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Preparation and physio-chemical properties of green chilli (*Capsicum annuum* L.) paste using natural preservatives

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Abstract
A study was conducted in Vegetable Science Laboratory, College of Horticulture, Rajendranagar, Hyderabad during the period from January 2022 to March 2022. The main objective of the investigation was to standardize the preparation, quality, sensory characteristics of the green chilli paste under ambient conditions using the variety Teja for developing a technique to preserve the green chilli paste. The experiment was carried out in Factorial Completely Randomized Design (FCRD) with control using contrast method of analysis compared with 21 treatments. The study revealed that significant differences were recorded among the treatments, storage intervals and their interactions of the green chilli paste due to effect of different treatment combinations. The results of the study on physical parameters revealed that the conversion ratio of the green chilli fruit to the paste found non-significant. Among the chemical parameters, the results showed that chilli paste prepared with clove oil (0.125%), vinegar (6%) and salt (2%) (T_{18}) recorded highest total chlorophyll (0.3244 mg 100 g^{-1}), titratable acidity (0.28), pH (4.0), and TSS (15.8 oBrix) with minimum increment by the end of the storage period and all the parameters are significantly differed among the treatments, storage and their interactions. The results of organoleptic evaluation can be disclosed that colour (7.93), flavour (7.80), texture (7.48), taste/pungency (7.96) and overall acceptability (7.92) found best in (T_{18}) (clove oil-0.125%, vinegar-6% and salt-2%) and differed significantly. Overall, T_{18} was the most effective treatment. The study also paved the way for working with other varieties, long storage, using different types of bagging materials, and developing new and more sustainable technologies to preserve green chilli paste with adequate nutritional quality, hygiene, and value addition.

Keywords: Natural preservatives, storage conditions, quality, green chilli

Introduction
Chilli (*Capsicum annuum* L.) is a popular vegetable and spice crop valued for its aroma, flavour, and pungency. It is originated in Mexico, and widely grown for its fruit throughout India (Gade *et al*., 2020) [7], Since it was introduced by the Portuguese during 16th century. It has the chromosome number 2n = 24 and is a member of the Solanaceae family. It is also known as hot peppers, red peppers, pod peppers, cayenne peppers, paprika, pimento, and capsicum, in different parts of the world (Babu *et al*., 2020) [3]. It is one of the most valuable spice crops in trade.

Chilli is cultivated in an area of 1.776 million ha worldwide, yielding 7.182 million MT (Gade *et al*., 2020) [7]. In India, the total area under chilli cultivation is 0.42 million ha, and the total chilli production is 4.09 million MT (NHB, 2019-2020). India is the world's largest producer and exporter of chilli, with exports to the United States, the United Kingdom, Saudi Arabia, Bangladesh, Pakistan, Sri Lanka, the United Arab Emirates, Singapore, Malaysia, Indonesia, Canada, Vietnam, Germany and many other countries. India and China are the world's largest chilli exporters, accounting for 25% and 24% of total global exports, respectively (Gade *et al*., 2020) [7].

More than 200 varieties of chilli are classified into more than 30 species, five of which are domesticated: C. *annuum* L., C. *chinense* Jacq, C. *baccatum*, C. *pubescens*, and *C. frutescens* L. (Hernandez *et al*., 1999) [26].

Among them, *Capsicum annuum* has the greatest economic significance due to its widespread distribution (Pino *et al*., 2007) [17]. It is widely used as a spice in culinary and in pharmaceutical industry. It can be used as raw or ripe, as well as dried, pickled, sauced, pasted, or powdered form (Rahman *et al*., 1978) [18]. Chilli is increasingly popular in fresh, processed, whole dried, frozen, and canned forms, as well as value-added products such as powder, oleoresin, paste, and chilli oil (Babu *et al*., 2020) [3].

It is used in the food and beverage industries as an oleoresin, which allows for better color and flavour distribution. Its powder is widely used to flavour and color meat, snacks, and sauces. Chilli powder has many beneficial properties that make it essential in Ayurvedic medicine for fighting many diseases, destroying harmful toxins, and stimulating gastric juices to aid in digestion. It also aids in the relief of nasal congestion, throat infections, and muscle pain (Babu *et al*., 2020) [3], due to its anti-inflammatory properties. In traditional medicine, chilli is used to treat asthma, arthritis, blood clots, cluster pains, headaches, and burns (Gade *et al*., 2020) [7].

Materials and Methods

The present investigation titled, "Preparation and storage qualities of green chilli paste prepared using natural preservatives", was undertaken for utilization and value addition of chilli. The studies were carried out during 2021-22 at Vegetable Science Laboratory, College of Horticulture, Rajendranagar, and Hyderabad. It deals with material used and analytical method employed in the research studies. All the Technological, physical, chemical, sensory evaluation and statistical aspects are described. The study was a laboratory work with two factors conducted in the completely randomized design (FCRD) with 21 treatments and three replications at 2-month storage period. The quality and sources of various materials were procured here under. Fresh green Chilli variety Teja was procured from the farmers growing in Gadwal (Jogulamaba district), Telangana, and India. Preservatives used for the experiment are Clove bud oil was purchased from Plant Lipids Private Limited and Synthite India Private Limited, Kolenchery, Kerala, India. The clove bud oil is a yellow-coloured clear liquid having eugenol content of 85.08% (v/v) with a density of 1.058 g/ml and refractive index of 1.530. Vinegar consisting of 5% acetic acid and rock salt was procured from the local market, Hyderabad, Telangana. The analytical grade chemicals required for analysis were purchased from Sigma Aldrich Bengaluru, India and HI Media, Mumbai, India.

The 21 treatments used in the present study

Treatments

T_1: Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1%
T_2: Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1.5%
T_3: Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 2%
T_4: Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1%
T_5: Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1.5%
T_6: Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 2%
T_7: Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1%
T_8: Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1.5%
T_9: Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 2%
T_{10}: Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1
T_{11}: Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1.5%
T_{12}: Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 2%
T_{13}: Clove oil @0.125%+ vinegar @ 6% + Salt @1%
T_{14}: Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1.5%
T_{15}: Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 2%
T_{16}: Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1
T_{17}: Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 1.5%
T_{18}: Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 2%
T_{19}: Clove oil @ 0.125% + Vinegar @ 6% (control-1)
T_{20}: Vinegar @ 6% + Salt @ 2% (control-2)
T_{21}: Control-3 (No added preservatives)

Fig 1: Flow chart for preparation of green chilli paste

Results and Discussion

Ratio of the green Chilli fruits to the paste

The data pertaining to a ratio of the green chilli fruits to the paste was presented in Table 1 and Figure 1 which revealed that the treatments had no significant effect on green chilli fruit to the paste. These results are in accordance with the study of Babu *et al*. (2020) [3] reported in contrast to the yield of the green chilli powder, the percent yield of the green chilli paste was as high as 135-140% which was much higher than chilli powder which was akin to the results obtained in the present experiment.

Titratable acidity (%)

The data pertaining to titratable acidity of chilli paste prepared using different treatments was presented in Table 4.4 which revealed that the treatments, storage period and their interactions differed significantly. Chilli pastes prepared with no added preservatives (control) (T_{21}) had maximum titratable acidity (0.37%) followed by Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) (0.28%) while minimum titratable acidity (0.09%) was found in the chilli paste prepared with Clove oil (0.075%) + Vinegar (5%) + Salt (1.5%) (T_5). Titratable acidity of chilli paste reported an increasing trend from beginning to end of the storage period. The data revealed that the highest titratable acidity (0.26%) was recorded on 60 days of storage while lowest titratable acidity (0.08%) was recorded on 0^{th} day of storage. Among the interactions between treatments and storage period maximum titratable acidity (0.89%) was found in the control (T_{21}) and minimum titratable acidity (0.05%) was found in the chilli paste prepared with Clove oil (0.075%) + Vinegar (6%) + Salt (1.5%) (T_2). According to Singh *et al*. (2015) [19], who studied the development of manufacturing

technology for green chilli powder, titratable acidity showed a minor increase during storage regardless of packaging used, implying the interplay of various constituents and resulting chemical changes. In the present study, it was observed that the pH value was gradually decreased. The increase in titratable acidity of clove-treated sample was slower than the control sample, which could be attributed to the antimicrobial action of clove plant essential oil. Khatkar *et al*. (2017) [13] obtained similar results in studies on the effect of clove essential oil addition on paneer storage stability. The increase in acidity of samples was caused by the same phenomenon that caused pH to decrease during storage. Aside from that, some solids reduced during storage and become salts and bases, resulting in titratable acidity variation from the original value. Kays (1997) [12] reported that the level of organic acids in fruits and vegetables is closely related to titratable acidity because organic acids exist as free acids, anions (malate), combined as salt (Potassium bitartrate), and esters such as isopentyl acetate. The concentrations of the predominant organic acids determine sourness.

pH

The data pertaining to pH of chilli paste was presented in Table 2 which revealed significant differences among the treatments, storage period and their interactions. The results revealed that chilli paste prepared with Vinegar (6%) + Salt (2%) (T_{20}) recorded the highest pH (4.57) which was on par with T_1, T_2, T_5, T_8, T_{12}, T_{19}, T_{21} while chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) recorded lowest pH (4.03). A significant decrease in the pH values of all samples was observed during 2 months of storage. Examination of results revealed that maximum pH (4.75) was recorded on 0th day of storage and minimum (3.98) on 60 days of storage. Among the interactions between the treatments and storage period, highest pH (5.20) was recorded in the chilli paste prepared with Vinegar (6%) + Salt (2%) (T_{20}) at 0th day while pH (3.80) was recorded in the chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (1.5%) (T_{14}) at 60 days of storage. The drop in pH of stored samples could be attributed to the fact that glucose and fructose are converted to carbon dioxide and alcohol, which can further hydrolyse to produce oxygen and acetic acid (Evahelda *et al*., 2017) [6]. According to Kang *et al*. (2019) [24], adding clove powder delayed the decrease in pH. The findings agreed with those of Toontom *et al*. (2012) [22] who discovered that the pH of all dried chilli ranged between 3.21 and 4.84 which was similar to the results obtained in this experiment.

TSS (ºBrix)

The data pertaining to total soluble solids of chilli paste prepared using different treatments was presented in Table 3 which revealed significant differences among the treatments, storage period and their interactions. Among the different treatments, chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) recorded highest TSS (15.3 ºBrix) which was on par with Clove oil (0.125%) + Vinegar (5%) + Salt (1.5%) (T_{17}) (15.00 ºBrix) while lowest TSS (11.9 ºBrix) was recorded in control (T_{21}). The data revealed that the maximum TSS (15.3 ºBrix) was found on 60 days of storage and minimum TSS (12.3 ºBrix) was found on 0th day of storage. The TSS of the chilli paste increased gradually over the storage period from 0 to 60th day. Among the interactions between treatments and storage period highest TSS (16.5 ºBrix) was recorded in chilli paste prepared with Clove oil (0.075%) + Vinegar (5%) + Salt (1.5%) (T_5) on 60th day while the lowest TSS (9.2 ºBrix) was recorded in control (T_{21}) on 0th day of storage. The present study revealed that the TSS ranged from 9.2-16.5 O.B., but Take *et al*. (2012) [21] reported that the TSS value of fresh green chilli in Teja variety is 10 O.B. Mudasir and Anju. (2018) [16] observed a significant increase in TSS irrespective of treatment during a six-month storage period in a study on the physicochemical characteristics and storage of pumpkin-guava blended jam and reported that the increase in TSS could be due to the conversion of starch and other insoluble carbohydrates into sugars which was similar to the results obtained in this experiment.

Total Chlorophyll (mg of Total Chlorophyll per gram of tissue)

The data pertaining to total chlorophyll of green chilli paste was presented in Table 4 revealed there were significant differences among the treatments, storage intervals, and their interactions. Among the different treatments, maximum total chlorophyll (0.3244 mg g^{-1}) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) followed by chilli paste prepared using Clove oil (0.10%) + Vinegar (6%) + Salt (1%) (T_{17}) (0.2592 mg g^{-1}) while minimum total chlorophyll (0.1692 mg g^{-1}) was recorded in chilli paste prepared with no added preservatives (control) (T_{21}). The data revealed that highest total chlorophyll (0.3393 mg g^{-1}) was recorded on 0th day and lowest total chlorophyll (0.1172 mg g^{-1}) at 60 days of storage. The total chlorophyll of the chilli paste decreased gradually over the storage period from 0 to 60th day. Among the interactions between treatments and storage period maximum total chlorophyll (0.4888 mg g^{-1}) recorded in the chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while minimum total chlorophyll (0.0704 mg g^{-1}) was recorded in the chilli paste prepared with Clove oil (0.10%) + Vinegar (6%) + Salt (1.5%) (T_8). A similar trend was observed in curry leaf chutney powder during a storage period of 90 days (Balaswamy *et al*. 2004) [4] & (Kizhedath and Suneetha. 2011) [25]. The presence of more total chlorophyll (chlorophyll a and b) in treated chilli pastes demonstrates the availability of more green colour in treated chilli paste compared to untreated chilli paste. In contrast, Maillard reaction between reducing sugar and amino acid in the pericarp of chilli and pigment oxidation and decomposition due to increased exposure to oxygen during drying may be the cause for higher color degradation in untreated samples (Toontom *et al*. 2012) [22]. However, the findings of this study suggested that chilli paste treated with clove oil, vinegar, and salt preserved the purity of color because salt can inhibit the browning reaction by binding with the carbonyl group of reducing sugars and other substances to delay the browning process (Take *et al*. 2012) [21]. Previous researchers reported that pre-treatment, i.e., blanching of green chilli in acetic acid solution, can prevent the enzyme reaction, i.e., enzymatic browning reaction (responsible for sample discolouration) induced by polyphenol oxidase reaction, and also acts as the green color fixing agent (Wiriya *et al*. 2009; Hossain and Bala 2007) [23, 8].

Sensory evaluation

As with all foods, sensory properties are generally the final guide of the quality from the consumer's point of view. As a result, comparing green chilli pastes was advantageous.

Colour

The data pertaining to colour of chilli paste was presented in Table 3. Which revealed that there were significant differences among treatments, storage and their interactions. Among the different treatments, highest treatment mean value of colour (7.93) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest treatment mean value of colour (5.28) was recorded in chilli paste prepared with no added preservatives (control) (T_{21}). The colour of the chilli paste decreased from the beginning to the end of the storage period. Among the different treatments, maximum storage mean value (7.73) was recorded on 0th day while minimum storage mean value (5.63) was recorded on 60th day. Among the various treatments, good color on the 0, 30, and 60th day (8.83, 7.83, 7.12) was observed in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest colour (8.43, 5.03, 2.71) were recorded in chilli paste prepared with no added preservatives (T_{21}). The study found that the colour of chilli paste degraded gradually over time. The colour of the chilli paste decreased from the beginning to the end of the storage period. The degradation in colour observed in the green chilli paste was caused by the chilli product being exposed to sunlight at ambient Temperature and fluctuation in sun temperature during the day. The colour of green chilli ranged from light to dark green, depending on the chlorophyll content of the fruits. It is obvious that carotenoid pigments coexist because chlorophyll contains more total carotenoids due to higher moisture and pericarp weight (Lease and Lease, 1962) [14]. The oxidation of carotenoid pigment is also likely to be responsible for the decrease in colour values during storage. Ahmed *et al*. reported a similar observation (2002) [1].

Flavour

The data pertaining to flavour of chilli paste was presented in Table 3. Which revealed that there were significant differences among treatments, storage and their interactions. Among the different treatments, highest treatment mean value of flavour (7.80) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest treatment mean value of flavour (5.26) was recorded in chilli paste prepared with vinegar (6%) and salt (2%) (T_{20}). Flavour of chilli paste observed a decrease in trend from beginning to end of the storage period. Among the different treatments, maximum storage mean value (7.60) was recorded on 0th day while minimum storage mean value (5.48) was recorded on 60th day. Among the various treatments, good flavour on 0, 30, 60th days (8.13, 7.93, 7.33) was observed in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest flavour (8.44, 5.22, 2.41) were recorded in chilli paste prepared with no added preservatives (T_{21}). The study revealed that flavour of chilli paste degraded gradually over the storage period. Flavour of chilli paste observed a decrease in trend from beginning to end of the storage period. Suhartini *et al*. (2019) [20] found that adding salt to chilli shrimp pastes produced similar results to the current experiment. The flavour is the sensory impression of a food or other substance that is determined primarily by the chemical senses of taste and smell it is also a very important character in the case of green chilli paste that improves product acceptability due to addition of salt. Fruits and vegetables with very low levels of organic acids may therefore lack characteristic flavour (Taste), (Kader, 2008) [11].

Texture

The data pertaining to texture of chilli paste was presented in Table 3. Which revealed that there were significant differences among treatments, storage and their interactions. Among the different treatments, highest treatment mean value of texture (7.24) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest treatment mean value of texture (5.88) was recorded in chilli paste prepared with no added preservatives (control) (T_{21}). Texture of chilli paste observed a decrease in trend from beginning to end of the storage period. Among the different treatments, maximum storage mean value (7.40) was recorded on 0th day while minimum storage mean value (6.12) was recorded on 60th day. Among the various treatments, good texture on 0, 30, 60th days (7.79, 7.45, 7.21) was found in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest texture (7.33, 6.08, 4.23) was recorded in chilli paste prepared with no added preservatives (T_{21}). The study revealed that texture of chilli paste degraded gradually over the storage period. Taste /pungency of chilli paste observed a decrease in trend from beginning to end of the storage period. The hardness or crispness of the chilli during storage is an important factor in determining quality and postharvest shelf-life. The postharvest texture changes are primarily caused by enzymatic degradation of the components responsible for the fruit's structural rigidity, primarily insoluble pectin and protopectin (Moalemiyan and Ramaswamy, 2012) [15], which was similar to the results obtained in the current experiment.

Taste/pungency

The data pertaining to the taste/pungency of chilli paste was presented in Table 4. Which revealed that there were significant differences among treatments, storage and their interactions. Among the different treatments, highest treatment mean value of taste/pungency (7.96) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%), (T_{18}) while lowest treatment mean value of taste/pungency (5.29) was recorded in chilli paste prepared with no added preservatives (control) (T_{21}). Taste/pungency of chilli paste observed a decrease in trend from beginning to end of the storage period. Among the different treatments, maximum storage mean value (7.66) was recorded on 0th day while minimum storage mean value (5.53) was recorded on 60th day. Among the different treatments, good taste/pungency on 0, 30, 60th days (8.64, 7.91, 7.32) was found in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest taste/pungency (7.61, 5.03, 3.24) were recorded in chilli paste prepared with no added preservatives (T_{21}). The study found that the taste/pungency of chilli paste degraded gradually over time. The taste/pungency of chilli paste decreased from the beginning to the end of the storage period. The condition of having a strong, sharp smell or

taste that is often so strong is known as pungency. Scientists use the term pungency to refer to the characteristics of food known as spiciness, hotness, and sometimes heat, which is found in foods such as chilli.

Table 1: Effect of different treatments on titratable acidity, pH and conversion ratio of fruit to the paste of green chilli paste supplemented with different preservative concentrations during storage.

Treatments	The ratio of fruit to paste	Terrible acidity (%)				pH			
		0	30	60	M	0	30	60	M
T_1-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1%	1.011	0.06	0.11	0.19	0.12	4.78	4.40	4.21	4.46
T_2-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1.5%	1.005	0.05	0.09	0.16	0.10	5.00	4.21	4.10	4.43
T_3-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 2%	1.004	0.08	0.14	0.25	0.16	4.60	4.29	4.01	4.30
T_4 -Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1%	1.009	0.07	0.10	0.17	0.11	4.64	4.19	3.91	4.25
T_5-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1.5%	1.003	0.04	0.09	0.15	0.09	5.00	4.50	4.21	4.57
T_6-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 2%	1.005	0.11	0.15	0.18	0.15	4.89	4.20	4.00	4.36
T_7-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1%	1.011	0.07	0.13	0.17	0.13	4.81	4.30	4.10	4.40
T_8-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1.5%	1.002	0.09	0.14	0.17	0.13	5.10	4.40	4.09	4.53
T_9-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 2%	1.003	0.05	0.11	0.21	0.12	4.79	4.09	4.10	4.33
T_{10}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1%	1.008	0.05	0.15	0.20	0.13	4.68	4.20	3.87	4.25
T_{11}-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1.5%	1.007	0.09	0.20	0.34	0.21	4.68	4.10	3.81	4.20
T_{12}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 2%	1.005	0.05	0.13	0.17	0.12	4.61	4.50	4.29	4.46
T_{13}-Clove oil @0.125%+ vinegar @ 6% + Salt @1%	1.006	0.06	0.17	0.20	0.14	4.69	4.11	3.89	4.23
T_{14}Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1.5%	1.004	0.06	0.20	0.21	0.16	4.59	4.20	3.80	4.20
T_{15}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 2%	1.011	0.11	0.15	0.23	0.16	4.61	4.40	3.79	4.27
T_{16}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1%	1.008	0.13	0.19	0.22	0.19	4.61	4.30	3.89	4.26
T_{17}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 1.5%	1.004	0.15	0.20	0.25	0.20	4.60	4.10	3.79	4.16
T_{18}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 2%	1.002	0.22	0.28	0.33	0.28	4.20	4.00	3.90	4.03
T_{19}-(Control-1)-Clove oil @ 0.125% + Vinegar @ 6%	1.003	0.07	0.19	0.25	0.17	4.90	4.48	3.88	4.42
T_{20} (Control-2)-Vinegar @ 6% + Salt @ 2%	1.003	0.05	0.20	0.43	0.23	5.20	4.70	3.81	4.57
T_{21}-(Control-3)-No added preservatives.	1.009	0.04	0.19	0.89	0.37	4.80	4.30	4.10	4.40
Storage (M)		0.08	0.16	0.26		4.75	4.28	3.98	
		T	S	T*S		T	S	T*S	
Sem.±		0.006	0.002	0.010		0.06	0.02	0.11	
CD at 5%		0.017	0.007	0.030		0.19	0.07	0.33	
Control vs treatments		*				*			

T-Treatments, S-Storage, T*S-Interaction between Treatments and Storage. *-Significant

Table 2: Effect of different treatments on TSS and Total chlorophyll activity of green chilli paste supplemented with different preservative concentrations during storage.

Treatments	TSS (°Brix)				Total chlorophyll content			
	0	30	60	M	0	30	60	M
T_1-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1%	11.3	13.9	14.9	13.4	0.3943	0.1965	0.0925	0.2278
T_2-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1.5%	11.1	13	15.4	13.2	0.3976	0.2054	0.0783	0.2271
T_3-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 2%	10.5	12.6	15.9	13.0	0.3893	0.2022	0.0773	0.2229
T_4 -Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1%	11.2	13.4	15.1	13.2	0.3561	0.2002	0.0725	0.2096
T_5-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1.5%	10.7	13.5	16.5	13.6	0.3518	0.2012	0.0841	0.2124
T_6-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 2%	12.2	13.8	16	14.0	0.3461	0.2059	0.0767	0.2096
T_7-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1%	13.9	13.8	15.2	14.3	0.3824	0.1908	0.0912	0.2215
T_8-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1.5%	12.4	12.9	14.5	13.3	0.3304	0.1983	0.0704	0.1997
T_9-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 2%	13.8	14.1	15.9	14.6	0.3426	0.1342	0.1908	0.2225
T_{10}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1%	12	13.9	16.5	14.1	0.3448	0.109	0.1657	0.2065
T_{11}-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1.5%	12.8	12.8	15.4	13.7	0.3409	0.2296	0.0878	0.2194
T_{12}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 2%	13.1	14.1	15.2	14.1	0.31	0.2754	0.0963	0.2272
T_{13}-Clove oil @0.125%+ vinegar @ 6% + Salt @1%	12.4	13.6	16.1	14.0	0.2997	0.1262	0.0961	0.1740
T_{14}Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1.5%	13.5	13.9	14.6	14.0	0.308	0.1293	0.1274	0.1882
T_{15}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 2%	12.6	13.4	14.2	13.4	0.2814	0.2405	0.1267	0.2162
T_{16}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1%	11.9	12.6	14.1	12.9	0.3067	0.2697	0.1879	0.2548
T_{17}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 1.5%	14.2	14.9	15.9	15.0	0.3007	0.2705	0.2064	0.2592
T_{18}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 2%	14.9	15.2	15.8	15.3	0.4888	0.2935	0.1908	0.3244
T_{19}-(Control-1)-Clove oil @ 0.125% + Vinegar @ 6%	10.1	12.4	15.6	12.7	0.2769	0.2666	0.1278	0.2238
T_{20} (Control-2)-Vinegar @ 6% + Salt @ 2%	10.4	13.7	14.6	12.9	0.2937	0.1603	0.0972	0.1837
T_{21}-(Control-3)-No added preservatives.	9.2	12.2	14.4	11.9	0.2835	0.1069	0.1173	0.1692
Storage (M)	12.3	13.6	15.3		0.3393	0.2005	0.1172	
	T	S	T*S		T	S	T*S	
Sem.±	0.2	0.1	0.4		0.00009	0.00004	0.00016	
CD at 5%	0.6	0.2	1.1		0.00027	0.00011	0.00046	
Control vs treatments	*				*			

T-Treatments, S-Storage, T*S-Interaction between Treatments and Storage. *-Significant

Table 3: Effect of different treatments organoleptic evaluation of green chilli paste supplemented with different preservative concentrations

during storage.

Treatments	Colour				Flavour				Texture			
	0	30	60	M	0	30	60	M	0	30	60	M
T_1-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1%	7.56	6.94	6.17	6.89	7.23	6.43	5.63	6.43	7.07	6.74	6.36	6.72
T_2-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1.5%	7.43	6.82	5.73	6.66	7.35	6.29	5.43	6.36	7.24	6.56	6.21	6.67
T_3-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 2%	7.22	6.49	5.17	6.29	7.67	6.64	5.29	6.53	7.46	6.49	6.10	6.68
T_4 -Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1%	7.78	6.99	6.45	7.07	7.26	6.85	5.14	6.42	7.29	6.74	6.27	6.77
T_5-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1.5%	7.32	6.54	4.42	6.09	7.74	5.32	4.73	5.93	7.12	6.53	6.18	6.61
T_6-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 2%	7.43	6.92	6.32	6.89	7.89	6.31	5.31	6.50	7.49	6.49	5.34	6.44
T_7-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1%	7.12	6.67	5.39	6.39	7.43	6.89	5.03	6.45	7.53	7.09	6.45	7.02
T_8-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1.5%	7.61	6.58	5.64	6.61	7.59	6.38	5.94	6.64	7.59	7.12	6.32	7.01
T_9-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 2%	7.41	6.75	5.43	6.53	7.65	6.91	5.66	6.74	7.17	6.23	5.98	6.46
T_{10}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1%	7.59	6.85	6.23	6.89	7.41	6.63	5.63	6.56	7.41	6.98	6.21	6.87
T_{11}-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1.5%	7.78	6.71	6.03	6.84	7.49	6.81	5.45	6.58	7.39	6.54	6.11	6.68
T_{12}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 2%	7.85	7.12	6.41	7.13	7.32	6.72	5.94	6.66	7.21	6.85	6.04	6.70
T_{13}-Clove oil @0.125%+ vinegar @ 6% + Salt @1%	7.29	6.26	5.14	6.23	7.12	6.63	6.03	6.59	7.36	6.76	6.32	6.81
T_{14}Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1.5%	7.69	6.96	6.44	7.03	7.61	6.54	6.12	6.76	7.44	6.86	6.51	6.94
T_{15}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 2%	7.54	7.06	6.93	7.18	7.93	7.32	6.97	7.41	7.31	6.75	6.11	6.72
T_{16}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1%	8.12	7.39	6.23	7.25	8.01	7.87	6.85	7.58	7.45	6.97	6.26	6.89
T_{17}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 1.5%	8.55	7.54	6.85	7.65	7.96	7.43	7.07	7.49	7.67	7.15	6.91	7.24
T_{18}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 2%	8.83	7.83	7.12	7.93	8.13	7.93	7.33	7.80	7.79	7.45	7.21	7.48
T_{19}-(Control-1)-Clove oil @ 0.125% + Vinegar @ 6%	7.91	6.43	4.28	6.21	7.32	6.31	4.45	6.03	7.48	6.94	6.34	6.92
T_{20} (Control-2)-Vinegar @ 6% + Salt @ 2%	7.78	5.34	3.24	5.57	7.01	6.12	2.65	5.26	7.52	6.12	5.03	6.22
T_{21}-(Control-3)-No added preservatives.	8.43	5.03	2.71	5.28	8.44	5.22	2.41	5.36	7.33	6.08	4.23	5.88
Storage (M)	7.73	6.72	5.63		7.60	6.65	5.48		7.40	6.74	6.12	
	T	S	T*S		T	S	T*S		T	S	T*S	
Sem.±	0.006	0.002	0.01		0.003	0.001	0.004		0.004	0.001	0.007	
CD at 5%	0.018	0.007	0.02		0.008	0.003	0.015		0.011	0.004	0.019	
Control vs treatments	*				*				*			

Table 4: Effect of different treatments organoleptic evaluation of green chilli paste supplemented with different preservative concentrations during storage.

Treatments	Taste				Overall acceptability			
	0	30	60	M	0	30	60	M
T_1-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1%	7.21	6.64	5.34	6.40	7.45	6.34	5.89	6.56
T_2-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1.5%	7.43	6.36	4.25	6.01	7.57	6.23	5.64	6.48
T_3-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 2%	7.29	6.18	5.98	6.48	7.31	6.46	5.43	6.40
T_4 -Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 1%	7.43	6.45	5.42	6.43	7.48	6.59	5.39	6.49
T_5-Clove oil @ 0.075% + Vinegar @ 5% + Salt @ 1.5%	7.59	6.49	5.62	6.57	7.55	6.43	5.78	6.59
T_6-Clove oil @ 0.075% + Vinegar @ 6% + Salt @ 2%	7.64	6.11	5.91	6.55	7.68	6.25	5.32	6.42
T_7-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1%	7.82	6.24	5.28	6.45	7.26	6.13	5.64	6.34
T_8-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1.5%	7.22	6.66	5.39	6.42	7.89	6.56	5.92	6.79
T_9-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 2%	7.26	6.81	5.65	6.57	7.21	6.77	5.21	6.40
T_{10}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 1%	7.12	6.42	5.45	6.33	7.12	6.71	5.12	6.32
T_{11}-Clove oil @ 0.10% + Vinegar @ 5% + Salt @ 1.5%	7.39	6.72	5.74	6.62	7.39	5.32	4.48	5.73
T_{12}-Clove oil @ 0.10% + Vinegar @ 6% + Salt @ 2%	7.91	6.89	5.31	6.70	7.76	6.32	5.67	6.58
T_{13}-Clove oil @0.125%+ vinegar @ 6% + Salt @1%	7.77	6.32	5.29	6.46	7.89	6.94	5.71	6.85
T_{14}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1.5%	8.03	7.36	6.19	7.19	7.32	6.67	5.16	6.38
T_{15}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 2%	7.86	7.41	6.39	7.22	7.93	6.23	5.24	6.47
T_{16}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 1%	8.13	7.81	6.54	7.49	8.43	6.99	5.45	6.96
T_{17}-Clove oil @ 0.125% + Vinegar @ 5% + Salt @ 1.5%	8.34	7.73	6.93	7.67	8.67	7.34	6.78	7.60
T_{18}-Clove oil @ 0.125% + Vinegar @ 6% + Salt @ 2%	8.64	7.91	7.32	7.96	8.88	7.98	6.91	7.92
T_{19}-(Control-1)-Clove oil @ 0.125% + Vinegar @ 6%	7.66	6.09	4.91	6.22	7.43	6.01	3.51	5.65
T_{20} (Control-2)-Vinegar @ 6% + Salt @ 2%	7.43	5.35	3.92	5.57	8.05	5.67	3.33	5.68
T_{21}-(Control-3)-No added preservatives.	7.61	5.03	3.24	5.29	8.3	5.18	2.25	5.24
Storage (M)	7.66	6.62	5.53		7.74	6.43	5.23	
	T	S	T*S		T	S	T*S	
Sem.±	0.003	0.001	0.006		0.004	0.001	0.007	
CD at 5%	0.010	0.004	0.017		0.012	0.004	0.021	
Control vs treatments	*				*			

T-Treatments, S-Storage, T*S-Interaction between Treatments and Storage. *-Significant

Overall acceptability

The data pertaining to overall acceptability of chilli paste was presented in Table 4. Which revealed that there were significant differences among treatments, storage and their interactions. Among the different treatments, highest treatment mean value of overall acceptability (7.92) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest treatment mean

value of overall acceptability (5.24) was recorded in chilli paste prepared with no added preservatives (control) (T_{21}). Overall acceptability of chilli paste observed a decrease in trend from beginning to end of the storage period. Among the different treatments, maximum storage mean value (7.74) was recorded on 0th day while minimum storage mean value (5.23) was recorded on 60th day. Among the various treatments, good overall acceptability on 0, 30, 60th days (8.88, 7.98, 6.91) was observed in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) while lowest overall acceptability (8.30, 5.18, 2.25) was recorded in chilli paste prepared with no added preservatives (T_{21}). The study revealed that overall acceptability of chilli paste degraded gradually over the storage period. Overall acceptability of chilli paste observed a decrease in trend from beginning to the end of the storage period. At all storage days, the overall acceptability score of control samples was lower than that of other treated samples. The samples revealed an inverse relationship between overall acceptability and storage period. This could be due to increased chemical spoilage activity in the samples during storage. Jyothirmayi *et al.* (2008) [10] studied on physicochemical changes during the processing and storage of green chilli (C*apsicum annuum* L.) powders which was akin to the results obtained in the present experiment.

Conclusion

The treatments had no significant effect on the ratio of the green chilli fruits to the paste. There was a gradual increase in titratable acidity throughout the storage period. Titratable acidity with minimum increments (0.22, 0.28, 0.33%) was observed in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%) (T_{18}) on 0, 30 and 60th days of storage. The increase in the acidity of samples was related to the same fact as pH decreased during storage. pH was decreased during the storage period. The pH was less (4.2, 4.0 3.9) in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%), (T_{18}) on 0, 30 and 60th days of storage. There was a gradual increase in TSS content of chilli paste throughout the storage period in all the treatments. The TSS content was maximum (14.9, 15.2, 15.8 o Brix) in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%), (T_{18}) on 0, 30 and 60th days of storage. There was a gradual decrease in the total chlorophyll content of chilli paste during the storage period. Maximum total chlorophyll content (0.4888, 0.2934, 0.1908 mg g^{-1}) was recorded in chilli paste prepared with Clove oil (0.125%) + Vinegar (6%) + Salt (2%), (T_{18}) on 0, 30 and 60th days of storage. Based on the results of the study the following conclusions could be drawn. Good quality and acceptable chilli paste could be prepared with clove oil (0.125%) + Vinegar (6%) + Salt (2%), (T_{18}). These chilli paste could be stored significantly for a period of 60 days at ambient conditions without much loss of sensory and nutritional qualities of the product followed by Clove oil (0.125%) + Vinegar (5%) + Salt (1.5%), (T_{17}).

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