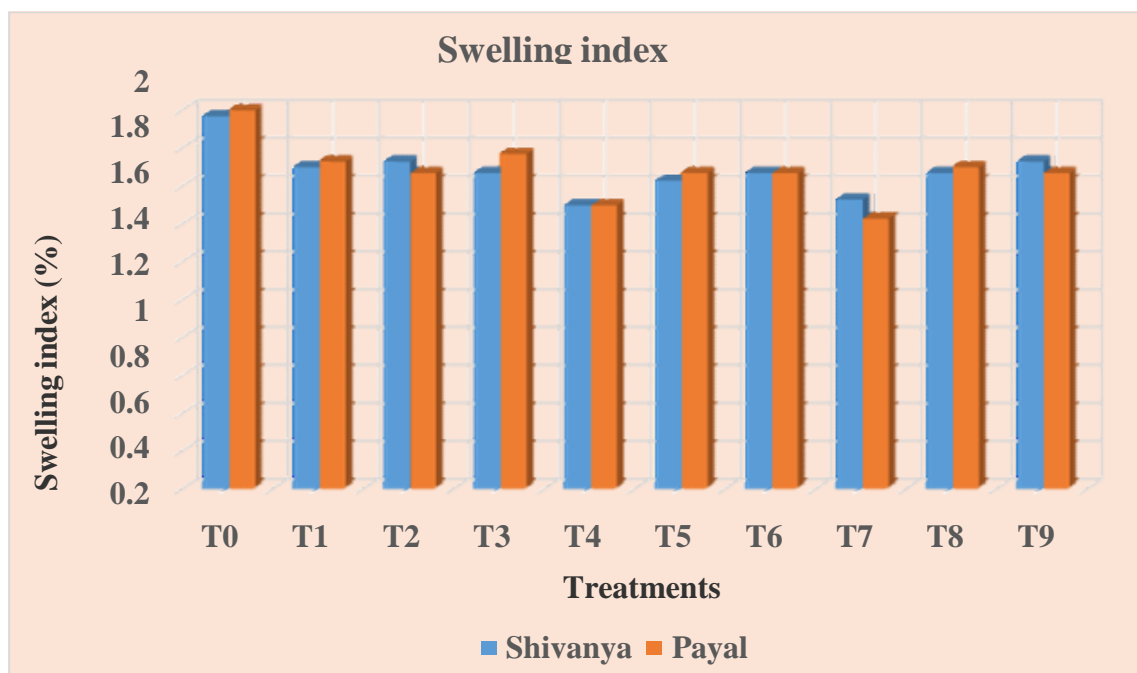


Figure 39: Effect of of swelling index on value added pasta from two different varieties of *Luffa cylindrica* L.

4.6.4 Cooking time (min.)

Cooking time is an important parameter of pasta was determined in the Table 4.40 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 40. The maximum cooking time was shown in T1 treatment of shivanya variety (9.90 min) followed by T1 treatment of payal (9.93 min). While, the minimum cooking time was found in T4 treatment of payal variety (7.93 min) followed by T4 treatment of shivanya variety (7.80 min). When pasta is cooked too long the bonds of molecules between them get damaged and which causes a loss of nutrients, texture, and cooking quality. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The less the cooking time better the pasta is prepared with good nutritional characteristics and sensory traits. Moreover, cooking time is affected by water absorption, swelling index, type of flour, and weight of flour. The less time for pasta preparation maintains its quality trait and defined good sensory factors (Wang *et al.*, 2021). The T4 treatment has less cooking time as compared to control of shivanya and payal varieties. A similar investigation is done by Devi and Geethanjali, (2017).

Table 4. 40: Effect of of cooking time on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Cooking time (min.)	
	Shivanya	Payal
T0	10.03	9.85
T1	9.90	9.93
T2	9.77	9.93
T3	9.80	9.87
T4	7.80	7.93
T5	9.17	9.00
T6	9.40	9.27
T7	8.50	8.53
T8	8.77	9.27
T9	8.87	8.90
CD (p≤0.05)	0.55	3.26

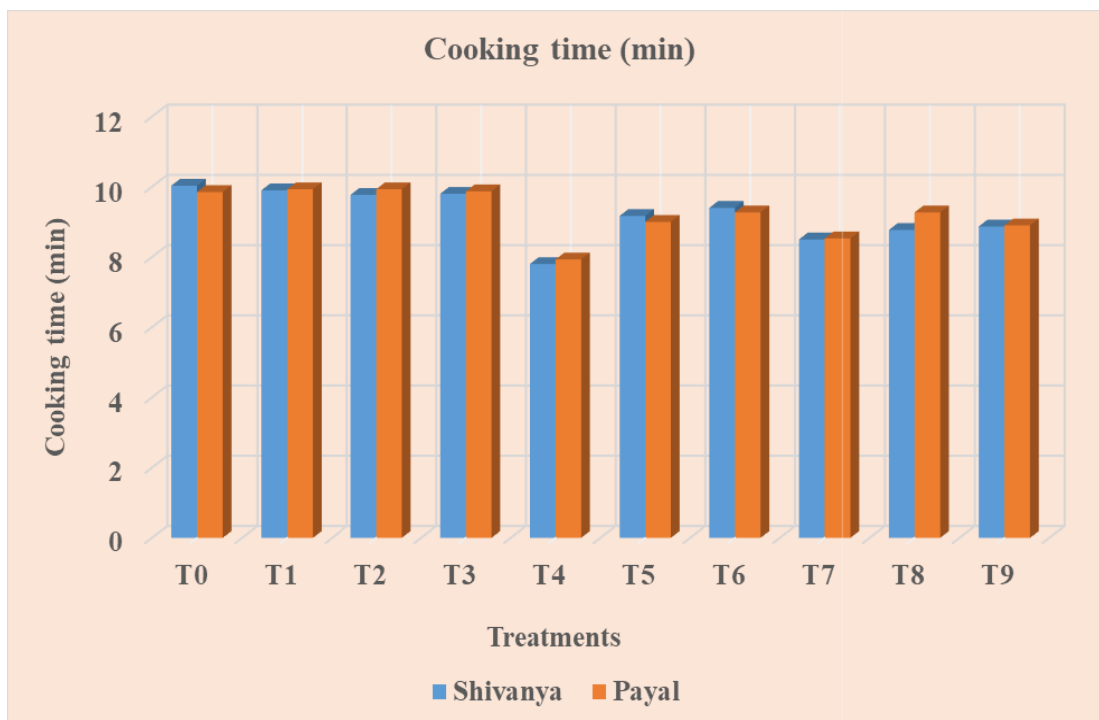


Figure 40: Effect of of cooking time on value added pasta from two different varieties of *Luffa cylindrica* L.

4.7 Biochemical

4.7.1 Ascorbic acid (mg/100 g)

Ascorbic acid is an important parameter of pastawas determined inthe Table 4.41 defined significant variation in two different varieties in year 2021-2022.The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 41. The maximumascorbic acid was shown in T7 treatment of shivanya variety (25.97 mg/100g) followed by T7 treatment of payal (27.43 mg/100g). While, the minimum ascorbic acid was found in T9 treatment of shivanya variety (18.4 mg/100g) followed by T9 treatment of payal variety (18.57 mg/100g) (Devi and Geethanjali, 2017). Ascorbic acid is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The prevention of diseases and providing nutritional trait to diet is influenced by the ascorbic acid factor. Similar findings are evaluated by Zebish *et al.*, (2017) and Wadhwa *et al.*, (2015).

Table 4.41: Effect of ascorbic acid on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Ascorbic acid (mg/100 g)	
	Shivanya	Payal
T0	18.97	19.43
T1	22.73	24.87
T2	23.53	25.2
T3	23.5	24.3
T4	25.73	27.37
T5	23.83	25.23
T6	24.3	24.93
T7	25.97	27.43
T8	25.17	25.33
T9	18.4	18.57
CD ($p \leq 0.05$)	1.21	1.20

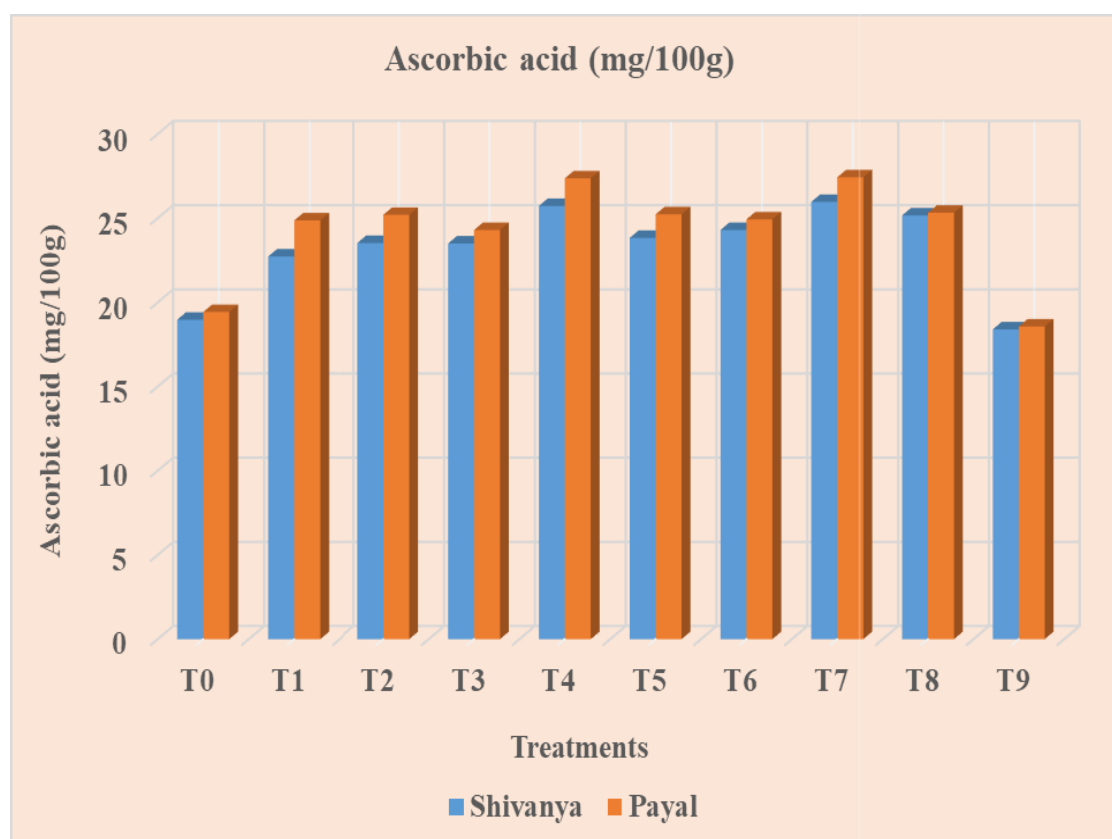


Figure 41: Effect of of ascorbic acid on value added pasta from two different varieties of *Luffa cylindrica* L.

4.7.2 DPPH (%)

The DPPH is an important parameter of pasta was determined in the Table 4.42 defined significant variation in two shivanya and payal varieties different varieties in year 2021-2022. The on value-added pasta was determined in significant influence of Figure 4 2 . The maximum ascorbic acid was shown in T7 treatment of shivanya variety (67.54 %) followed by T7 treatment of payal (67.24 %). While, the minimum DPPH was found in T9 treatment of shivanya variety (53.71 %) followed by T9 treatment of payal variety (54.27 %). The flours defined the antioxidant activity. Antioxidant activity is an important parameter of pasta. Antioxidant activity is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The active compounds present in pasta provide health benefits and other healthy nutrients. The antioxidant activity prevents diseases and providing of nutritional traits to diet (Tripathi *et al.*, 2015).

The T7 treatment has more antioxidant activity as compared to the T4 of shivanya and payal varieties. Similar findings are defined by Zebish *et al.*, (2017) and Devi and Geethanjali, (2017).

Table 4.42: Effect of of DPPH on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	DPPH (%)	
	Shivanya	Payal
T0	53.5	53.77
T1	63.56	66.57
T2	65.66	64.39
T3	65.4	66.41
T4	66.41	66.55
T5	66.54	66.47
T6	66.64	65.94
T7	67.54	67.24
T8	66.69	66.87
T9	53.71	54.27
CD (p≤0.05)	0.62	0.54

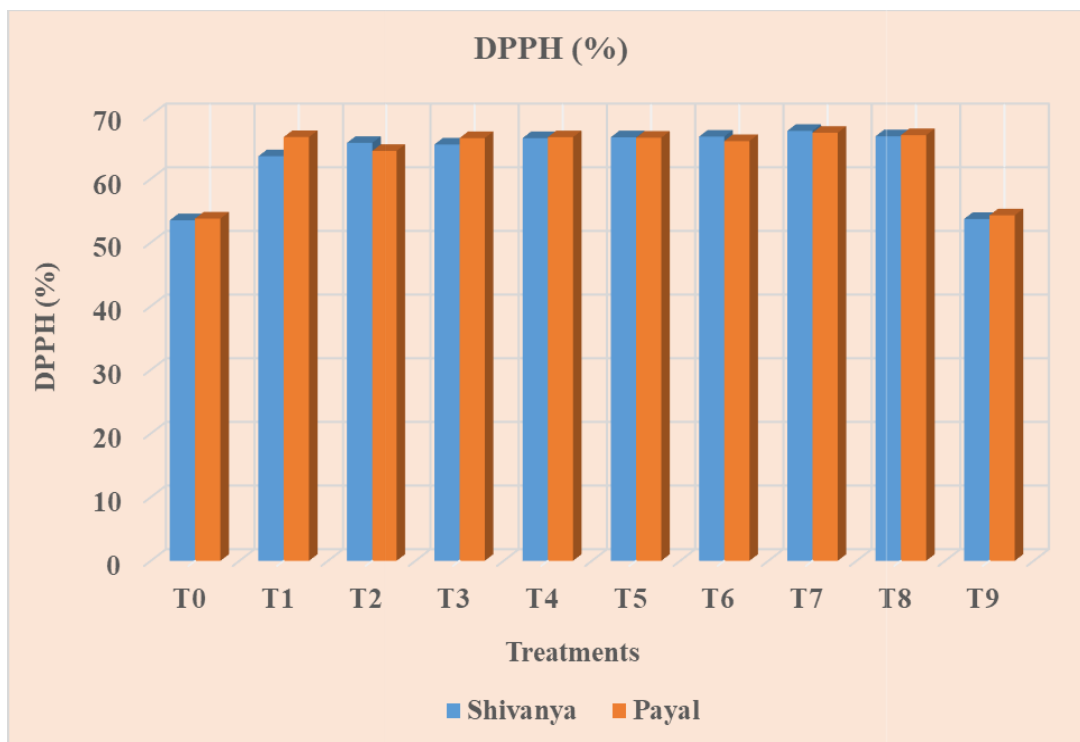


Figure 42: Effect of of DPPH on value added pasta from two different varieties of *Luffa cylindrica* L.

4.8 Nutritional parameter

4.8.1 Protein (%)

The protein is an important parameter of pasta was determined in the Table 4.43 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 43. The maximum protein was shown in T4 treatment of payal variety (29.14 %) followed by T4 treatment of shivanya variety (29.11 %). While, the minimum protein was found in T9 treatment of shivanya variety (18.91 %) followed by T9 treatment of payal variety (18.81 %). The protein in the pasta provides brighter color and also adds nutrition. As the protein increases, the firmness of protein also increases and cooking loss decreases. The starch digestion decreases as the amount of protein content increases. Protein adds flavor and amino acids to food and maintains the molecule's binding. The protein content is an important parameter of pasta. The protein content is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina

+ sponge gourd pulp with different concentrations is defined in the present study. The protein content prevents diseases and providing of nutritional traits to the diet. Similar results are determined by Oliviero and Fogliano, (2016) and Yadav *et al.*, (2014).

Table 4.43: Effect of protein on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Protein (%)	
	Shivanya	Payal
T0	18.73	18.82
T1	27.11	26.78
T2	25.34	25.34
T3	26.14	26.78
T4	29.11	29.14
T5	26.01	25.88
T6	25.1	25.09
T7	29.0	29.07
T8	26.06	26.51
T9	18.81	18.91
CD (p≤0.05)	4.09	3.81

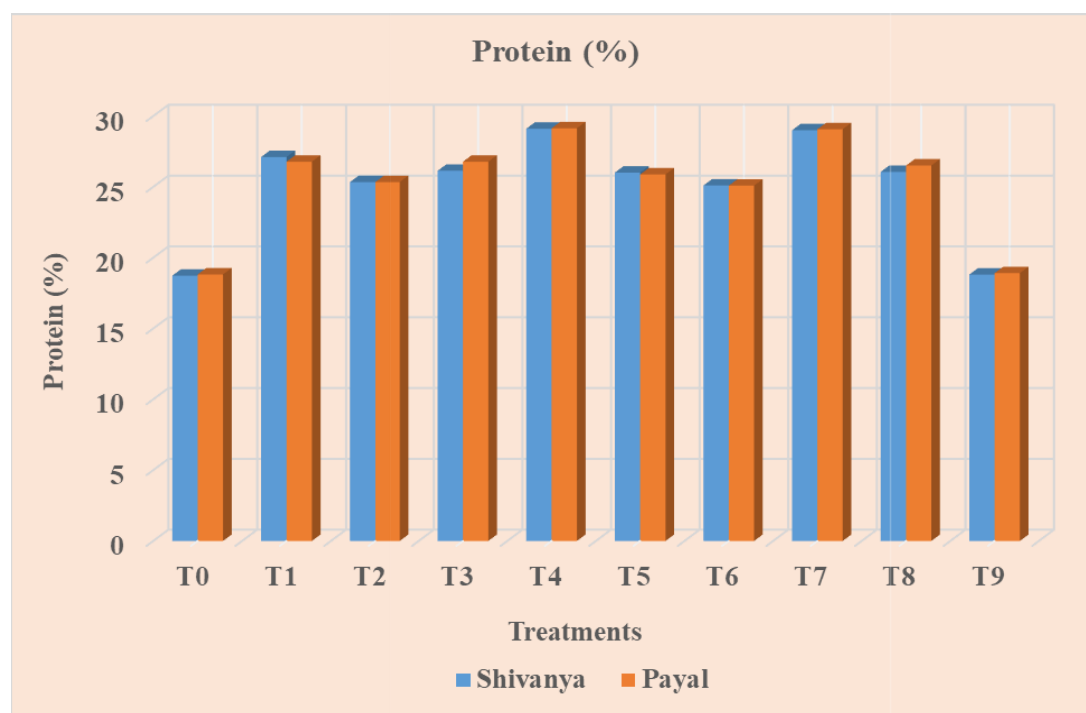


Figure 43: Effect of protein on value added pasta from two different varieties of *Luffa cylindrica* L.

4.8.2 Fat (%)

The fat is an important parameter of pasta was determined in the Table 4.44 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 44. The maximum fat was shown in T4 treatment of payal variety (4.5 %) followed by T4 treatment of shivanya variety (4.33 %). While, the minimum fat was found in T7 treatment of shivanya variety (2.17 %) followed by T7 treatment of payal variety (2.23 %). The fat in the pasta provides nutrition to the diet. As, increases the firmness of protein decreases and cooking loss increases. Fat is an important parameter of pasta. Fat content is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The fat content defines the gumminess and more amount of oil in pasta. Fat is depends upon the flour used for pasta preparation (Wang *et al.*, 2021). Less fatty pasta is good for health and provides nutrition to the diet. Similar findings are defined by Oliviero and Fogliano, (2016) and Yadav *et al.*, (2014).

Table 4.44: Effect of fat on value added pasta from two different varieties of *Luffa cylindrical L.*

Treatments	Fat (%)	
	Shivanya	Payal
T0	5.43	5.53
T1	4.17	4.3
T2	4.33	4.5
T3	4.6	4.67
T4	2.3	2.43
T5	4.3	4.7
T6	4.6	4.8
T7	2.17	2.23
T8	3.83	3.93
T9	3.77	3.9
CD (p≤0.05)	0.57	0.57

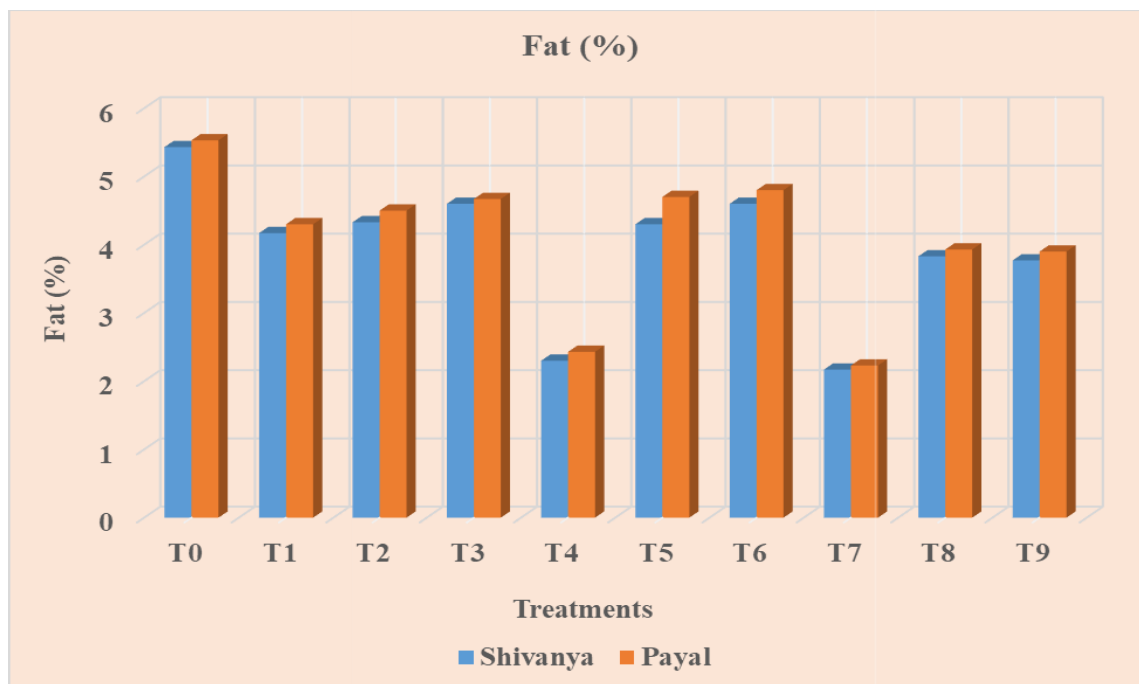


Figure 44: Effect of fat on value added pasta from two different varieties of *Luffa cylindrica* L.

4.8.3 Ash (%)

The ash is an important parameter of pasta was determined in the Table 4.45 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 45. The maximum ash was shown in T4 treatment of payal variety (1.53 %) followed by T4 treatment of shivanya variety (1.4 %). While, the minimum fat was found in T9 treatment of shivanya variety (0.97 %) followed by T9 treatment of payal variety (1.43 %). Ash is the amount of residue that is left after the removal of water and organic content such as protein and fat. Ash is composed of good sources of essential minerals like potassium, phosphorus, calcium, and magnesium. etc (Chetrariu and Dabija, 2021). Ash is an important parameter of pasta. Ash content is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The ash content provides a source of nutrients such as phosphorus, magnesium, potassium, and calcium etc. Similar investigations are evaluated by Dayakar Rao *et al.*, (2016) and Chetrariu and Dabija, (2021).

Table 4.45: Effect of ash on value added pasta from two different varieties of *Luffa cylindrical* L.

Treatments	Ash (%)	
	Shivanya	Payal
T0	0.9	0.97
T1	1.27	1.47
T2	1.17	1.5
T3	1.37	1.5
T4	1.4	1.53
T5	1.27	1.5
T6	1.33	1.47
T7	1.37	1.47
T8	1.27	1.47
T9	0.97	1.43
CD ($p \leq 0.05$)	0.15	0.17

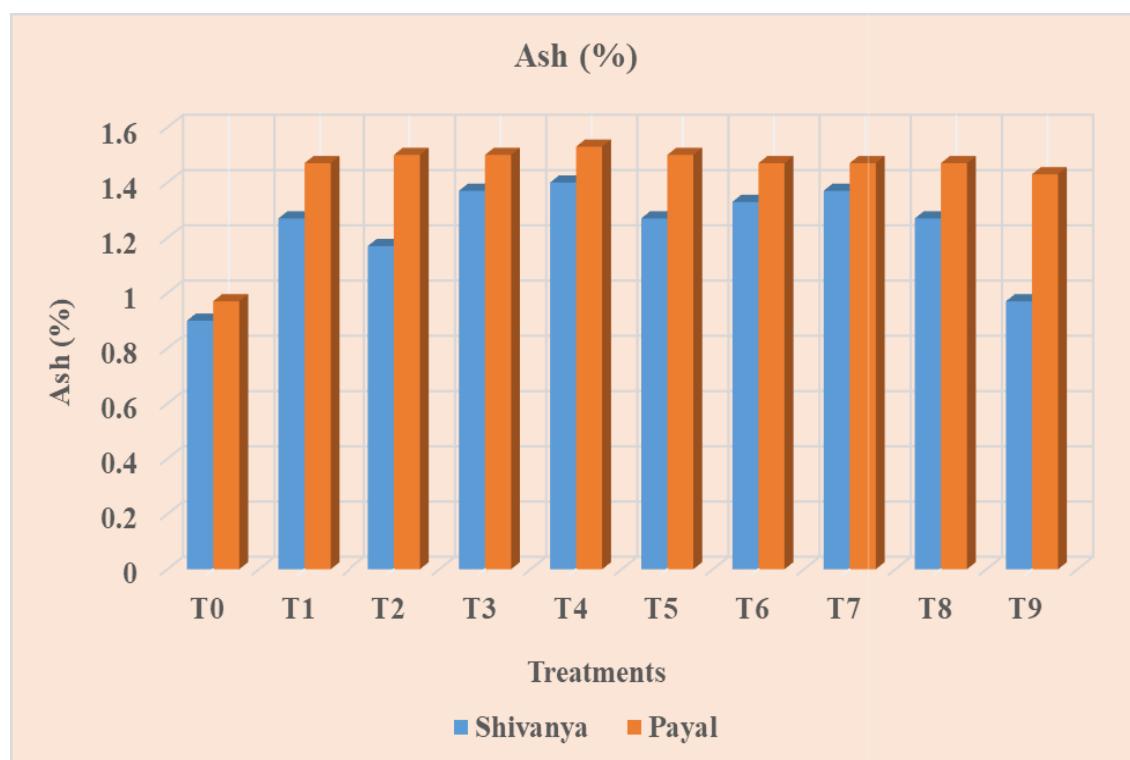


Figure 45: Effect of ash on value added pasta from two different varieties of *Luffa cylindrical* L.

4.8.4 Crude fiber (%)

The crude fiber is an important parameter of pasta was determined in the Table 4.46 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 46. The maximum crude fiber was shown in T4 treatment of payal variety (2.77 %) followed by T4 treatment of shivanya variety (2.75 %). While, the minimum crude fiber was found in T9 treatment of shivanya variety (1.25 %) followed by T9 treatment of payal variety (1.29 %). Crude fiber defined the amount of fiber content in the food. Crude fiber is an important parameter of pasta. Table 10 defined the ash content of pasta of 2 selected varieties (Shivanya and Payal). Crude fiber is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The crude fiber provides a source of nutrients such as phosphorus, magnesium, potassium, and calcium and also adds fiber to our diet (Wang *et al.*, 2021). Similar results are Fogliano, (2016) and Yadav *et al.*, (2014).

Table 4.46: Effect of crude fiber on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Crude fiber (%)	
	Shivanya	Payal
T0	1.2	1.29
T1	2.39	2.38
T2	2.47	2.48
T3	2.55	2.58
T4	2.75	2.77
T5	2.57	2.58
T6	2.54	2.57
T7	2.65	2.66
T8	2.63	2.65
T9	1.25	1.29
CD (p≤0.05)	0.19	0.15

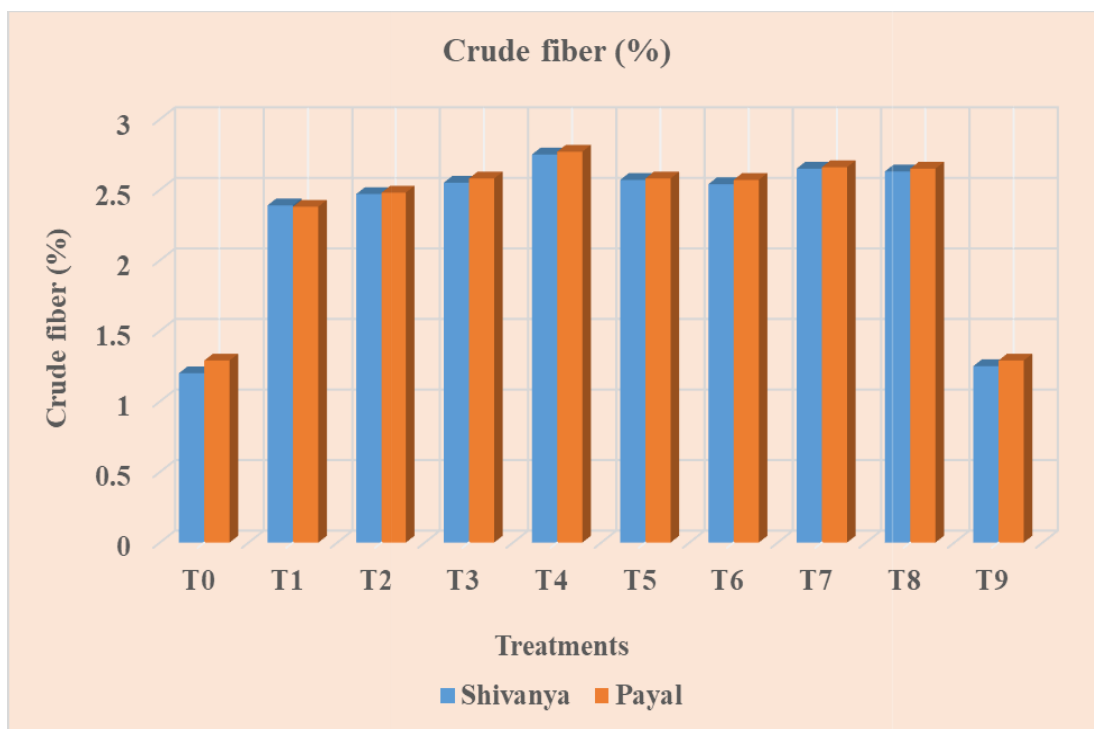


Figure 46: Effect of crude fiber on value added pasta from two different varieties of *Luffa cylindrica* L.

4.8.5 Carbohydrate (%)

The carbohydrate is an important parameter of pasta was determined in the Table 4.47 defined significant variation in two different varieties in year 2021-2022. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 47. The maximum carbohydrate was shown in T4 treatment of payal variety (13.2 %) followed by T4 treatment of shivanya variety (13 %). While, the minimum carbohydrate was found in T6 treatment of shivanya variety (9.33 %) followed by T6 treatment of payal variety (9.23 %). Carbohydrates are extracted into glucose in the blood and maintain the blood sugar level in the body. Pasta defines s a high number of carbohydrates and lowers the amount of fiber content. The presence of a good amount of carbohydrates in pasta aids in digestion, keeping a check on blood sugar levels, adds fiber to the diet. Carbohydrate is an important parameter of pasta. Carbohydrate is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. Carbohydrate provides a source of nutrients such as phosphorus,

magnesium, potassium, and calcium and also adds fiber to our diet. Similar findings are defined by Zebish *et al.*, (2017) and Devi and Geethanjali, (2017).

Table 4.47: Effect of carbohydrate on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Carbohydrate (%)	
	Shivanya	Payal
T0	9.1	9.23
T1	11.73	11.9
T2	11.93	12.47
T3	12.53	12.23
T4	13	13.2
T5	12.6	12.77
T6	9.23	9.33
T7	12.97	12.93
T8	12.1	12.23
T9	12.8	12.87
CD (p≤0.05)	0.69	0.76

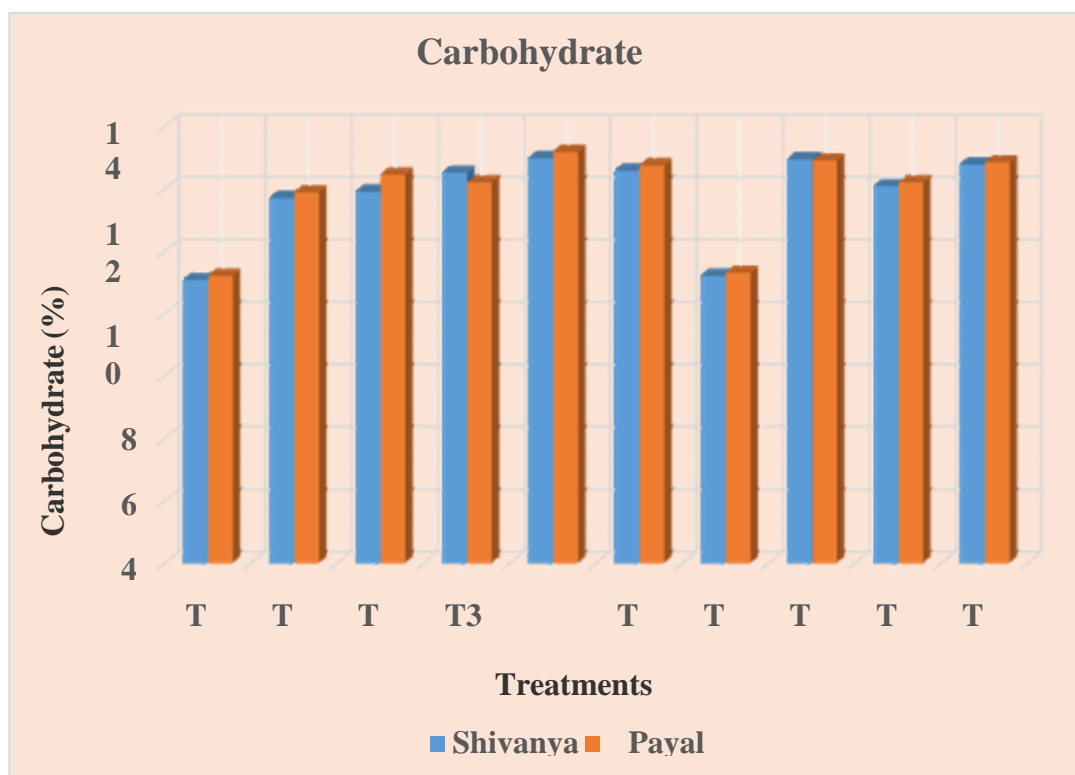


Figure 47: Effect of carbohydrate on value added pasta from two different varieties of *Luffa cylindrica* L.

4.9 Sensory quality

The sensory quality of pasta is determined by different factors such as color, flavor, texture, firmness, stickiness, and overall acceptability. These factors of sensory evaluation are depending upon the type of flour, cooking time, quality, and water absorption. The quality of pasta mainly improves its acceptability rate (Devi and Geethanjali, 2017). Sensory quality is the important parameter of pasta determination. Table 4.48 defined the sensory quality of pasta of 2 selected varieties (Shivanya and Payal). The sensory factor is beneficial to the human body as they add nutritional importance to the daily diet. The pasta prepared by addition of wheat flour + semolina + sponge gourd pulp with different concentrations is defined in the present study. The significant influence of shivanya and payal varieties on value-added pasta was determined in Figure 48. The sensory evaluation determines the color, texture, flavor, firmness, and stickiness of pasta. The lower the cooking time, the cooking loss is higher in the quality of pasta. The texture of pasta depends upon the surface area of pasta. The varieties shivanya and payal with treatment T4 and T7 defined good sensory quality and determined the significant behavior as compared to control and other treatments. The T4 treatment has sensory quality as compared to T7 of shivanya and payal varieties. Similar findings are defined by Zebish *et al.*, (2017).

Table 4.48: Effect of sensory quality on value added pasta from two different varieties of *Luffa cylindrica* L.

Treatments	Sensory quality											
	Shivanya	Payal	Shivanya	Payal	Shivanya	Payal	Shivanya	Payal	Shivanya	Payal	Shivanya	Payal
	Color		Flavor		Texture		Firmness		Stickiness		Overall acceptability	
T0	5.87	5.97	6.33	6.50	6.57	6.70	6.70	6.77	6.87	7.00	6.33	6.43
T1	7.17	7.40	7.17	7.27	7.23	7.33	7.33	7.47	7.47	7.63	7.57	7.63
T2	7.77	7.97	7.83	7.90	7.87	7.97	7.97	8.03	8.07	8.13	8.13	8.20
T3	7.23	7.33	7.40	7.53	7.30	7.37	7.40	7.53	7.73	7.77	7.53	7.57
T4	9.00	9.17	9.13	9.00	9.30	9.40	9.40	9.40	9.53	9.60	9.50	9.57
T5	7.30	7.37	7.40	7.47	7.47	7.57	7.57	7.60	7.67	7.70	7.77	7.77
T6	8.27	8.33	8.57	8.67	8.67	8.73	8.77	8.77	8.80	8.97	8.87	8.90
T7	8.90	9.00	8.93	9.00	9.07	9.10	9.10	9.13	9.17	9.20	9.37	9.43
T8	7.67	7.70	7.77	7.83	7.87	7.93	7.87	7.87	8.07	8.20	8.33	8.37
T9	6.73	6.87	6.83	6.87	6.90	6.97	6.97	7.23	7.07	7.27	7.23	7.30
CD (p≤0.05)	0.36	0.36	0.43	0.46	0.47	0.49	0.53	0.68	6.55	6.63	0.26	0.28

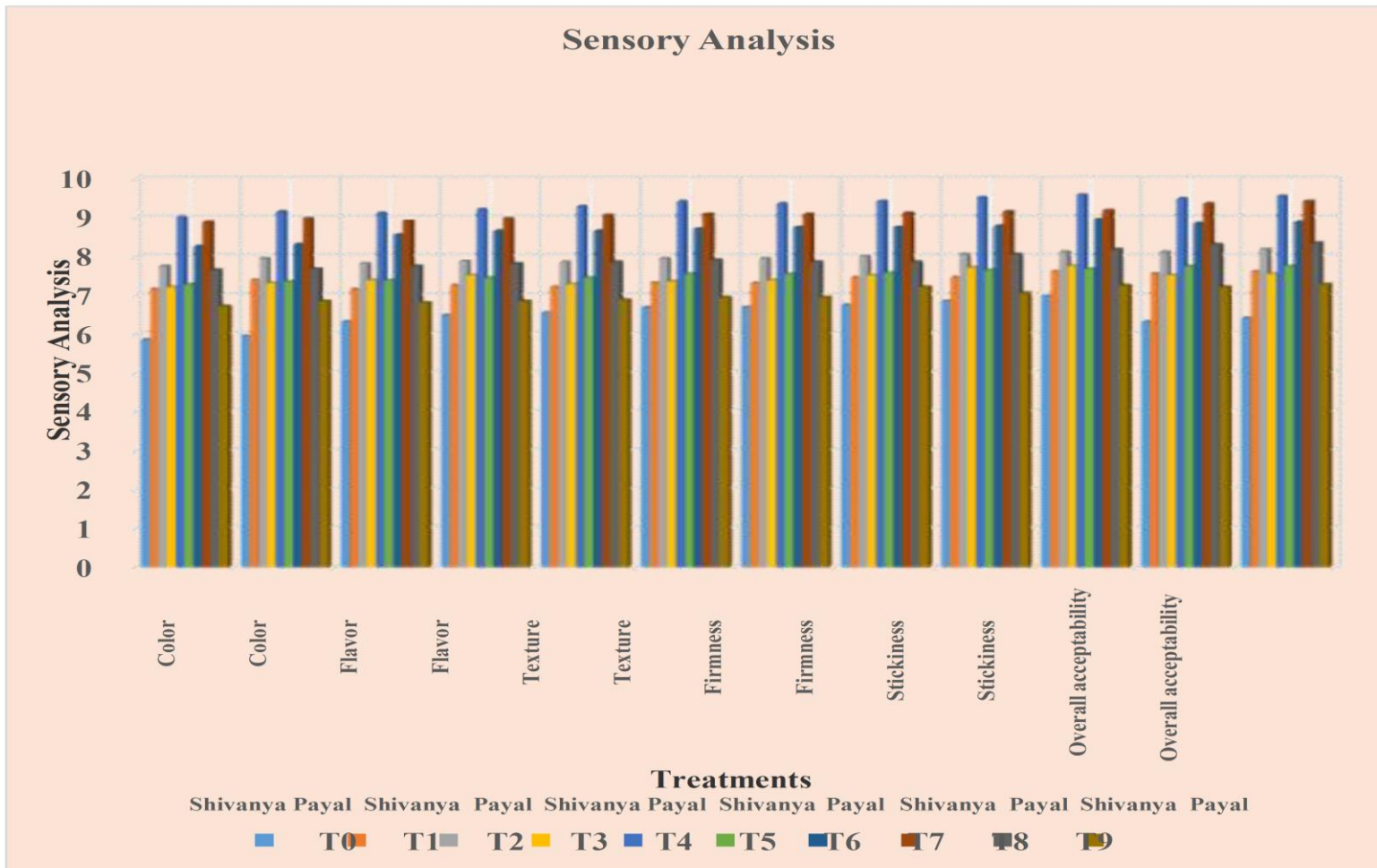


Figure 48: Effect of sensory quality on value added pasta from two different varieties of *Luffa cylindrica* L.

SUMMARY AND CONCLUSION

Post-harvest losses cause deterioration during handling, transport, and storage. The usage of edible coating is a way helps to improve quality as they increase the shelf life of foods in food industries. There has been great interest in the usage of herbal coatings to enhance the properties of horticulture products where shelf life of the product improves by reducing respiration. Therefore the experimental study was conducted for comparative morphological and yield related traits among different four varieties of sponge gourd i.e. Shivanya, Payal, Alok & Garima. Further the development of composite herbal edible coating was prepared with different formulations among these varieties. Then preparation of value added pasta product from two highest yielded varieties viz. Shivanya and Payal was studied under different parameters. The results of present investigation entitled “**Pre and Post harvest studies and value addition in sponge gourd (*Luffa cylindrica* L.)**” have been summarized below:

5.1 Effect of morphological & yield related parameters

The results depicted that days to emergence in Alok variety took maximum days to emerge (13.20) followed by Garima variety (12.00), Payal variety (11.20) during 2020-2021 whereas Shivanya variety took minimum days to germinate (8.40). During 2021-2022 Garima variety took maximum days to emerge (14.40) followed by Alok variety (11.60). However, Shivanya variety took minimum days to germinate (8.00). The emergence % defined that the Shivanya variety had maximum emergence % (95.60) followed by Payal variety (92.00), Alok variety (83.60). The Garima variety had minimum emergence % (82.60). The Garima variety took minimum days to germinate (84.60). The days to anthesis of first male flower represented that Alok variety required highest days of the floral anthesis of first male (61.60) followed by Garima variety (56.00) during 2020-2021.

The Shivanya variety took minimum days required of the floral anthesis of first male (48.60). During 2021-2022 the Alok variety took maximum days to

anthesis of first male flower (61.80) followed by Garima variety (58.40). The Shivanya took less days (46.60). The node to anthesis of first male flower defined that the Shivanya and Payal had high nodes to anthesis of first male flower as (4.0) and (4.20) during 2020-2021.

The number of fruits per plant data presented in that in the year of 2020-2021 Shivanya variety had maximum number of fruits (6.82) after that Payal variety (5.87), Garima variety (4.37), whereas, Alok variety recorded minimum value (3.85). In 2021-2022 year, the more number of fruits per plant observed in Shivanya variety (7.03) followed by Payal variety (6.55). In comparison of other varieties Garima variety (4.48) and Alok variety (4.05) had less number of fruits per plant. The average fruit weight per plant in gram defined that the maximum average fruit weight per plant was shown in Shivanya variety (72.43 g) followed by Payal variety (67.13).

In 2021-2022, highest average fruit weight per plant (74.34 g) was present in Shivanya variety followed by Payal variety (67.07 g) and minimum values were recorded in Alok (55.63). The average fruit yield per plant had maximum average fruit yield was observed in Shivanya (0.55 kg) followed by Payal variety (0.43 kg), Garima variety (0.25 kg) and minimum value for average fruit yield in Alok variety was observed (0.21 kg) in 2020-2021. Whereas in year of 2021-2022, Shivanya variety had maximum average fruit yield (0.58 kg), followed by Payal (0.46 kg), Garima variety (0.32 kg) while, least average fruit yield per plant was seen in Alok (0.25 kg). The data of plant yield per plot (kg/plot) represented that Shivanya had maximum plant yield per plot (342.58) followed by Payal (271.97).

The yield per hectare in tonne defined that the maximum yield per hectare was shown in Shivanya variety (35.85 ton) followed by Payal variety (29.35 ton), Garima variety (16.65 ton) in 2020-2021. While, the minimum yield per hectare was observed in Alok variety (14.25 ton). In 2021-2022, highest yield per hectare (24.20 ton) was present in Shivanya variety followed by Payal variety (19.26 ton) and minimum values were recorded in Alok variety (10.31 ton).

The main vine length described that the Shivanya variety (8.50 m) and Payal variety (8.62 m) had maximum vine length after that Garima variety (6.68 m). In comparison of other varieties Garima (5.50 m) and Alok variety (5.82 m) had less

vine length. The data of fruit length represented that the Shivanya variety had maximum fruit length (19.52 cm) followed by Payal variety (18.58 cm). On the other hand, in year of 2021- 2022 the length of fruit was more in Shivanya variety (23.24 cm) followed by Payal variety (22.28 cm), Garima variety (18.54 cm). The fruit diameter represented in Payal variety had maximum of 27.42 mm fruit.

5.2 Physio chemical Parameters

The pH data defined that Shivanya and Payal variety had highest pH as (5.32) and (5.30) in 2020-2021. In 2021-2022 the pH of Shivanya and Payal variety had highest pH as (6.78) and (6.64) as compared to Garima and Alok variety. The TSS data defined that Shivanya and Payal variety had highest TSS as (3.63°B) and (3.59°B) in 2020-2021. In 2021-2022 the TSS of Shivanya and Payal variety had highest TSS as (2.63°B) and (2.63°B) as compared to Garima and Alok variety. The ascorbic acid data defined that Shivanya and Payal variety had highest ascorbic acid as (34.47 mg/100g) and (34.46 mg/100g) in 2020- 2021. In 2021-2022 the ascorbic acid of Shivanya and Payal variety had highest ascorbic acid as (39.75 mg/100g) and (36.59 mg/100g) as compared to Garima and Alok variety.

The moisture content data defined that Shivanya and Payal variety had highest moisture content as (96.97 %) and (95.23 %) in 2020-2021. In 2021-2022 the Shivanya and Payal variety had highest moisture content as (95.37 %) and (93.43 %) as compared to Garima and Alok variety. The DPPH data defined that Shivanya and Payal variety had highest DPPH as (80.40 %) and (79.31 %) in 2020-2021. In 2021-2022 the Shivanya and Payal variety had highest DPPH as (81.31 %) and (80.11 %) as compared to Garima and Alok variety.

The acidity data defined that Shivanya and Payal variety had highest acidity as (0.63 %) and (0.62 %) in 2020-2021. In 2021-2022 the Shivanya and Payal variety had highest acidity as (8.41 %) and (7.49 %) as compared to Garima and Alok variety. The phenolic data defined that Shivanya and Payal variety had highest phenolic content as (10.51 mg/kg) and (9.44 mg/kg) in 2020-2021. In 2021-2022 the Shivanya and Payal variety had highest phenolic content as (10.68 mg/kg) and (10.44 mg/kg) as compared to Garima and Alok variety.

5.3 Physiological Parameters

The physiological loss of weight in luffa defined that shivanya and payal varieties showed less loss in weight whereas the varieties alok and garima defined more physiological loss in weight. In 2021 the shivanya and payal varieties defined less loss in weight in T4 = (5.329%) and (5.312%) as compared to garima and alok varieties. In 2022 data shivanya and payal varieties had less physiological loss in weight in T4 (5.318%) and (5.298%) as compared to alok and garima varieties. The treatments T5 and T6, had defined the more loss in weight as compared to other treatments. The decay loss in luffa described that shivanya and payal varieties had less loss in decay in T4 (1.521%) and (1.532%) compared to garima and alok varieties during 2021.

Similarly, in 2022 data shivanya and payal varieties had less decay losses in T4 (1.494%) and (1.511%) as compared to alok and garima varieties. Treatments T3 and T4 had less decay loss in weight in varieties shivanya and payal as compared to alok and garima varieties under refrigerator conditions. Control treatment had more decay loss as compared to treated produce. The pulp peel ratio in luffa elaborated in the year 2021 shivanya and payal varieties had good pulp-peel ratio in T4 (5.589) and (5.613) as compared to alok and garima varieties. Likewise, in 2022 data shivanya and payal varieties had high pulp peel ratio in T4 (5.586) and (5.604) as compared to alok and garima varieties. Treatments T3 and T4 had high pulp peel ratio in shivanya and payal varieties as compared to alok and garima varieties under refrigerator conditions.

5.4 Quality Parameters

The pH of in luffa defined that in the year 2021 shivanya and payal varieties had less decrease in pH in T4 (6.204) and (6.233) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties had less loss in pH in T4 (6.178) and (6.247) as compared to alok and garima varieties. The effect of different varieties of luffa defined that shivanya and payal varieties defined less decrease in pH whereas the varieties of alok and garima defined high decrease in pH content. The TSS in luffa proclaimed that in the year 2021 it had been seen that shivanya and payal varieties had less loss in TSS in T4 (5.883) and (5.916) as compared to alok and garima varieties.

Similarly, in 2022 data shivanya and payal varieties had less loss in TSS in T4 (5.987) and (5.906) as compared to alok and garima varieties. The treatments T3 and T4 defined good total soluble solids as compared to other treatments. The control fruits with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa. The titratable acidity in luffa defined that in the year 2021 it had been evaluated that shivanya and payal varieties had less loss in acidity in T4 (0.509%) and (0.509%) as compared to alok and garima varieties. In 2022 data shivanya and payal varieties had less loss in titratable acidity in T4 (0.513%) and (0.499%) as compared to alok and garima varieties.

The effect of different varieties of luffa defined that shivanya and payal varieties defined less loss in acidity whereas the varieties of alok and garima defined high loss in acidity. The produce coated with T3 and T4 retained more titratable acidity. The ascorbic acid in luffa described that in the year 2021 it had been studied that shivanya and payal varieties had less loss in ascorbic acid in T4 (29.38 mg/100g) and (29.53 mg/100g) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties had less loss in ascorbic acid in T4 (29.20) and (29.45) as compared to alok and garima varieties. The treatments T3 and T4 defined a high amount of ascorbic acid as compared to other treatments.

The fruit weight of luffa described in the year 2021 has been studied that shivanya and payal varieties had less decrease of fruit weight in T4 (113.18 g) and (113.70 g) as compared to alok and garima varieties. In 2022 data shivanya and payal varieties retained the fruit weight in T4 (113.04) and (113.72) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more fruit weight. The overall acceptability in luffa defined that in the year 2021 it had been studied that shivanya and payal varieties had good overall acceptability in T4 (6.63) and (6.70) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the overall acceptability in T4 (7.03) and (7.08) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more overall acceptability.

5.4 Biochemical parameter

The phenols in luffa presented that in the year 2021 it had been studied that

shivanya and payal varieties had less decrease in phenolic content in T4 (385.64 mg/Kg) and (384.86 mg/Kg) as compared to alok and garima varieties. Similarly, in 2022 data shivanya and payal varieties retained the phenolic content in T4 (380.21) and (380.72) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more phenols. The treatments T3 and T4 defined a high amount of phenols as compared to other treatments.

The DPPH in luffa defined that in the year 2021 it had been studied that shivanya and payal varieties had less decrease in antioxidant activity in T4 (32.58 %) and (32.68 %) as compared to alok and garima varieties. In 2022 data shivanya and payal varieties retained the DPPH in T4 = (32.40 %) and (32.98 %) as compared to alok and garima varieties. The produce coated with T3 and T4 retained more DPPH. The treatments T3 and T4 defined a high amount of antioxidants as compared to other treatments. The DPPH in luffa presented that in the year 2021 it had been studied that shivanya and payal varieties had retained more firmness in T4= (10.20) and (10.21) as compared to alok and garima varieties. The treatments T3 and T4 defined a high amount of firmness as compared to other treatments. The control produces with their more respiration rate cause loss of metabolites from luffa and causes deterioration of luffa.

5.5 Cooking quality analysis of Pasta:

Cooking loss of pasta defined that the maximum cooking loss was shown in T6 treatment of Payal variety (6.85 g/100g) followed by T6 treatment of Shivanya (6.83 g/100g). While, the minimum cooking loss was found in T7 treatment of Shivanya variety (4.88 g/100g) followed by T7 treatment of Payal variety (4.89 g/100g). Water absorption of pasta described that the maximum water absorption was shown in T2 treatment of shivanya variety (178.67 %) followed by T2 treatment of payal (6.83 %). While, the minimum water absorption was found in T7 treatment of payal variety (166.67 %) followed by T7 treatment of shivanya variety (165.27%).

Swelling index of pasta claimed that the maximum swelling index was shown in T2 treatment of shivanya variety (1.73%) followed by T2 treatment of payal (1.67 %). While, the minimum swelling index was found in T4 treatment of payal variety (1.50 %) followed by T4 treatment of shivanya variety (1.50 %). Cooking time

described that the maximum cooking time was shown in T1 treatment of shivanya variety (9.90 min) followed by T1 treatment of payal (9.93 min). While, the minimum cooking time was found in T4 treatment of payal variety (7.93 min) followed by T4 treatment of shivanya variety (7.80 min).

5.6 Nutritional & physiochemical parameters

The protein content of pastadefined that the maximum protein was shown in T4 treatment of payal variety (29.14 %) followed by T4 treatment of shivanya variety (29.11 %). While, the minimum protein was found in T9 treatment of shivanya variety (18.91 %) followed by T9 treatment of payal variety (18.81 %). The fat parameter of pasta determined the maximum fat was shown in T4 treatment of payal variety (4.5 %) followed by T4 treatment of shivanya variety (4.33 %). While, the minimum fat was found in T7 treatment of shivanya variety (2.17 %) followed by T7 treatment of payal variety (2.23 %).

The ash parameter of pasta determined the maximum ash was shown in T4 treatment of payal variety (1.53 %) followed by T4 treatment of shivanya variety (1.4 %). While, the minimum fat was found in T9 treatment of shivanya variety (0.97 %) followed by T9 treatment of payal variety (1.43 %). The crude fiber parameter of pasta determined the maximum crude fiber was shown in T4 treatment of payal variety (2.77 %) followed by T4 treatment of shivanya variety (2.75%). While, the minimum crude fiber was found in T9 treatment of shivanya variety (1.25 %) followed by T9 treatment of payal variety (1.29 %). The carbohydrate of pasta was defined that the maximum carbohydrate was shown in T4 treatment of payal variety (13.2 %) followed by T4 treatment of shivanya variety (13 %). While, the minimum carbohydrate was found in T6 treatment of shivanya variety (9.33 %) followed by T6 treatment of payal variety (9.23 %).

Ascorbic acid of pasta defined that the maximum ascorbic acid was shown in T7 treatment of shivanya variety (25.97 mg/100g) followed by T7 treatment of payal (27.43 mg/100g). While, the minimum ascorbic acid was found in T9 treatment of shivanya variety (18.4 mg/100g) followed by T9 treatment of payal variety (18.57 mg/100g). The DPPH described that the maximum ascorbic acid was shown in T7 treatment of shivanya variety (67.54 %) followed by T7 treatment of payal (67.24

%). While, the minimum DPPH was found in T9 treatment of shivanya variety (53.71%) followed by T9 treatment of payal variety (54.27 %).

5.7 Sensory quality

The sensory quality of pasta determined sensory evaluations are depends upon the type of flour, cooking time, quality, and water absorption. The sensory evaluation determines the color, texture, flavor, firmness, and stickiness of pasta. The varieties shivanya and payal with treatment T4 and T7 defined good sensory quality and determined the significant behavior as compared to control and other treatments. The T4 treatment incorporated semolina flour 20g, durum wheat 90g, & sponge gourd pulp 60g has best sensory quality.

CONCLUSION

The fresh produce is valuable source for consumption. But due to their perishability nature it's very difficult to procure them after post-harvest losses and transportation time.

- ❖ In the present study, four varieties were evaluated for different objectives. The objective one defined the morphological and yield related traits of sponge gourd vegetable in which it is concluded that shivanya and payal varieties of *Luffa cylindrica* L. have highest morphological and yield related traits as compared to garima and alok varieties & therefore can be suggested to farmers for higher production & yield prespective.
- ❖ From the present investigation, it can be concluded that shivanya and payal varieties of *Luffa cylindrica* L. have highest morphological and yield related traits as compared to garima and alok varieties & therefore can be suggested to farmers for higher production & yield prespective.
- ❖ Further in second objective, the effect of post-herbal edible coating on sponge gourd was studied where it was evaluated that the treatment 4 combination of chitosan 0.75% + aloe vera 2.5% + mint leave juice 1% of shivanya and payal variety as compared to garima and alok varieties had more shelf life & is good for shelf-life enhancement of sponge gourd. As sponge gourd is perishable commodity coating improves its shelf life and maintains its quality for longer time.
- ❖ In addition of objective 3, the value-added pasta prepared from two best yielded varieties of sponge gourd i.e., shivanya & payal were evaluated for different parameters such as cooking loss, water absorption, swelling index, fat, ash, protein. etc. It had been indicated from the results that the T4 treatment incorporated semolina flour 20g, durum wheat 90g, & sponge gourd pulp 60g of shivanya variety had good quality pasta as compared to payal variety whereas variety shivanya had more industrial importance and market value as its pasta contains more nutritional components.

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ANNEXURE

Annexure1: Detailed data of weather forecasting from February- June month.

SMW	2020-21 year					2021-22 year				
	MaxT (°C)	MinT (°C)	RH% Morning	RH% Evening	Rainfall, mm	MaxT (°C)	MinT (°C)	RH% Morning	RH% Evening	Rainfall, mm
43	0	15.8	62.5	43	0	17.1	9.3	60.9	48.4	2.3
44	30.1	19.4	61.1	41.4	0	22.7	14.1	53.9	43.4	0
45	30	19.1	60.5	42	0	28	20	53.7	42.4	0
46	29	14.7	60.1	35	0.6	31.9	21.6	52.7	42	0
47	32.8	13.8	46.2	30.8	0	31.4	21	50.9	42.4	0
48	30.7	14.5	41.5	29.4	0.71	33.3	24	47.6	38.1	0
49	31.8	17.7	39.1	28	0.03	41.3	25.4	44.6	33.3	0.1
50	29.2	17.7	47.2	28.4	2.62	39.6	28.7	41.7	29.3	0
51	34.2	21.2	38.7	24.2	0.57	41.3	30.7	34.6	23.1	0
52	39.1	26.7	40.4	16.4	0	39.9	30	35.3	21.4	0
1	37.1	26.1	44.2	19.7	0	40.1	31	37	26.1	0

SMW= Standard Meteorological Week; Max T= Average Maximum Temperature (°C); Min T= Average Minimum Temperature (°C); RH (M)= Morning Relative Humidity (%); RH (E)= Evening Relative Humidity (%); ; R= rainfall (mm per week)

Annexure-2: Hedonic Scale Card for sensory testing.

NAME: _____ DATE: _____

You are required to evaluate the provided sample of Sponge gourd Pasta using the following mentioned sensory 9-point hedonic scale.

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

SAMPLE	COLOUR AND APPEARANCE	FLAVOUR	TEXTURE	FIRMNESS	STICKINESS	OVERALL GRADE

SIGNATURE:

LIST OF CONFERENCES & WORKSHOPS

- Oral Presentation in International Conference on “ *Recent Trends in Smart and Sustainable Agriculture for Food Security (SSAFS-2022)*” on 21 to 22 January 2022 organized by School of Agriculture, Lovely Professional University, Punjab.
- Oral Presentation in International Conference on “ *Global Initiatives in Agricultural, Forestry and Applied Sciences (GIAFAS-2021)*” on 17th to 18th October 2021 organized by Shri Guru Ram Rai University, Dehradun, Uttarakhand.
- Participated in webinar on “*National Farmers Day*” organized by International Association of Students in Agricultural And Related Sciences (IAAS) India LPU on 23rd Decemer,2021
- Participated in Training program on “*International Meet on Precision Agricultural Technologies (IPAT-2022)*”, organized by Punjab Agricultural University, Ludhiana from 13th -26th July 2022.

PUBLICATION OF PAPER FOR Ph.D

TITLE OF PAPER WITH AUTHOR NAMES	NAME OF JOURNAL / CONFERENCE	PUBLISHED DATE	ISSN NO/ VOL NO, ISSUE NO
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