

“Effect of Blanching Parameters on Quality Attributes of Purslane (*Portulaca oleracea* L.)”

THESIS



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In

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**HORTICULTURE
(VEGETABLE SCIENCE)**

By

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CERTIFICATE – I

This is to certify that the thesis entitled “**Effect of blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)**” submitted in partial fulfilment of the requirements for the Degree of MASTER OF SCIENCE (Ag.) Horticulture (Vegetable Science) of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior is a record of the bona-side research work carried out by **Mr. RAKESH RAJPUT, ID No. 19131407** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instruction.

No part of the thesis has been submitted for any degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	Stand for
/	Per
@	At the rate of
%	Per cent
+	Plus, Minus
$^{\circ}\text{C}$	Degree Celsius
ANOVA	Analysis of variance
CaCl_2	Calcium Chloride
C.D.	Critical Difference
CIAE	Central Institute of Agricultural Engineering
cm	Centimeter
C.V.	Coefficient of Variation
DB	Dry Basis
D.W.	Dry Weight
d.f.	Degree of Freedom
<i>et al.</i>	And others
Fig.	Figure
FW	Fresh Weight
g	Gram
H	Hour
Ha	Hectare
i.e.	That is
Kg	Kilogram (s)
Kgha^{-1}	Kilogram per hectare
KMS	Potassium metabisulfite
Mg	Milligram
Min	Minute
Mt	Million ton
M.S.	Mean of square
No.	Number
NS	Non significant
R.H.	Relative humidity
Rs.	Rupees
Sec	Seconds
S.N.	Serial Number
RSM	Response Surface Methodology
$\text{SEm} \pm$	Standard Error of Means
spp.	Species
S.S.	Sum of Square
Std. Dev.	Standard deviation
Symb.	Symbol
t	Tonne
Viz.	(Videlicet) Namely
WB	Weight Basis
NS	Non-significant

CHAPTER - I

INTRODUCTION

Purslane is a herbaceous weed and underutilized vegetable. It is known by the name 'Rudravanti' in Hindi; 'Dahna' in Oriya and 'Nuner' in Kashmiri. The name *Portulaca* is thought to be derived from the Latin 'porto' to carry and 'lac' meaning milk, since the plant contains a milky juice (Masoodi *et al.*, 2011).

Portulaca oleracea L. is a cosmopolitan species and the genus *Portulaca* belongs to the family Portulacaceae, a small family with 21 genera and 580 species, and is cosmopolitan in distribution, occurring especially in America with some species found in Arabia. Purslane plants are succulent, annual herbaceous, and erect or decumbent up to 30 cm high. Purslane is botanically known as *Portulaca oleracea* L. and is also called portulaca (Danin and Reyes, 2006).

Purslane has been studied in detail as a prolific weed, but very little is known about its production as a food crop and the effects of cultural conditions on its nutritional value, although there have been some studies carried out to determine the best cultural conditions to obtain higher levels of fatty acids and lower levels of oxalic acid in the leaves (Palaniswamy *et al.*, 2001). Purslane is distributed widely in the tropical and subtropical areas of the world including many parts of the United States. It is eaten extensively as a potherb and is added to soups and salads around the Mediterranean and tropical Asian countries. Its soft stem and leaves are used raw, alone or with other greens (Palaniswamy *et al.*, 2002).

Purslane is native to Indian sub continent and now distributed widely across the continent but actual as a wild weed (Garima Jaiswal, 2017). Purslane is distributed all over the world, *Portulaca oleracea* is a herbaceous annual, native of many parts of Europe, found in the East and West Indies, India, China, Japan and Ascension Island, and though found also in the British Isles is not indigenous there. It is a weedy summer annual species that is abundant throughout the world, invading vegetable gardens, bare areas,

low-maintenance lawns, ornamental plantings, and agricultural areas (Brill and Wildman, 1994).

With global consumer demand shifting towards the consumption of healthier foods, it is crucial to discover new sources of foods with high nutritional value and low cost. Unique edible part such as purslane has potential to be used as an untapped source of unconventional food with diverse nutrients and beneficial bioactive properties. The leaves and stem contained ashes 22.66%, crude protein 23.47%, crude lipid 5.26%, crude fibre-8.0% and carbohydrates-40.67%. The stem and leaves also have high energy values [303.9 kcal/100 g dry weight (DW)] (Aberoumand A., 2009). Concentration of macro minerals in purslane leaves powder N, P, K, Na, Ca, and Mg (184.6, 14.18, 656, 154.4, 104.2, and 101.4 mg/100g DW) was reported respectively (Alam *et al.*, 2014).

Purslane is a good source of α -tocopherol, ascorbic acid, β -carotene, and glutathione, which through their abilities to neutralize free radicals can prevent certain disorders (Liu *et al.* 2000). Purslane is also a rich source of omega-3 fatty acids, in particular α -linolenic acid, which is important in preventing heart attacks and strengthening the immune system. Despite all of its nutritional values, purslane's acceptance as a green leafy vegetable may be limited because of its high oxalic acid. *P. oleracea* L. leaves and stem can be recommended as a good source of nutrients (fibre, protein, carbohydrates, K, Na, Ca, Zn and calorie) to supplement other major sources (Aberoumand A., 2009).

Purslane has been studied for its relatively high salinity tolerance, especially as it pertains to its use as a vegetable crop. Purslane is also known to be high in antioxidants and is a rich source of essential fatty acids (18:2 ω 6 and 18:3 ω 3) and carotenes, which have been shown to have human health benefits of edible wild plants tested, purslane has the highest amount of α -linolenic acid as well as high concentrations of the antioxidants α -tocopherol, β -carotene, and glutathione. In addition, melatonin has been discovered in relatively high amounts in purslane leaves (Simopoulos *et al.*, 2005). The benefits of melatonin in human health and cancer growth prevention have been documented (Tan *et al.*, 1993). The function of melatonin in plants is less well understood. In addition to its antioxidative properties, it is thought to

perform roles in diurnal regulation as a plant hormone-like molecule. Purslane is a good source of α -tocopherol, ascorbic acid, β -carotene, and glutathione, which through their abilities to neutralize free radicals can prevent certain disorders (Siriamornpun and Suttajit, 2010).

There were presence of alkaloid, flavonoid, phenol, saponin, sterol, tannin and terpenoid in the leaf, stem and root of both extracts. Alkaloid and saponin have highest concentrations in both aqueous and ethanol extracts. Sitosterols, mono,di and terpens phenolics compounds and omega-3 fatty acids are major phyto-constituents present in the purslane plant (Gindy, 2017). Oxalic acid is the most abundant organic acid in purslane. Oxalic acid can form insoluble oxalates with Ca and Fe and reduce Ca and Fe bio-availability and increase the incidence of kidney stone formation. Several organic acids, including citric acid, fumaric acid, succinic acid and oxalic acid are present in purslane. Oxalic acid is the most abundant organic acid in purslane. Organic acid can form insoluble oxalates with Ca and Fe and reduce Ca and Fe bio-availability and increase incidence of kidney stone formation (Waleed *et al.*, 2018).

Not much work has been done on the various processing techniques which can be used to reduce the amount of oxalic acid and increase the bioavailability of nutrient after its consumption.

Considering the above facts in view the experiment entitled “**Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)**” will be conducted during 2020-21 at Fruit Research Station, Entkhedi (Bhopal) M.P. with the following objectives:

- (i) To study the effect of CaCl_2 , blanching time, Blanching temperature on quality attributes of Purslane.
- (ii) To optimize the blanching parameters.
- (iii) To study the organoleptic properties of developed product incorporated with Purslane Powder at different composition.

CHAPTER - II

REVIEW OF LITERATURE

Green leafy vegetables are considered to be the major contributors of vitamins and minerals in the diet. According to available official figures leafy vegetables are grown in about 0.11 million hectares of land in India and the production is about 0.73 million tonnes. Despite the fact that green leafy vegetables are a store house of many micronutrients, their consumption is far from satisfactory (Yeggammai & Unnithan, 1992).

2.1 Purslane characteristics and description

Miyaniishi and Cavers (1980) studied on the biology of Canadian weeds and described that Purslane belongs to the Portulacaceae family. It is an annual, succulent, prostrate herb, with thick tap root and many fibrous secondary roots. Its prostrate growth habit makes a mat up to 60 cm in diameter per plant. Stems are reddish, glabrous, succulent, and fleshy and the toothless leaves are also succulent. The flowers are small and yellow-petaled. The spherical, many-seeded pods (globular pointed capsule), open with a circular lid. The purslane growing season is limited to the hottest months of the year. The seed requires high temperatures for germination, which is optimal above 30 °C and extremely poor below 24 °C. Plants are sensitive to cold and are killed by chilling temperatures. However, purslane seed can survive well in areas where winter temperatures are below -30 °C and areas where the temperature reaches 50 °C.

Proctor *et al.* (2011) described the portulaca as the dark green egg-shaped leaves are arranged opposite or alternate. Leaves are flat, fleshy, having variable shapes, ovate, 1–5 cm long, and 0.5–2 cm across, obtuse or slightly notched at the apex, tapering at base, sessile or indistinctly petiolate, glabrous, smooth, and waxy on the upper surface, with entire margin, small stipules, and cluster of hairs up to 1 mm long. Leaves are green or green with red margin. It can reproduce vegetatively from stem cuttings by forming adventitious roots from the cut end of the stem. Apart from large stem

cuttings, it is unclear whether purslane cuttings of various plant tissues differ in their ability to reproduce asexually.

2.2 Nutritional value of purslane

Purslane has a high nutritional value due to the presence of large amount of nutrients and phytochemicals, such as fibres, proteins, fat, carbohydrate, vitamins (ascorbic acid, thiamine, and riboflavin), phenolics, and minerals (Uddin *et al* 2012; Aberoumand 2009). In this part, we comprehensively discussed the purslane nutrients and phytochemicals.

Liu *et al.* (2000) determined the fatty acid profile and b-carotene content of a number of Australian varieties of purslane (*Portulaca oleracea*) by GC and HPLC and showed that the total fatty acid content ranged from 1.5 to 2.5 mg/g of fresh mass in leaves, 0.6 to 0.9 mg/g in stems and 80 to 170 mg/g in seeds. α -Linolenic acid (C_{18:3 ω 3}) accounted for around 60% and 40% of the total acid content in leaves and seeds, respectively. Longer-chain omega-3 fatty acids were not detected. The b-carotene and ascorbic acid content was found 270 mg/100g and 323 mg/100g fresh mass in leaves respectively.

Aberoumand A. (2009) studied the proximate composition and mineral constituents of *Portulaca oleracea* L. leaves and stem and showed that the leaves and stem contained ashes 22.66%, crude protein 23.47%, crude lipid 5.26%, crude fibre 8.0%, carbohydrates 40.67% and ascorbic acid (249.48 mg/100g DW). The stem and leaves also have high energy values [303.9 kcal/100 g dry weight (DW)]. Mineral ranges (mg/100 g DW) were: K (14.71), Na (7.17), Ca (18.71), Fe (0.48) and Zn (03.02). Comparing the leaves and stem mineral contents with recommended dietary allowances, the results indicated that *P. oleracea* L. leaves and stem could be a good supplement for some nutrients such as protein, carbohydrates, Ca, K, Zn and Na.

Uddin *et al.* (2012) Studied on changes in mineral content and antioxidant attributes of *Portulaca oleracea* over different growth stages. The finding revealed that the iodine titration method was used to determine the ascorbic acid content (AAC). 1,1-diphenyl-2-picrylhydrazyl (DPPH) scavenging (IC₅₀) capacity ranged from 1.30 $\pm$ 0.04 to 1.71 $\pm$ 0.04 mg/mL, while the ascorbic acid equivalent antioxidant activity (AEAC) values were

229.5 $\pm$ 7.9 to 319.3 $\pm$ 8.7 mg AA/100 g, total phenol content (TPC) varied from 174.5 $\pm$ 8.5 to 348.5 $\pm$ 7.9 mg GAE/100 g. AAC 60.5 $\pm$ 2.1 to 86.5 $\pm$ 3.9 mg/100 g and FRAP 1.8 $\pm$ 0.1 to 4.3 $\pm$ 0.1 mg GAE/g. The concentrations of Ca, Mg, K, Fe and Zn increased with plant maturity. Calcium (Ca) was negatively correlated with sodium (Na) and chloride (Cl), but positively correlated with magnesium (Mg), potassium (K), iron (Fe) and zinc (Zn).

Alam *et al.* (2014) analyzed the methanolic extracts of 13 accessions of purslane for their total phenol content (TPC), total flavonoid contents (TFC), and total carotenoid contents (TCC) and antioxidant activity of extracts. It was screened using FRAP assay and DPPH radical scavenging methods and elaborate that the TPC, TFC, and TCC ranged from 0.96 $\pm$ 0.04 to 9.12 $\pm$ 0.29 mg GAE/g DW, 0.13 $\pm$ 0.04 to 1.44 $\pm$ 0.08 mg RE/g DW, and 0.52 $\pm$ 0.06 to 5.64 $\pm$ 0.09 mg (β -carotene equivalent) BCE/g DW, respectively. The DPPH scavenging (IC₅₀) activity varied between 2.52 $\pm$ 0.03 mg/mL and 3.29 $\pm$ 0.01 mg/mL and FRAP ranged from 7.39 $\pm$ 0.08 to 104.2 $\pm$ 6.34 μ mol TE/gDW. Among all the measured micro- and macro minerals K content was the highest followed by N, Na, Ca, Mg, P, Fe, Zn, and Mn. The overall findings proved that ornamental purslane was richer in antioxidant properties, whereas common purslane possesses more mineral contents than ornamental ones.

Uddin *et al.* (2014) concluded on the basis of various studies on purslane nutritive value that the purslane is a rich source of potassium (494mg/100 g) followed by magnesium (68mg/100 g) and calcium (65mg/100 g) possesses the potential to be used as vegetable source of omega-3 fatty acid. It is very good source of alpha-linolenic acid (ALA) and gamma-linolenic acid (LNA, 18 : 3 w3) (4mg/g fresh weight) of any green leafy vegetable. It also contained anti nutrient oxalic acid (623.68 mg/100 g DW). It contained the highest amount (22.2mg and 130mg per 100 g of fresh and dry weight, resp.) of alphanatocopherol and ascorbic acid (26.6mg and 506mg per 100 g of fresh and dry weight, resp.). The oxalate content of purslane leaves was reported as 671–869mg/100 g fresh weight.

Sarvanan and Mishra (2018) Studied on analysis of physical and quality parameters of purslane and reported that, fresh purslane leaves

contained 81 % to 88 % moisture, and the leaves content 27% protein, 19% ashes, ascorbic acid ranges from 271.56 mg/100g to 327.72 mg/100g (DW) and 657.84 mg/100 g (DW) oxalic acid, and also contained high value of omega-3 fatty acids.

Petropoulos *et al.* (2019) worked on the nutritional value and chemical composition of purslane plants in relation to plant part and harvesting stage (29, 43 and 52 days after sowing (DAS)). The study revealed that Leaves contained higher amounts of macronutrients than stems, especially at 52 DAS. α -tocopherol was the main isoform, which increased at 52 DAS, as well total tocopherols (values were in the ranges of 197–327 μ g/100 g fresh weight (fw) and 302–481 μ g/100 g fw, for α -tocopherol and total tocopherols, respectively). Whereas stems contained higher amounts of total sugars (values were ranged between 0.83 g and 1.28 g/100 g fw). Oxalic and total organic acid content was higher in leaves, especially at the last harvesting stage (52 DAS; 8.6 g and 30.3 g/100 g fw for oxalic acid and total organic acids, respectively). Regarding the fatty acid content, stems contained mainly palmitic (20.2–21.8%) and linolenic acid (23.02–27.11%), while leaves were abundant in α -linolenic acid (35.4–54.92%).

Uddin *et al.* (2020) reported that purslane is the richest source of α -linolenic acid, essential omega-3 and 6 fatty acids, ascorbic acid, glutathione, α -tocopherol and β -carotene. The stems and leaves also have high energy values which is 303.9 Kcal/100g dry weight. Mineral contents (mg/100g DM) were K (14.71), Na (7.17), Ca (18.71), Fe (0.48) and Zn (3.02). *P. oleracea* has higher total phenolics and antioxidant content than plants at immature stages. The antioxidant content and nutritional value of purslane are important for human consumption.

2.3 Effect of processing techniques on quality of purslane and other similar leafy vegetables.

Mosha *et al.* (1995) conducted study on effect of blanching on the anti nutritional (Phytic acid, Tannic acid and Oxalic acid) content in cabbage, turnip, collard, sweet potato and peanut leaves, and reported that the Levels of oxalic acid were significantly reduced by conventional and microwave

blanching methods. In general, blanching is recommended as an effective method for reducing the anti nutritional factors in green vegetables. Blanching also helps to destroy microorganisms on the surface of the vegetables.

Negi and Roy (2000) studied on effect of blanching and drying methods on b-carotene, ascorbic acid and chlorophyll retention of leafy vegetables and reported that vegetables were blanched at 95 $\pm$ 3 $^{\circ}$ C in (i) water, (ii) water followed by potassium metabisulphite (KMS) dip, (iii) salt solution, (iv) salt solution followed by KMS dip, and (v) mixture of sodium bicarbonate, magnesium oxide and KMS and dried in (a) sun, (b) shade, (c) solar drier, (d) cabinet drier, and (e) low temperature drier. Method (ii) was found most suitable for blanching and selected for subsequent drying and method (e) had least drastic effect on b-carotene, ascorbic acid and chlorophyll content of the processed product. The ascorbic acid content was ranges from 197 to 249 mg/100g in blanched leaves.

Weiwen and Michael (2005) Reported that there was a high proportion of water-soluble oxalate in most of the tested raw vegetables. Boiling markedly reduced soluble oxalate content by 30-87% and was more effective than steaming (5-53%) and baking (used only for potatoes, no oxalate loss). An assessment of the oxalate content of cooking water used for boiling and steaming revealed an approximately 100% recovery of oxalate losses. The losses of insoluble oxalate during cooking varied greatly, ranging from 0 to 74%. Because soluble sources of oxalate appear to be better absorbed than insoluble sources, employing cooking methods that significantly reduce soluble oxalate may be an effective strategy for decreasing oxalate in individuals predisposed to the development of kidney stones.

Poeydomenge and Savage (2007) investigated the oxalate content of raw and cooked purslane leaves and reported that the fresh leaves, stems and buds contained respectively 23.45 $\pm$ 0.45, 5.58 $\pm$ 0.18 and 9.09 $\pm$ 0.12 g total oxalates kg⁻¹ fresh weight. The stems and buds contained a mean of 75.0% soluble oxalates while the leaves contained only 27.5% soluble oxalates. Boiling the leaves stems and buds resulted in a loss of soluble oxalates from the tissue which resulted an overall 27% reduction in total oxalate in the

tissues. Pickling the whole plant resulted in a loss of soluble oxalates from the tissue by leaching into the vinegar, resulting in a reduction of total oxalate content of the pickled tissue by 16%. Larger leaves contained 40% more total oxalates than the small leaves while the oxalate content of the stems ranged between 4.9 and 6.2 g total oxalates kg⁻¹ fresh weight. The leaves contained 33% soluble oxalate while in contrast the stems contained a mean of 67% soluble oxalates. Overall, the results of this experiment confirm that cooking and pickling purslane reduces the soluble oxalate content of the processed tissue.

Gupta S. *et al.* (2008) blanched ten commonly consumed leafy vegetables for 1, 2 and 4 min at 80, 90 and 98 °C in water and chemical media, steamed for 5 and 10 min with and without chemical treatment, unblanched greens served as control. The study revealed that the retention of ascorbic acid was reduced as the blanching time and temperature increased in all greens. It was comparatively higher in chemically treated samples both in conventional and steam blanched samples. Steam blanched samples (5 min) had a higher level of ascorbic acid than conventional blanched samples irrespective of blanching media. From the nutrition point of view, chemical blanching proved to be advantageous both in steam and conventional blanching for short period and it also ensured enzyme inactivation.

Paul V. *et al.* (2012) studied on Effect of cooking and processing methods on oxalate content of green leafy vegetables and found that the blanching for 10 minutes (green leafy vegetables) was found to be the best methods for lowering the oxalate content. The average reduction ranges on cooking for oxalate were 40.4% (spinach) and 115.9% (bathua) for green leafy vegetables. Cooking methods showed considerable reduction in oxalate, but blanching was fairly effective. The reduction of anti-nutrients on cooking is expected to enhance the nutritional value of these green leafy vegetables.

Kikon and Eliza (2013) studied on effect of blanching treatment on physical and quality parameters of underexploited green leafy vegetable, and reported that the purslane leaf treated with high concentration of calcium chloride (3.5%) and high temperature (95 °C) was reduced oxalic acid (307

mg/100g DW) 46.31%. The leaves treated with low temperature and high CaCl_2 retained the dry weight (6%) and ascorbic acid (276.23) by 36%. The negative result was found that blanching reduced the fatty acids.

Rajeswari *et al.* (2013) conducted a study on processed amaranths leaves and its quality evaluation. Initially the leaves were blanched by immersing in boiling water for two minutes and thereafter they were dried at 60°C for 2 hrs 37 minutes in a cabinet drier. The results revealed that blanched dehydrated leaves registered higher moisture (3.72%), protein (18.34%), ash (18.64%), iron (56.21%) and copper (0.50%) in comparison to unblanched leaves, which had registered lower values of moisture (3.25%), protein (17.81%), ash (16.24%), iron (33.84%) and copper (0.46%). Therefore, it can be concluded that blanched dehydrated sample retained better nutrients in comparison to unblanched dehydrated sample.

Youssef and Mokhtar (2014) evaluate the effects of different drying methods (hot-air drying, microwave drying and freeze-drying) on the color, phytochemicals content and antioxidant capacity of purslane leaves. These study showed that the the fresh purslane leaves had high contents of total phenolics (1447.59 mg GAE/ 100 g) and flavonoids (5011.87 mg QE/ 100 g) on dry weight basis. They exhibited high antioxidant capacity (53.23% and 147.78 $\mu\text{mol trolox/ 100 g}$) measured by DPPH and ABTS assay, respectively. Chromatic coordinates (L^* , a^* and b^*) as well as total color difference (ΔE) were affected by drying methods. Drying methods caused a significant decrease in total phenolics, total flavonoids and antioxidant capacity of purslane leaves. The changes in the antioxidant capacity due to the drying methods were positively correlated with the content of phenolics ($R^2 = 0.9043$ - 0.9885). Therefore, it can be suggested that special care should be taken when processing method is selected for the exploration of purslane leaves.

Acho *et al.* (2015) studied on the effect of blanching on the proximate composition, nutritive value and antioxidant properties of five leafy vegetable. This study highlighted losses of nutrients and anti-nutrients components at 15 min of blanching as follow: ash (6.68 – 33.80 %), proteins (0.56 - 15.71 %), vitamin C (4.75 – 73.21 %), carotenoids (18.77 - 72.76%) oxalates (2.16 –

42.62 %) and phytates (20.32 – 71.56 %). Contrary to the registered losses, the average increases of polyphenols and crude fibers contents at 15 min of blanching were 1.51 to 5.19% and 0.62 to 8.87%, respectively.

Njoroge *et al.* (2015) studied on effects of blanching time/temperature combination coupled with solar-drying on the nutritional and microbial quality of leafy vegetables (LVs); Study revealed that the greatest nutrient loss was observed for LVs that were blanched at 100 °C for 30 min, then sundried. Most nutrients were retained at 80 °C/10 min compared to those retained at 90 °C/5 min. Microbial load (5.3-5.6 cfu/g) was significantly lower for solar dried LVs ($p < 0.05$) blanched at 90 °C/5 min. This indicates that blanching at 80 °C/10 min followed by solar drying is a potential option to be used as a local preservation technique for LVs.

Sarkar *et al* (2015) conducted study on effect of blanching treatment on physical and quality parameters of underutilized leafy vegetable crops, and reported that the increases in blanching time and temperature retain the moisture content and reduces product recovery and With Increases in sodium chloride concentration in blanching solution product recovery also increased and moisture content decreases. Weight loss of purslane leaves after drying was also increased with increases in blanching time and temperature and slightly reduced with increases in sodium chloride concentration.

Shanker and Debnath (2015) investigated the Impact of dehydration of purslane on retention of bioactive molecules and antioxidant activity and results revealed that total PUFA, α -linolenic acid (ALA), total polyphenol content and antiradical activity were found to retain in the dried purslane in the range of (47.9–59.9 %), (42.5–50 %), (188–408GAE/100 g) and (33.0–88.8 mg/100 g) respectively. The highest values of ALA, total polyphenol content and antiradical activity were found to obtain in the vacuum dried sample. Rehydration ratio was found in the range of 3.2–4.3 and vacuum dried purslane showed maximum rehydration.

Singh R. R. and Harshal A. (2016) studied on the effect of processing on the Vitamin C content of five Indian green leafy vegetables namely, Spinach (*Spinacia oleracea*), Methi (*Trigonella foenum-graecum*), Lal maath

(*Amaranthus cruentus*), Chauli (*Thotakur avepudu*) and Bhathua (*Chenopodium album*), and the results revealed that maximum reduction in Vitamin C activity of vegetable samples were observed with microwave heating followed by boiling and blanching. Vitamin C content of boiled vegetable samples showed 40-50% reduction in their vitamin C activity, microwave heated samples resulted into 50-75% reduction and blanching lead to minimum reduction i.e. 20-35% as compared to unprocessed vegetable samples. Vitamin C is easily destroyed by excessive heat and water as well as exposure to air.

Xiao *et al.* (2017) reported that the loss of nutrients during hot water blanching is caused mainly by leaching or diffusion. All water-soluble nutrients, such as vitamins, flavors, minerals, carbohydrates, sugars, and proteins, can leach out from plant tissues to the blanching water. In addition, hot water blanching can also lead to degradation of some thermal sensitive substances such as ascorbic acid, aroma and flavor compounds.

Waleed *et al.* (2018) studied the effect of cooking and pickling processes on Chemical composition. In addition, oxalate content of purslane was analyzed after cooking at three temperatures (60, 80 and 100 °C) for different durations (5, 10, 15 and 20 minute), and pickling for various durations (3, 6 and 9 days). Fatty acid analysis, sensory evaluation and quality characteristics of biscuits fortified by purslane powder, after oxalate reduction treatment, were carried out. Ash, fiber, protein and fat contents of were 23.42, 16.03, 5.64 and 5.30 %, respectively on dry matter basis. Of the elements, potassium had the highest concentration (4694.0 mg K/100g), while zinc was found in the lowest concentration (0.93 mg Zn/100g). The soluble fraction of total oxalate in purslane cooked for 20 minutes at 60, 80 and 100 °C were 34.65, 19.84 and 15.84 %, respectively. While after pickling for 0, 3, 6 and 9 days, the soluble fraction of total oxalate of purslane was 47.80, 36.23, 25.60 and 14.39 %, respectively. Addition of purslane powder after oxalate reducing treatments improved the quality characteristics of wheat flour biscuits.

Tyohemba *et al.* (2019) studied on the effect of blanching time on the oxalate content of five non-conventional green leafy vegetables, and the results revealed that the oxalate content of all the studied vegetables decreased with increase in blanching time. Blanching at 5 min had the highest reducing effect on the phytate and oxalate content of the vegetables. The reduction is expected to enhance the nutritional value of these green leafy vegetables.

Mishra V. *et al.* (2020) concluded that the presence of high oxalate content in purslane poses certain health risks and needs to be addressed by the research community through suitable approaches. Although much of the emphasis has been put on the phytochemistry and pharmacology of the purslane till date but studies on culinary aspects of purslane are still lacking. Utilization of purslane as functional food ingredients might help us to conserve this potential plant as well as encourage sustainable agriculture.

2.4 Purslane product formulation

Tarkergari *et al.* (2013) studied acceptability of value added product (with the dehydrated powder and with dhal and vegetable combinations) with purslane and the study revealed that the nutrient content of the prepared recipes especially with reference to dietary fiber, protein, calcium and vitamin c were higher than the control, significant differences were observed in a few of the recipes in regards with the sensory attributes of *portulaca oleracea* recipes with that of control.

Debnath and Verma (2014) prepared food products (curry, dal and papad) with purslane powder incorporation and reported that the most acceptable curry, dal and papad products was prepared with 10%, 8% and 15% purslane powder incorporation respectively. In addition, the appearance, flavor and taste scores for cooked recipes containing purslane were not significantly different when compared to the control in Bengal gram dhal curry, greens curry, missi roti, green chutney and snacks (pakoda and vada) but were significantly different than control in red gram and puneer curry, utappam and pulihora.

Sawai and Singh (2014) conducted a study on preparation of value added products from dehydrated purslane leaves. The leaves were tray dried and incorporated in two conventional foods namely green gram dal (3%, 5% and 7%) and parantha (5%, 10% and 15%). Organoleptic properties of products were judged by nine point hedonic scale. Green gram dal and parantha incorporated with 7 and 5 percent dehydrated purslane leaves were liked most. Iron content of green gram dal (2.09 mg/100g) at 7% and parantha (8.81 mg/100g) at 15% incorporated with dehydrated purslane leaves was higher than their respective control. In comparison to control enriched parantha (4255.66 µg/100g) and green gram dal (984 µg/100g) has many fold greater carotene content. Therefore, it can be concluded from the results that incorporation of dehydrated purslane leaves in various conventional items can improve the nutritional quality of the products as well as add variety in the diet.

Renu and waghray (2016) studied on development of papads; A traditional savoury with purslane, *Portulaca oleracea*, leaves, the result showed that all the chemical constituents like moisture content, ash content, pH, alkalinity, acid insoluble ash of all the different amounts were on par with the control, whereas β-carotene content and crude fiber which were calculated theoretically increased as the percentage of incorporated green leafy vegetables increased. All the samples subjected for sensory evaluation were accepted equally by the panelists.

Mastud *et al.* (2018) conducted a study to develop purslane powder from purslane and utilizing the purslane powder for the development of ice-cream and cookies Purslane powder added in ice-cream and cookies were formulated with 1, 2, 3g and 2, 4, 6, 8g addition respectively. Now the experimental result revealed that purslane powder added ice-cream and cookies contains significant amount of protein and antioxidants with potential health benefits and nutritional characteristics. Sensory evaluations of all developed ice-cream and cookies were also carried out and it was found that 2g purslane powder in ice- cream and 6g of purslane powder in cookies formulation was acceptable

Minh *et al.* (2019) studied on the effect of blanching, drying and storage of herbal tea produced from *Portulaca oleracea*. Optimal results found that herbal tea would have stable antioxidant capacity while blanching at 95 °C in 4 seconds with the presence of 3% CaCl₂ submersed in blanching solution; drying at 40°C with 1.5 cm in dimension of *Portulaca oleracea*; storage under vacuum in PET/AL/PE bag within 6 months without any deterioration. Purslane (*Portulaca oleracea*) could be used as a good source of minerals, antioxidants and omega-3 especially for functional food in form of herbal tea.

Delvarianzadeh *et al.* (2020) investigated the psychochemical, rheological, and sensory properties of voluminous breads enriched by different amounts of purslane powder (0, 5, 10, and 15%) were compared to a control group. The results showed that, with an increase in the concentration of Purslane in samples, water absorption capacity, stability under mixer, and softening level increased. In terms of sensory properties, the sample with 15% purslane powder obtained the minimum score and other samples had acceptable conditions in terms of different sensory properties like taste, texture, color, odor, and general acceptability. In summary incorporation of purslane in voluminous bread is feasible and the optimum percentage of the purslane powder is 10% for the best acceptance in sensory evaluation.

CHAPTER-III

MATERIAL AND METHODS

This chapter deals with the materials used and the methods adopted during the course of study entitled, “Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)”. The details of material used and procedure of experiment are described here:

Experiment site:-

The experiment was carried out at Fruit processing centre, under Fruit research station, Entkhedi, Bhopal (M.P.) during the academic year 2020-21. The present investigation was accomplished in the following phases:

3.1 Phase I – Procurement and preparation of Purslane leaves sample

3.1.1 Selection and Procurement of the leaves

3.1.2 Preparation of the leaves (Sorting, Washing)

3.2 Phase II – Analysis of non-nutritional, nutritional and anti-nutritional estimations of fresh leaves (Non-Blanched/control sample)

3.2.1 Non-nutritional components

3.2.2 Nutritional components

3.2.3 Anti nutritional components

3.3 Phase III – Blanching, Drying and grinding.

3.3.1 Blanching (with treatment and without treatment)

3.3.2 Solar drying

3.3.3 Grinding

3.4 Phase IV – Analysis of nutritional, non-nutritional and anti-nutritional composition of Sample (Blanched/treated samples)

3.4.1 Non nutritional components: Moisture (percent)

3.4.2 Nutritional components: Ascorbic acid (mg/100g)

3.4.3 Anti nutritional components: Oxalic acid (mg/100g).

3.5 Phase V - Product formulation

3.5.1 Selection of the food product

3.5.2 Standardization of control recipe and formulation of value added products.

3.6 Phase VI – Organoleptic evaluation of recipes

3.6.1 Selection of panel members

3.6.2 Organoleptic evaluation of recipes

3.7 Phase VII – Data Analysis

3.7.1 Analysis of non-nutritional, nutritional and anti-nutritional estimations

3.7.2 Organoleptic evaluation of recipes

3.1 Phase I – Procurement and Preparation of Purslane leaves sample

3.1.1 Selection and Procurement of the leaves:

The leaves of purslane (*Portulaca oleracea* L.) were selected for the present study, as these leaves are easily available source of all the nutrient and vitamins, especially omega-3-fatty acid and ascorbic acid (Vitamin – C). In peak season, these leaves are available in plenty there is lack of consumers and hence they are available as a weed in field and available in market cheaply. After selection of the leaves, they were procured from Pandit Laxminarayan Sharma krishi upaj mandi, Karond Bhopal (M.P.). They were obtained during the winter season (November-December).

3.1.2 Preparation of the leaves:

Sorting: Fresh, green, undamaged and non insect infested purslane leaves (*Portulaca oleracea* L.) were selected. Damaged, insect infested, bruised, discolored, decayed and wilted leaves were discarded before washing the leaves, as decayed and wilted leaves will give a bad flavor to the whole batch. Besides decay and wilted leaves can lead to loss of nutrients too.

Washing: The leaves with secondary branches were cut from the main branches and the leaves were washed thoroughly three to four times with plenty of cold water to remove all the adhering dust, dirt particles or insecticides. After washing, leaves were kept entitle together in small bunches and was hung in an airy space to drain away extra water and to air dry the leaves. The residual moisture was evaporated at a room temperature, before the actual drying process on a clean paper with constant turning over to avert fungal growth. All the stems and branches were then removed and only the

leaves of purslane were used for processing. The leaves were then weighed and they were further used for nutritional estimations.

3.2 Phase II – Analysis of nutritional, non nutritional and anti-nutritional estimations of fresh leaves

3.2.1 Analysis of Non-nutritional Components

The physical parameters observation was recorded immediately after drying and gridding. The following observations of dried purslane leaves were recorded.

3.2.1.1 Initial weight:

A sample of 100 g of Purslane green leaves was weighted after plucking and sorting.

3.2.1.2 Final weight

A sample of 100 g fresh purslane leaves was dehydrated and the final weight of sample at constant drying rate was noted.

3.2.1.3 Loss in weight

The weight of dehydrated purslane leaves at the end of the drying obtained from each treatment was noted down and the loss g/100g fresh weight was calculated by the following formula:

$$\text{Loss in weight} = \text{Fresh weight} - \text{dried weight}$$

3.2.1.4 Product recovery (%)

A sample of 100 g purslane leaves was dehydrated and the product recovery (%) of sample at constant drying rate was noted.

3.2.1.5 Rehydration ratio

Rehydration was carried out by steeping the dried samples (5 g) in warm water (50 ml) at 60 °C for half an hour and then draining the water. Rehydration ratio of the Purslane leaves was calculated by dividing the weight of the drained rehydrated sample (WR) by the weight of the dried sample (WD).

$$\text{Rehydration ratio (RR)} = \frac{WR}{WD}$$

Where-

WR= weight of rehydrated purslane, g

WD= weight of dehydrated purslane, g

3.2.1.6 Moisture content (%)

Moisture content was determined by standard official methods of analysis. This involves drying the desired material to a constant weight at suitable temperature and calculating moisture as the loss in weight of the dried samples. The percentage moisture content was calculated as loss in weight of the original samples. For evaluation of the moisture content of fresh purslane, a sample of 100g of fresh purslane leaves was kept in Petri-dishes and the dishes are covered and then put in hot air oven and dried for 24 hr at 80°C. After the drying, cover was replaced, cooled in a desiccators and weighed again. The moisture content is calculated by the following equation.

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

Where,

W1 = Initial weight, g

W2 = Final weight after drying sample, g

3.2.2 Analysis of nutritional estimations

3.2.2.1 Estimation of vitamin-C (ascorbic acid) Content

Ascorbic acid content of purslane were determined by 2, 6-dichlorophenol indophenol (DCPIP) titration method described by Rao, B. and Deshpande, V (Rao, B. and Deshpande, V., 2006).

Principle

Ascorbic acid reduce the 2, 6-dichlorophenol indophenols dye to a colourless leuco-base. The ascorbic acid gets oxidized to dehydrate ascorbic acid though the dye is a blue coloured compound, the end point is the appearance of pink colour. The dye is pink colored in acid medium. Oxalic acid used as the titrating agent.

Materials:

1. Oxalic acid 4%
2. Dye solution: 42mg sodium bicarbonate was weight into a small volume of distilled water. 52 mg 2,6-dichlorophenol indophenols was dissolved in it and was made up to 200ml with distilled water.
3. Stock standard solution: 100 mg ascorbic acid in 100 ml of 4% oxalic acid solution in a standard flask (1 mg/ml).
4. Working standard: 10 ml of stock solution was diluted in 100 ml with 4% oxalic acid. The concentration of working standard was 100 µg/ml.

Procedure:

1. 5 ml of the working standard sample was taken into a 100 ml conical flask.
2. 10 ml of 4% oxalic acid was added and titrated against the dye (V1 ml). End point was the appearance of pink colour which persisted for a few minutes. The amount of the dye consumed was equivalent to the amount of ascorbic acid.
3. The sample (0.5-5 g depending on the sample) was extracted in 4 percent oxalic acid and made up to a known volume (100 ml) and centrifuged.
4. 5 ml of this supernatant was taken, added 10 ml of 4 per cent oxalic acid and titrated against the dye (V2 ml)

Calculation

$$\text{Ascorbic acid (mg/100g)} = \frac{0.5 \times V_2 \times 10 \text{ ml} \times 100}{V_1 \times 5 \text{ ml} \times \text{Weight of sample}} \times 100$$

3.2.3 Anti nutritional estimations:**3.2.3.1 Determination of oxalic acid content****Apparatus**

- Balance
- Boiling water bath
- Hot plate

Reagents

- HCl (6N): Add equal amounts of concentrated HCl and distilled water to prepare 6N HCl.

- Methyl red indicator.
- Calcium chloride (5%).
- Sulphuric acid in water (1:4).
- KMNO₄ (N/20).

Standard AOAC method (AOAC, 1995) was used to analyze the oxalic acid content of plant samples. The method includes 3 steps; sample extraction precipitation and quantification.

All the plant samples were washed and air-dried. Edible portion of each plant sample was chopped and weighed accurately (40.00 g) and transferred to a high speed blender with distilled water (100 mL). The blended sample was homogenized (15 min, 1700r pm) and mixture cooled to room temperature. The slurry (35.00 g) was accurately weighed in to a 500mL beaker and distilled water added to make a final weight of 300 g. Hydrochloric acid (6N, 55 mL) and Caprylic alcohol (2 drops) were added and the mixture boiled (15min) in a boiling water bath to increase the efficiency of dissolving. The sample was carefully transferred to the volumetric flask once cool and volume made up to 500 ml with distilled water. Thus prepared samples were left overnight at room temperature (30 °C).

On the following day the sample was mixed, filtered and first 100 ml discarded to minimize contamination. Precipitation of oxalic acid was achieved by pipetting the above filtrate (25 ml) in to a Erlenmeyer flask. Tungstophosphoric acid reagent (5 ml) was added to purify the filtrate from any contaminated metals which was then allowed to stand for 5 hours. After 5 hour the sample was filtered and 20.0 ml of filtrate was pipette in to a 50 ml conical centrifuge tube and ammonia hydroxide (NH₄OH) added till pH was 4.5, acetate buffer (pH 4.5, 5 ml; 2.5g anhydrous CaCl₂ in 50 ml CH₃COOH and 33 g NaCH₃COO×3H₂O in 50 ml) was added to the sample, mixed well and left overnight. The precipitate obtained following centrifugation of the sample (15 min, 1700rpm) was washed completely, breaking up into fine suspension with fine jet stream of filtered cold wash liquid (20 ml, saturated). Centrifugation and decanting step were repeated and the precipitate was finally dissolved in 10% sulfuric acid (5 ml).

Both reagent blank and sample were heated in a boiling water bath to facilitate the liberation of oxalic acid from calcium oxalate precipitate. Titration of the sample and blank was carried out while hot, with 0.01N KMnO₄. The endpoint reading was the first pink colour in the sample persisting for more than 30 sec.

Calculation

The mg oxalic acid/100 g was calculated using the following equation.

$$\text{Mg oxalic acid/100 g} = \frac{\text{mL } 0.01\text{N KMnO}_4 \times 1350 \times (\text{Net weight} + 100 \text{ g})}{(\text{Wet slurry} \times \text{net weight})}$$

Where, 1350= 0.45 (mg anhydrous oxalic acid equivalent to 1 mL 0.01N KMnO₄) × [(30/20) × (500/25)(dilution factor)] × 100 (to convert to 100 g product).

3.3 Phase III – Blanching, Drying and grinding

3.3.1 Blanching of purslane leaves

Blanching stops all life processes, it inactivates enzymes, fixes green colour and removes certain harsh flavors which are common in green leafy vegetables. The leaves of *Portulaca oleracea* L. (Purslane) were exposed to hot water for blanching. It was achieved by tying the *Portulaca oleracea* L. leaves in a muslin cloth and dipping it into hot water for a specified duration & different temperature for each sample. The samples were then cooled in a tap water to avoid over cooking and discoloration. This causes the vegetables to cool rapidly, keeping it from overcooking which could turn it mushy and affects the beautiful green colour. Most of the green leafy vegetables are usually blanched before consumption, this is usually carried out in order to reduce the bitter taste and make it more palatable (Obboh, 2005).

All the samples were blanched through following treatment which mentioned in Table 3.1.

Table 3.1 Details of blanching treatments (i.e. blanching time, blanching temperature and % of calcium chloride concentration) for purslane leaves.

Sr. No.	Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration(C) (%)
01.	T ₁	15	90	3
02.	T ₂	20	95	0.6
03.	T ₃	10	85	2.4
04.	T ₄	15	90	1.5
05.	T ₅	15	81.6	1.5
06.	T ₆	20	85	0.6
07.	T ₇	10	85	0.6
08.	T ₈	15	98.4	1.5
09.	T ₉	10	95	0.6
10.	T ₁₀	20	95	2.4
11.	T ₁₁	23.4	90	1.5
12.	T ₁₂	15	90	1.5
13.	T ₁₃	20	85	2.4
14.	T ₁₄	15	90	1.5
15.	T ₁₅	15	90	0
16.	T ₁₆	15	90	1.5
17.	T ₁₇	15	90	1.5
18.	T ₁₈	6.6	90	1.5
19.	T ₁₉	15	90	1.5
20.	T ₂₀	10	95	2.4

3.3.2 Drying Method

Solar drying

Fresh and blanched purslane leaves samples were placed on stainless steel trays (80cm x 40cm) in single layer and placed in a solar dryer and turned occasionally to assure even drying. The outer dimensions of the drier were 200cm x 100cm. The chamber could act both as solar collector as well as dehydrator.

The product temperature (39⁰ – 69⁰ C) and relative humidity (50-68%) during the solar drying of leaves were recorded. Drying was continued till the purslane leaves samples obtained constant weight and their final weights and time taken for drying were recorded.

3.3.3 Grinding

In small scale dried leafs can be grinded by mortar and pestles or pulverizer machine can be used for fine grinding. Commonly 0.5 mm – 1.0

mm pore size screen is used for the separation of the fine grinded leaf powder.

3.4 Phase IV: Analysis of Nutritional, Non nutritional and anti nutritional composition of blanched/treated sample

The analysis of nutritional, non nutritional and anti nutritional components of blanched/treated sample was done by using the same standard procedures as mentioned before.

3.5 Phase V - Product formulation

3.5.1 Selection of the food product

All products were selected on the basis that they could be formulated with purslane leaves powder. Three products; Indian bread, Curry and Tea were selected with following combination as mentioned in table 3.5.1

Purslane powder preparation: Fresh purslane leaves was plucked, washed and shorted. 1000 g of leaves was taken for blanching. Blanching was performed at 90 °C for 15 sec and blanched leaves spread out in single thin layer in ten stainless steel trays (80cm x 40cm) for drying. And trays were placed in solar dryer. After drying the leaves were grinded through electric grinder and sieved in 212 µm sieve for bread and curry and 355 µm sieve for tea.

Table 3.2 Products with purslane powder (%) formulation

Product Formulation	S. No.	Product Name	% of Purslane Powder
	1.	Indian Bread	4%
			8%
			12%
	2.	Curry	5%
			10%
			15%
	3.	Tea	5%
			10%
			15%

3.5.2 Standardization of control recipe and formulation of value added products.

3.5.2.1 Indian bread

Chapatti is either leavened or unleavened flat bread consumed throughout the Indian subcontinent and other parts of Middle East. It is usually

prepared from whole wheat flour and sometimes yeast and fat is also included in the formulation to improve the dough handling, mixing and textural properties. The product is prepared by mixing the flour with water and other ingredients to develop the dough, sheeted and baked for short time. They have creamish brown colour generally prepared in households, forming a cheap source of protein and energy.

Material collection

Commercial wheat flour and salt were purchased from local market (Bhopal, Madhya Pradesh, India) were used for the bread and dough preparation.

Preparation of bread

Bread production was conducted through straight dough bread making method. Three samples were prepared by mixing 176, 184 and 192 g wheat flour with 24, 16 and 8 g purslane powder respectively. 3 g salt added in each sample and 90-100 ml water was added in each sample for making dough. Dough was rested for half an hour. Dough (40 g) was rounded and then placed on the rolling board and sheeted using a rolling pin. Dough was rolled in one direction, inverted and then rolled in a perpendicular direction. The raw chapati was immediately placed on a hot plate (tawa) and heated for 15 s at 220 °C on one side and 10 s at 220 °C on the other side. It was again turned and baked for 35 s at 290 °C.

3.5.2.1 CURRY

There are various types of curry recipes followed in India with different gram flour but mostly besan (Bengal gram flour) curry is prepared traditionally.

Material collection

Commercial bengal gram flour (Besan), soybean refined oil, Cumin, Mustard seeds, asafoetida, turmeric -red chili powder, coriander powder, green coriander leaves and salt were purchased from local market (Bhopal, Madhya Pradesh, India) and used for curry preparation.

Preparation of curry

Three samples were prepared by mixing 85, 90 and 95 g Bengal gram flour with 15, 10 and 5 g purslane powder in three bowls. After that ½-1 cups (80-120 ml) of water was slowly added in each sample to make a smooth batter.

After that following procedure was used for each sample separately:

Gas stove heat was set on moderate (medium high) and a metal container (Kadhai) placed on it. After that two tea spoon (10 ml) refined oil was placed in metal container, when oil was moderately hot add cumin seeds (6 g), mustard seeds (3 g), asafoetida (1 g), 2g turmeric powder, 2 g chili powder and 2 g coriander powder putted in oil and stir it with ladle for two minutes. Add the sample batter, keep whipping it and batter will start thickening, add salt (6 g) and keep adding the water (60-140 ml) and mixed it well. After curry comes to boil flour will start splattering, reduce the heat to low, cover the pan and let it simmer for about 5 to 8 minutes. Curry will become thick, add chopped cilantro (green leaves of coriander) and let it cook for two more minutes.

3.5.2.3 Tea

Tea holds a unique place in the culture of many societies. Tea is an infusion of dried leaves and buds of the plant *Camellia sinensis* and it is predominantly consumed due to its attractive aroma and taste as well its immense health benefit. Tea has been traditionally categorized into black tea, green tea, oolong tea, and earl gray tea according to different processing methods. In the recent years, a fourth category called the “herb tea” has been growing popularity among consumers. Herb tea or herbal tea is defined as an infusion made from herbs, fruits, flowers, stems, roots, etc. made from plant parts other than *Camellia sinensis*. Such teas are usually caffeine-free tea. The use of Cinnamon leaves & cloves, Citronella leaves, Purslane leaves, Peppermint, Moringa leaves, Ginger, Lemon, Jasmine, Milk thistle, Rosehip, Hibiscus, Dandelion, Fennel and other indigenous herbs in making herbal tea has become a common practice.(Colak. H. *et al.*2005).

Sample collection

Fresh purslane was purchased from vegetable market (Bhopal, Madhya Pradesh, India). Tea leaves, sugar cubes and milk purchased from local market Bhopal, Madhya Pradesh, India.

Sample preparation

All plant materials were carefully inspected and all foreign materials removed. Three samples were prepared by mixing 8.5, 9.0 and 9.5 g tea leaves with 1.5, 1.0 and 0.5 g purslane powder respectively in three bowls.

Preparation of tea

There are different methods of tea making but the traditional Indian method was followed. One cup water (100 ml) was poured in a Stainless steel container (Patila) and container placed on gas stove. Gas stove flame set on medium high and when water was boiled the prepared sample was putted in water. After few minutes, when the leaf boiled and colour became brown yellow add four cup of milk in it. It was boiled for four to five minutes and when its colour became chocolaty brown, the gas stove was turned off.

3.6 Phase VI – Organoleptic evaluation of prepared products

3.6.1 Selection of panel members

A panel of 15 semi trained members (5 members for each product) was constituted for carrying out sensory evaluation of the developed products. The selection of these panel members was done on the basis of threshold test, which was carried out to check their perception for taste. The threshold test was conducted using dilution technique, which is described as one of the subjective tests useful in selection and training of panel. The test was conducted by preparing five dilutions of salt and sugar in 100 ml water. All the dilutions were marked and arranged in random manner. The members were asked to mark the solutions in ascending order of salinity and sweetness in prepared score card.

- Sugar solution (Glucose) prepared in five concentrations: 0.05, 0.1, 0.3, 0.7 and 1gram/100ml
- Salt solution (Sodium chloride) prepared in five concentrations: 0.01, 0.1, 0.2, 0.6, 1 gram/100ml.

A total of 27 faculty members and PhD scholars of Central institute of agriculture engineering (CIAE, Bhopal, M.P., India) were invited to undergo the threshold test. Each panel members was given two sets of five glasses, each having sugar solution (five different concentrations) and salt concentrations (five different concentrations) and 1 glass of plain water. They were then asked to identify the given saline and sugar solutions in increasing order of their strength (sweetness or salinity) and note these observations in the score card provided to them. On the basis of result of the dilution test, the

members who arranged the solutions in correct order were selected for the panel for organoleptic evaluation of the value added products prepared in the study. The sensitivity threshold was performed of 27 members, 10 could pass the test. Other factors like experience, knowledge, willingness, interest, availability and sincerity on the part of panel members were also taken into account while selecting the judges. The panel consisted of 6 scientist and 4 PhD students of different department of central institute of agriculture engineering who were absolutely unfamiliar with dried purslane leaf powder. Samples whose total score approached more closely with the standard were considered best.

3.6.2 Organoleptic evaluation of recipes

Organoleptic evaluation of all the recipes containing different levels of dried leaf powder was done on the basis of their appearance, colour, taste, aroma and overall acceptability. The sensory quality of developed product will be judge by panelists using 9- point hedonic scale (Lawless and Klein, 1991).

Table 3.3. Details of 9-point hedonic scale

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

3.7 Phase VII – Data Analysis

3.7.1 Analysis of non-nutritional, nutritional and anti-nutritional estimations

Data will be analyzed using response surface methodology (RSM). The analysis was performed using design expert software (digital software). After proper analysis of, data were accommodated in the tables as per the needs of objectives for interpretation of results.

3.7.2 Data analysis for organoleptic score evaluation of developed products

Data will be analyzed using complete randomized design. All the experiment were conducted in this part of study were conducted in multiple replication (five replication) and mean value reported. After proper analysis of, data were accommodated in the tables as per the needs of objectives for interpretation of results. The statistical procedures for agriculture research given by Gomez and Gomez (1984) were referred. Analyses of variance (ANOVA) were conducted to determine whether significant effect.

CHAPTER – IV

RESULTS

This chapter deals with results obtained by different experiments of the present investigation entitled “Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)” The observation recorded through various experiments for the objective “To study the effect of CaCl_2 , blanching time, Blanching temperature on quality attributes of Purslane” have been analyzed using response surface methodology (RSM) and the observation recorded through various experiments for objective “To study the organoleptic properties of developed product incorporated with Purslane Powder at different composition” have been analyzed using complete randomize design (CRD), In support of tabular representation of data and graphs have also been also inserted for better understanding. The significance was established at 5% level CD.

Table 4.1 assessments and comparison of physical and quality parameters of blanched (treated and untreated) and unblanched purslane powder.

S. No.	Parameters	Unblanched leaves	Blanched leaves without CaCl_2 treatment (90°C temp, 15 sec)	Blanched leaves with CaCl_2 treatment (90°C temp., 15 sec and 3% CaCl_2)
1.	Initial weight of sample (g)	100	100	100
2.	Final weight (after drying) (g)	21	13.86	14.36
3.	Loss in weight (g)	79	86.14	85.63
4.	Product recovery (%)	21	13.86	14.36
5.	Moisture content (%)	79	86.14	85.63
6.	Rehydration ratio	4.3	3.2	4.1
7.	Ascorbic acid mg/100 g DW	296.68	170.13	232.55
8.	Oxalic acid mg/100 g DW	642.37	582.43	339.27

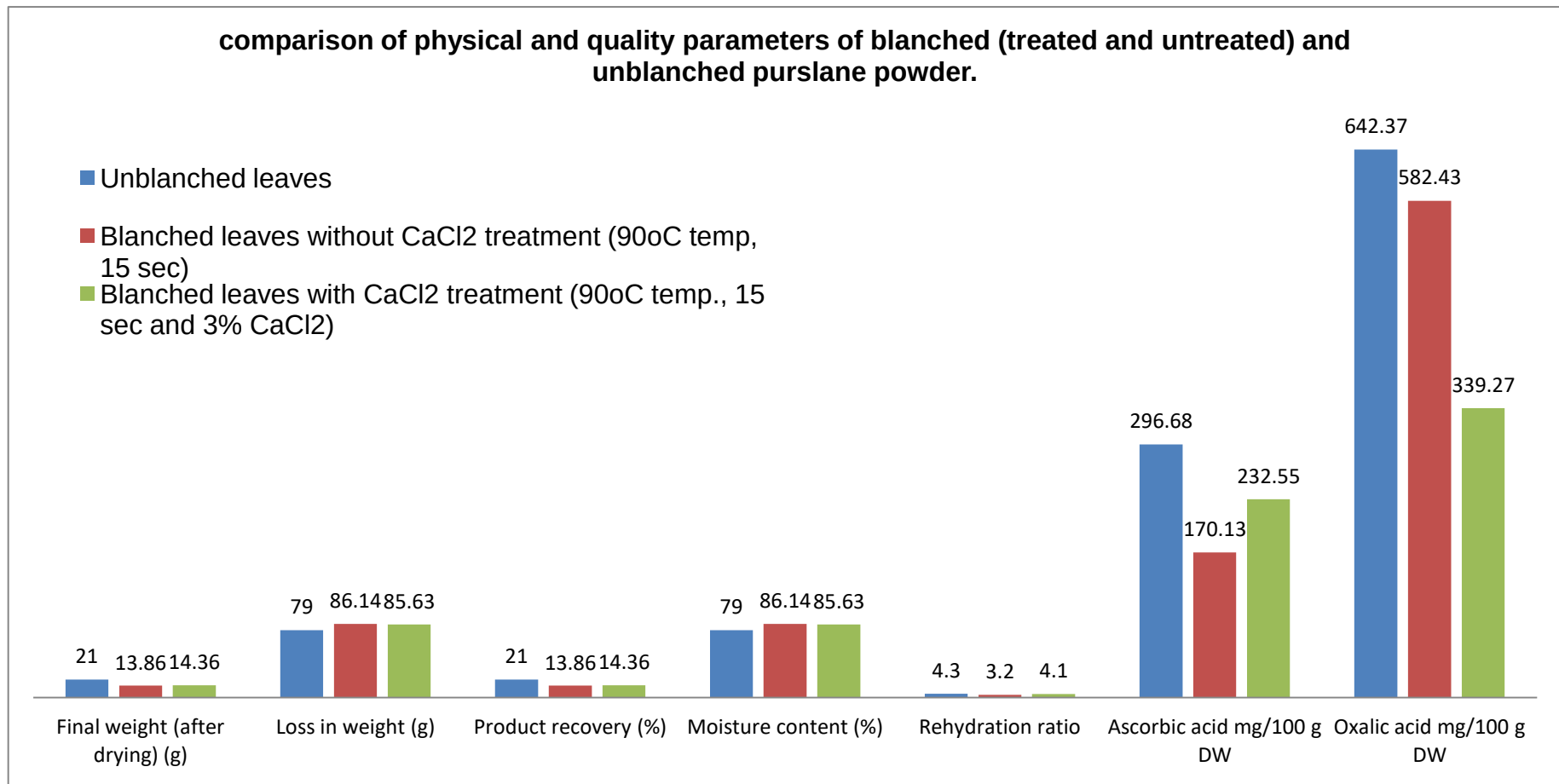


Fig 4.1 assessments and comparison of physical and quality parameters of blanched (treated and untreated) and unblanched purslane powder.

4.1 Analysis of non-nutritional, nutritional and anti-nutritional estimations of blanched (purslane powder) leaves.

4.1.1 Analysis of non-nutritional estimation of (blanched) purslane powder.

4.1.1.1 Final weight (g/100g):-

The result pertaining to the reckoning for final weight of purslane leaves as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.2 and depicted in Figure 4.2, 4.3 and 4.4. The analysis of variance is given in Appendix-I

Table 4.2 Effect of blanching parameters on final weight (g) of purslane leaves

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration (C) (%)	Final weight g/100g
T ₁	15	90	3	14.36
T ₂	20	95	0.6	12.91
T ₃	10	85	2.4	15.13
T ₄	15	90	1.5	13.97
T ₅	15	81.6	1.5	15.32
T ₆	20	85	0.6	13.91
T ₇	10	85	0.6	15.01
T ₈	15	98.4	1.5	13.27
T ₉	10	95	0.6	14.01
T ₁₀	20	95	2.4	13.22
T ₁₁	23.4	90	1.5	13.21
T ₁₂	15	90	1.5	14.75
T ₁₃	20	85	2.4	14.22
T ₁₄	15	90	1.5	14.29
T ₁₅	15	90	0	13.86
T ₁₆	15	90	1.5	14.11
T ₁₇	15	90	1.5	14.19
T ₁₈	6.6	90	1.5	15.57
T ₁₉	15	90	1.5	14.11
T ₂₀	10	95	2.4	14.31
Std. Dev.	0.2191			
Mean	14.19			
C.V. %	1.54			

An examination of Table 4.2 reveals that the maximum final weight (15.57 g/100g DW) was recorded in T₁₈ and the second maximum final weight (15.32 g/100g DW) was recorded in T₅, where the minimum final weight (12.91 g/100g DW) was recorded in T₂.

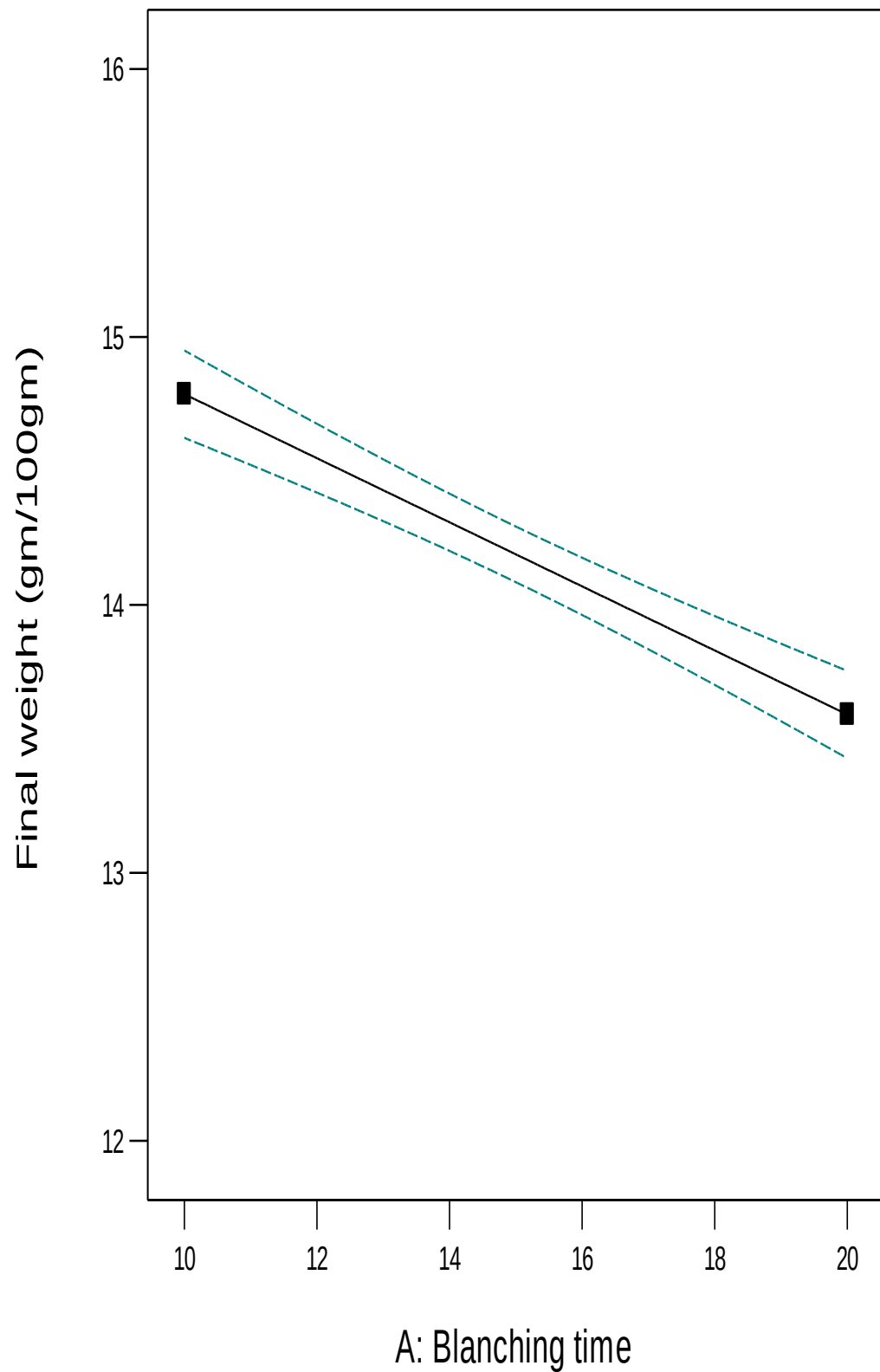


Fig. 4.2 Effect of blanching time (sec) on final weight (g) of purslane leaves.

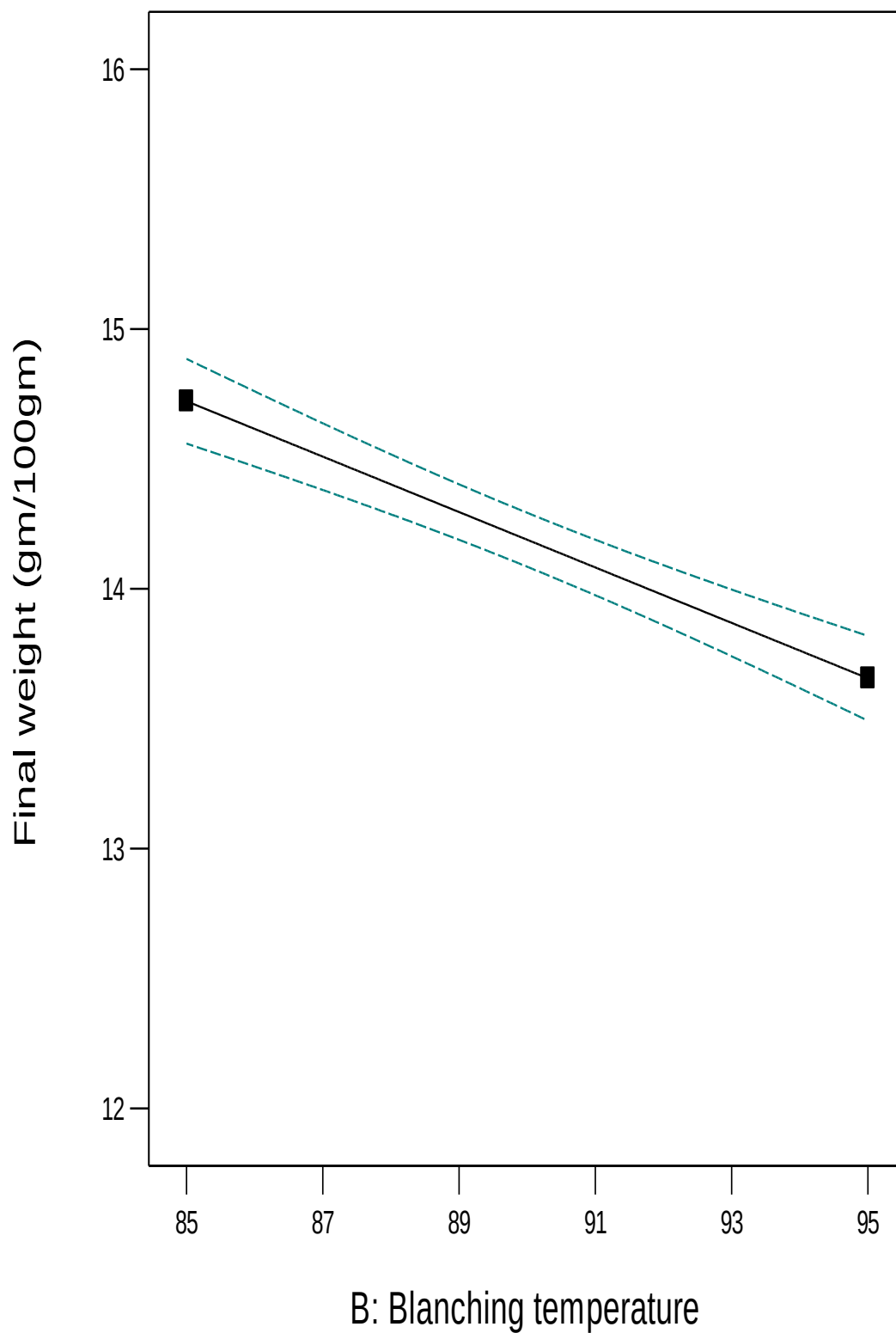


Fig. 4.3 Effect of blanching temperature (°C) on final weight (g) of purslane leaves.

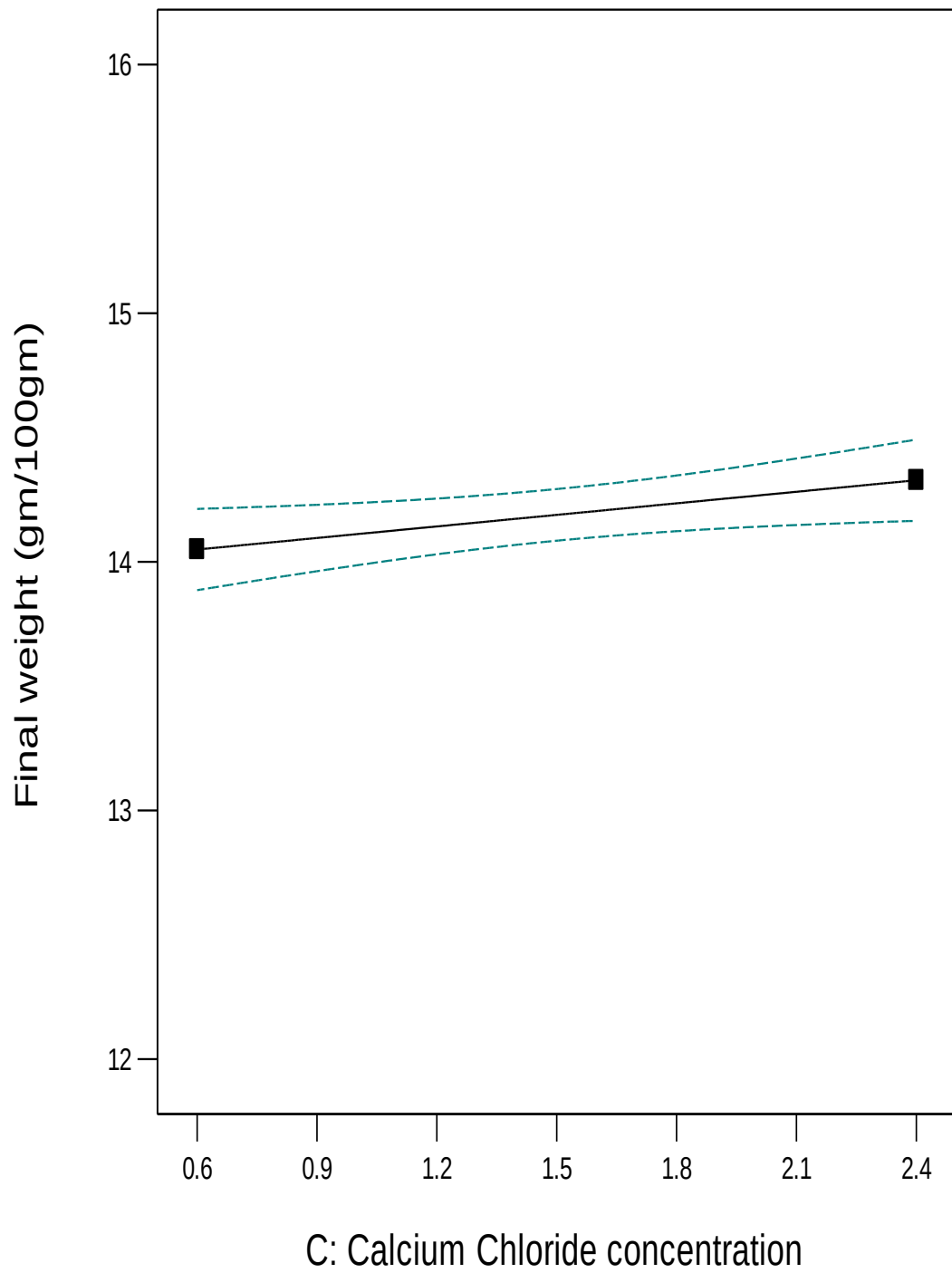


Fig. 4.4 Effect of CaCl_2 concentration % on final weight (g) of purslane leaves.

4.1.1.2 Loss in weight (g/100g):-

The result pertaining to the reckoning for loss in weight of purslane leaves as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.3 and depicted in Figure 4.5, 4.6 and 4.7. The analysis of variance is given in Appendix-II

Table 4.3 Effect of blanching parameters on loss in weight (g) of purslane leaves

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration(C) (%)	Loss in weight g/100g
T ₁	15	90	3	85.63
T ₂	20	95	0.6	87.08
T ₃	10	85	2.4	84.86
T ₄	15	90	1.5	86.03
T ₅	15	81.6	1.5	84.67
T ₆	20	85	0.6	86.08
T ₇	10	85	0.6	84.99
T ₈	15	98.4	1.5	86.72
T ₉	10	95	0.6	85.99
T ₁₀	20	95	2.4	86.77
T ₁₁	23.4	90	1.5	86.79
T ₁₂	15	90	1.5	85.24
T ₁₃	20	85	2.4	85.77
T ₁₄	15	90	1.5	85.71
T ₁₅	15	90	0	86.14
T ₁₆	15	90	1.5	85.88
T ₁₇	15	90	1.5	85.81
T ₁₈	6.6	90	1.5	84.42
T ₁₉	15	90	1.5	85.88
T ₂₀	10	95	2.4	85.68
Std. Dev.	0.2191			
Mean	85.81			
C.V. %	0.2554			

An examination of Table 4.3 reveals that the maximum loss in weight (87.08 g/100g) was recorded in T₂, where the minimum loss in weight (84.42 g/100g) was recorded in T₁₈ and second minimum loss in weight (84.67 g/100g) was recorded in T₅.

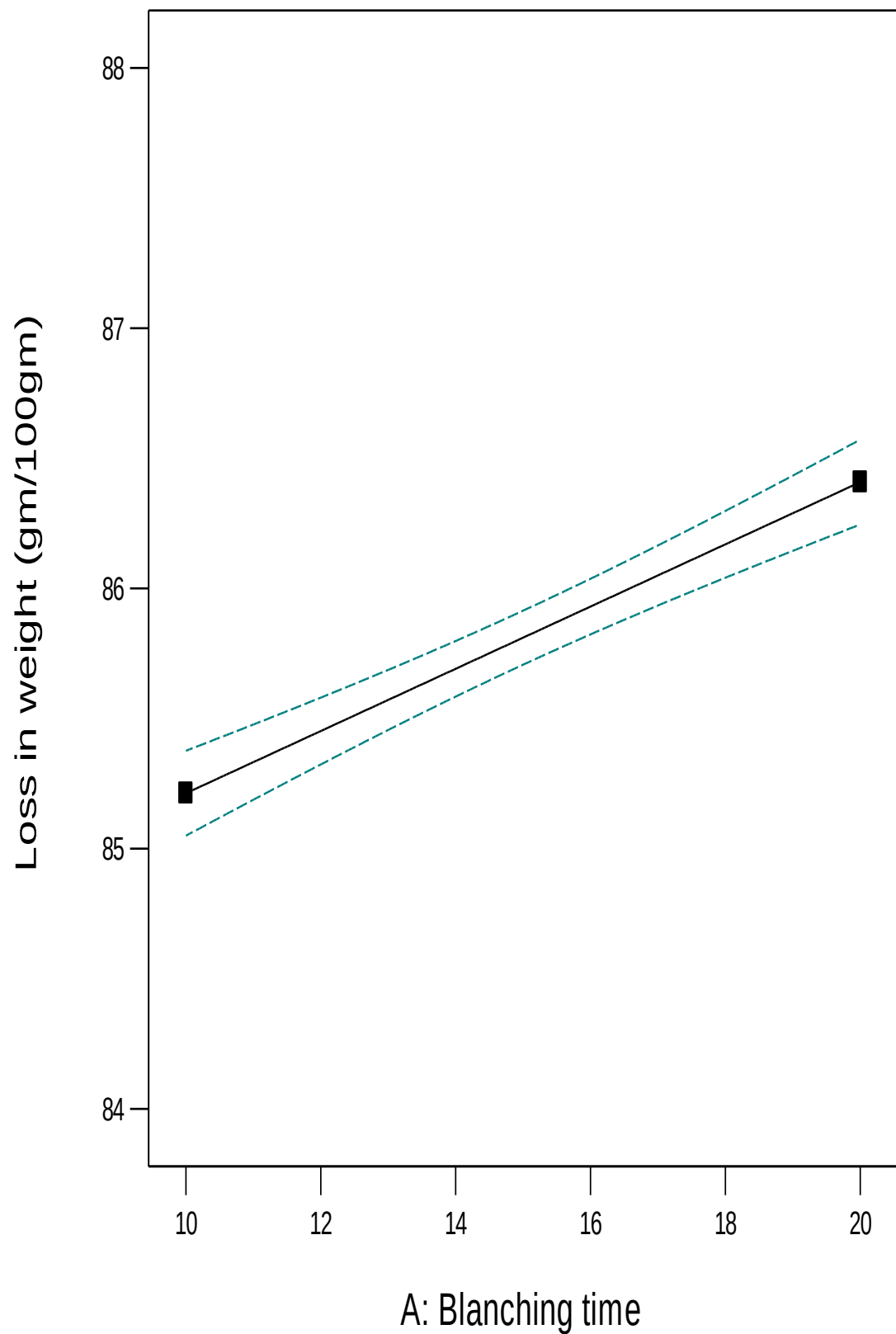


Fig. 4.5 Effect of blanching time (Sec.) on loss in weight (g) of purslane leaves.

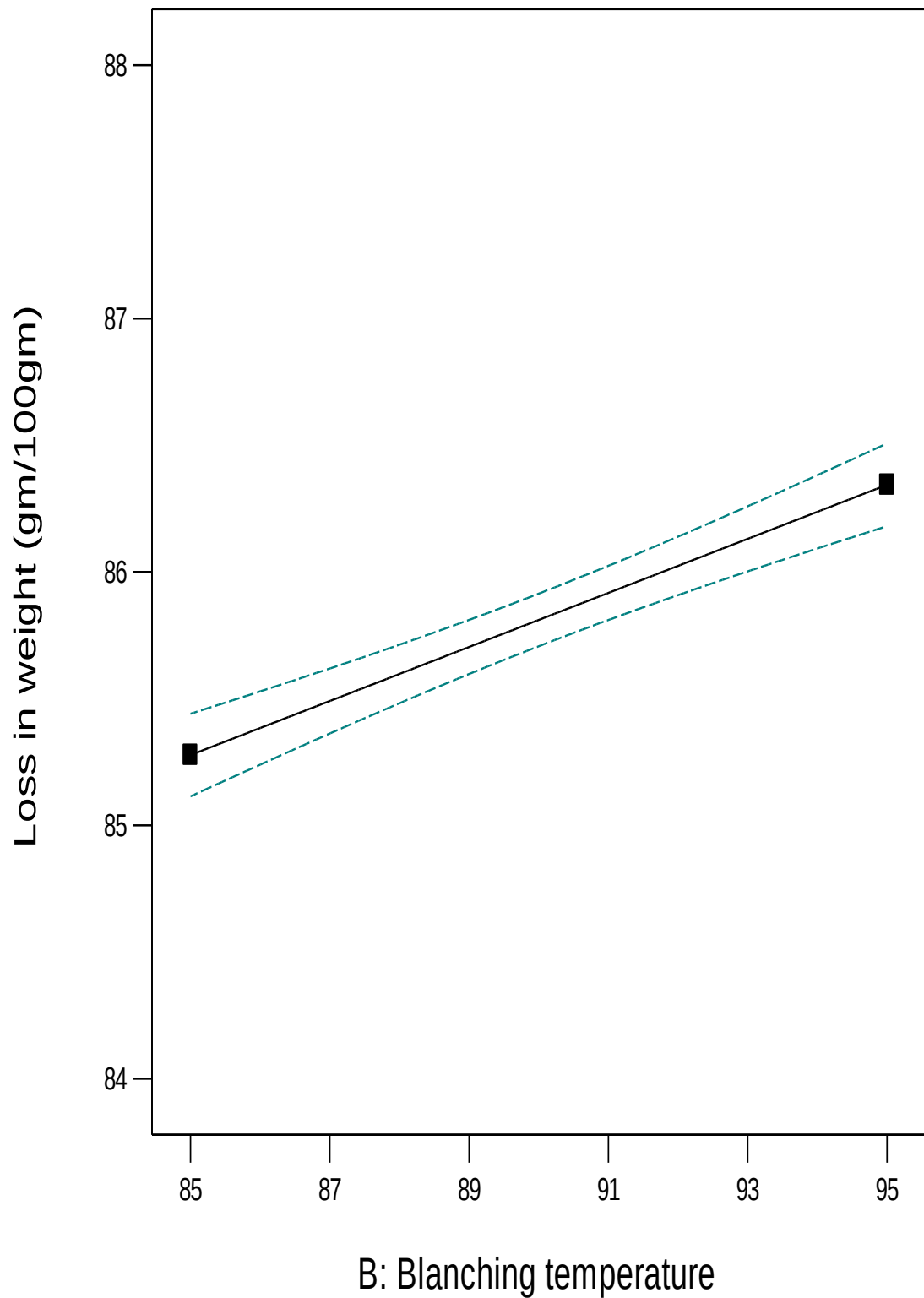


Fig. 4.6 Effect of blanching temperature (°C) on loss in weight (g) of purslane leaves.

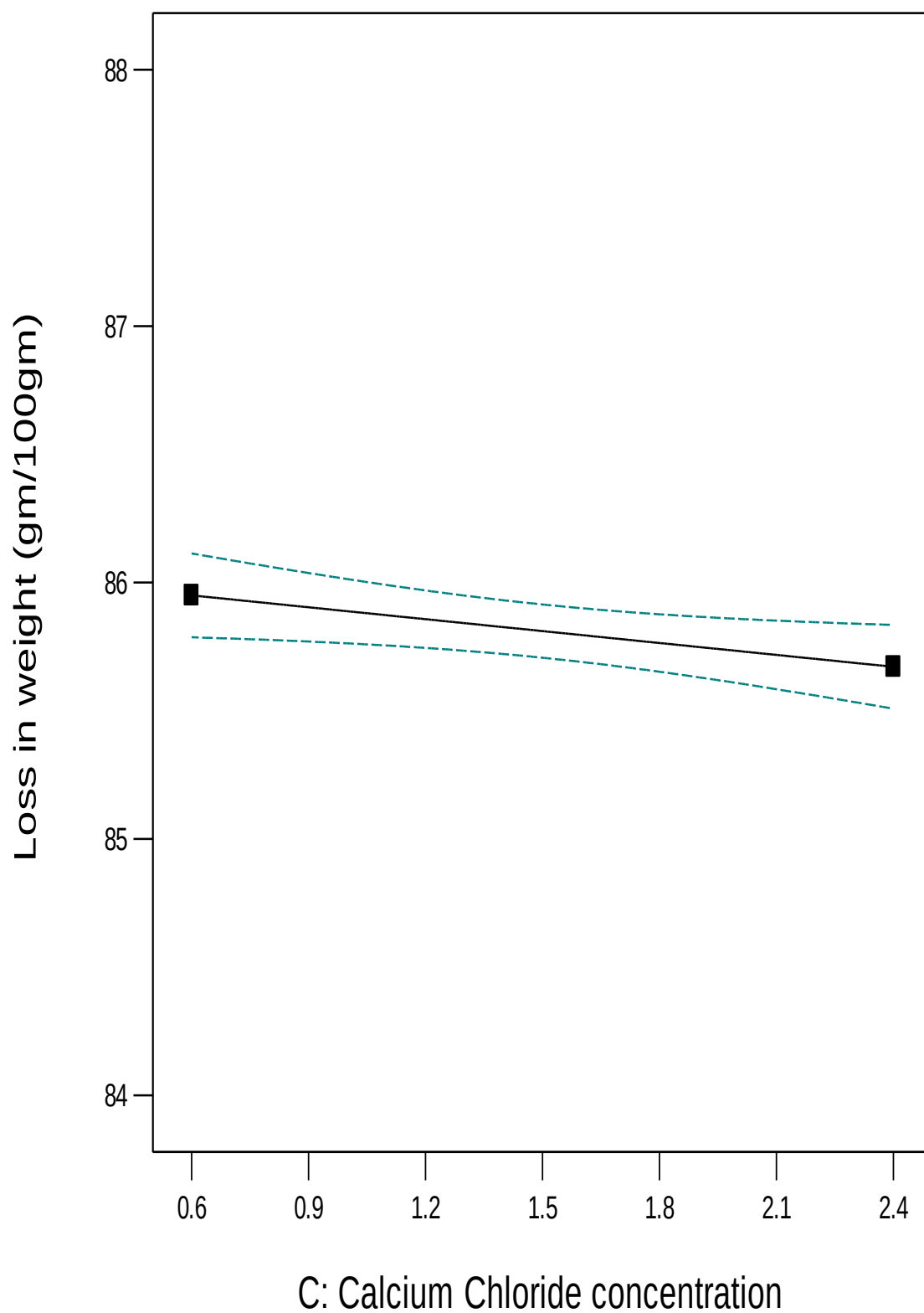


Fig. 4.7 Effect of CaCl_2 concentration (%) on loss in weight (g) of purslane leaves.

4.1.1.3 Product recovery (%):-

The result pertaining to the reckoning for product recovery (%) of purslane leaves as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.4 and depicted in Figure 4.8, 4.9 and 4.10. The analysis of variance is given in Appendix-III

Table 4.4 Effect of blanching parameters on product recovery (%) of purslane leaves

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration (C) (%)	Product recovery (%)
T ₁	15	90	3	14.36
T ₂	20	95	0.6	12.91
T ₃	10	85	2.4	15.13
T ₄	15	90	1.5	13.97
T ₅	15	81.6	1.5	15.32
T ₆	20	85	0.6	13.91
T ₇	10	85	0.6	15.01
T ₈	15	98.4	1.5	13.27
T ₉	10	95	0.6	14.01
T ₁₀	20	95	2.4	13.22
T ₁₁	23.4	90	1.5	13.21
T ₁₂	15	90	1.5	14.75
T ₁₃	20	85	2.4	14.22
T ₁₄	15	90	1.5	14.29
T ₁₅	15	90	0	13.86
T ₁₆	15	90	1.5	14.11
T ₁₇	15	90	1.5	14.19
T ₁₈	6.6	90	1.5	15.57
T ₁₉	15	90	1.5	14.11
T ₂₀	10	95	2.4	14.31
Std. Dev.	0.2191			
Mean	14.19			
C.V. %	1.54			

An examination of Table 4.4 reveals that the maximum product recovery (15.57 %) was recorded in T₁₈ and the second maximum product recovery (15.32 %) was recorded in T₅, where the minimum product recovery (12.91 %) was recorded in T₂.

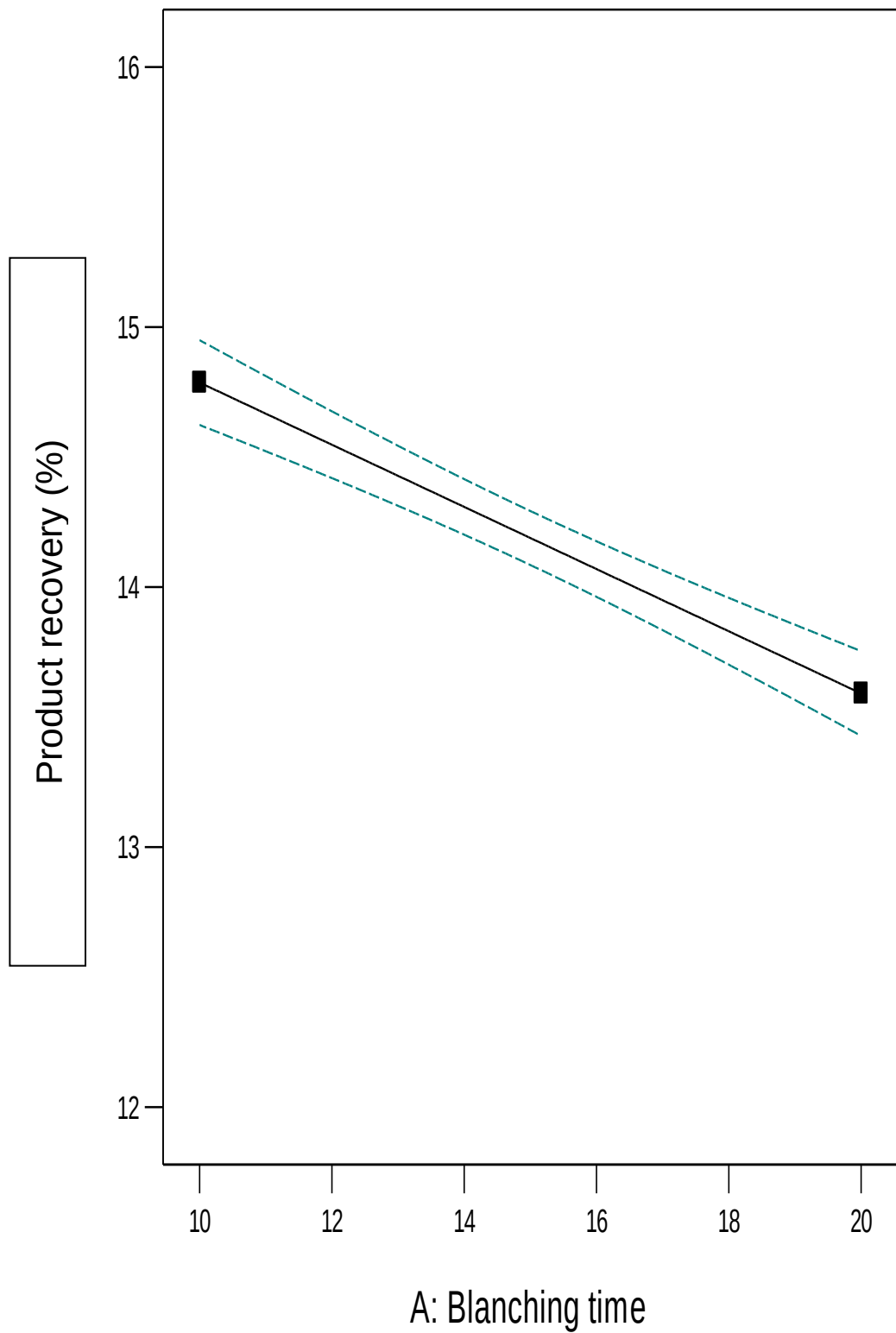


Fig. 4.8 Effect of blanching time (Sec) on product recovery (%) of purslane leaves.

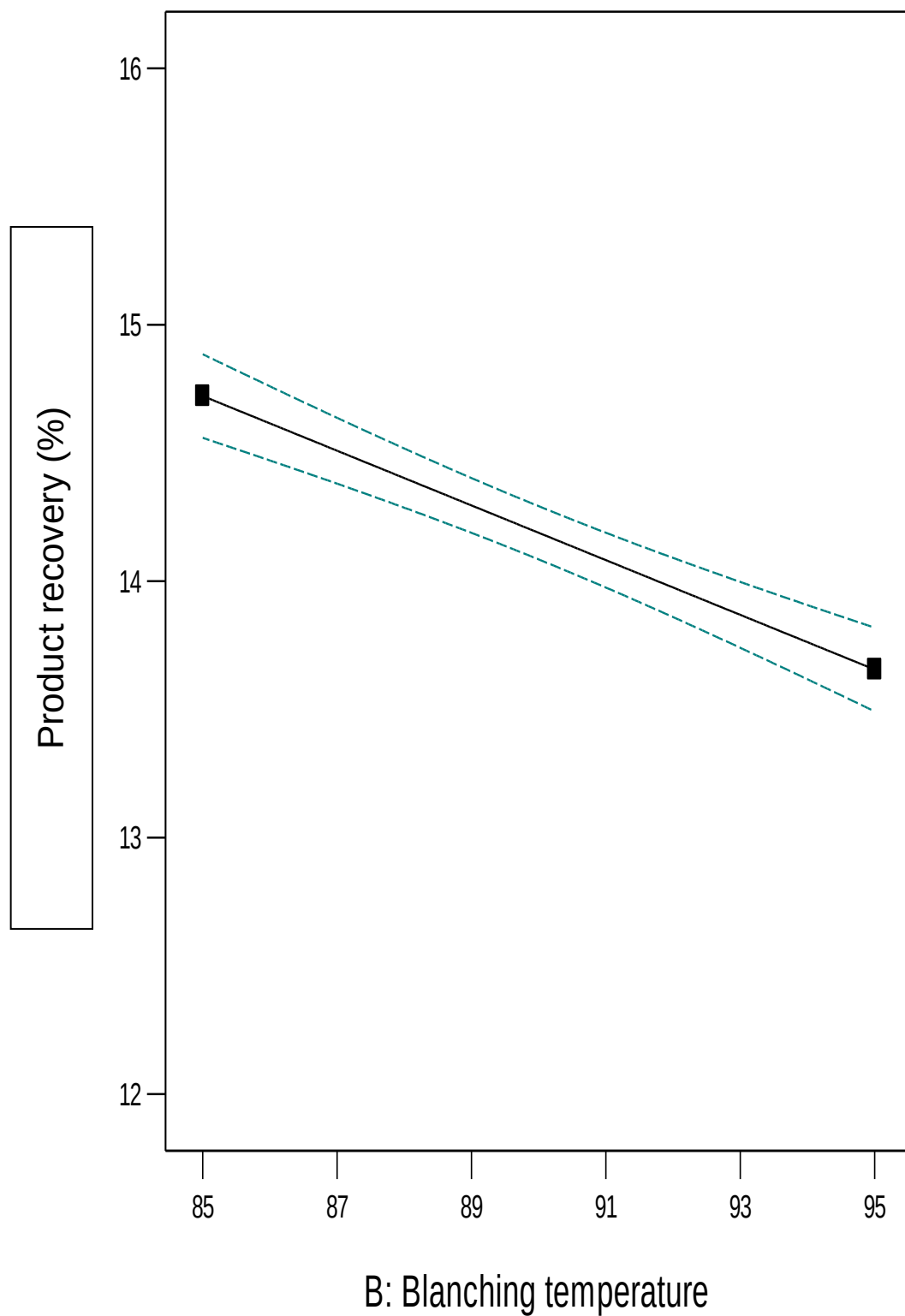


Fig. 4.9 Effect of blanching temperature (°C) on product recovery (%) of purslane leaves.

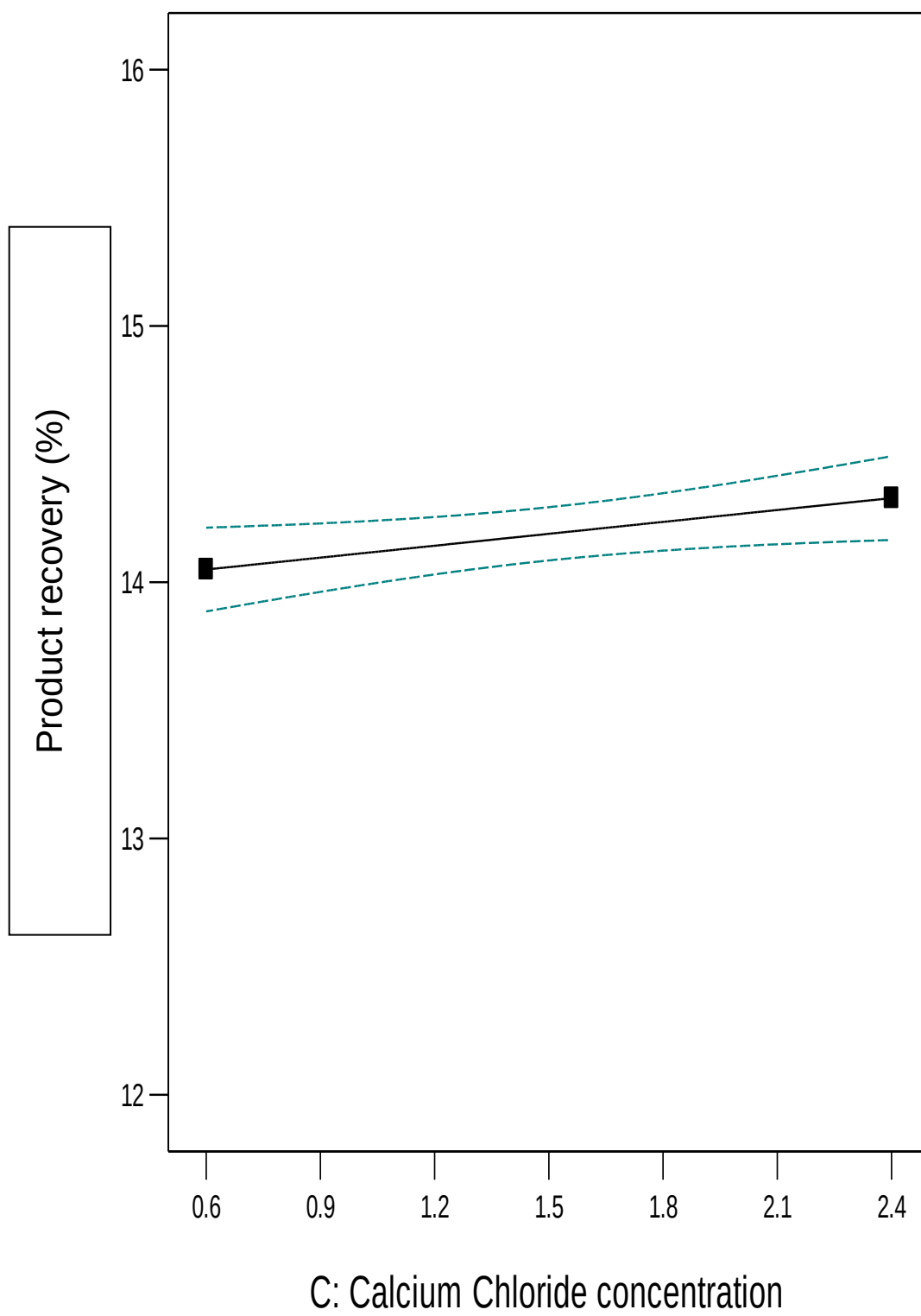


Fig. 4.10 Effect of CaCl_2 (%) on product recovery (%) of purslane leaves.

4.1.1.4 Moisture content (%):-

The result pertaining to the reckoning for moisture content (%) of purslane leaves as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.5 and depicted in Figure 4.11, 4.12 and 4.13. The analysis of variance is given in Appendix-IV

Table 4.5 Effect of blanching parameters on moisture content (%)

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration(C) (%)	Moisture content (%)
T ₁	15	90	3	85.63
T ₂	20	95	0.6	87.08
T ₃	10	85	2.4	84.86
T ₄	15	90	1.5	86.03
T ₅	15	81.6	1.5	84.67
T ₆	20	85	0.6	86.08
T ₇	10	85	0.6	84.99
T ₈	15	98.4	1.5	86.72
T ₉	10	95	0.6	85.99
T ₁₀	20	95	2.4	86.77
T ₁₁	23.4	90	1.5	86.79
T ₁₂	15	90	1.5	85.24
T ₁₃	20	85	2.4	85.77
T ₁₄	15	90	1.5	85.71
T ₁₅	15	90	0	86.14
T ₁₆	15	90	1.5	85.88
T ₁₇	15	90	1.5	85.81
T ₁₈	6.6	90	1.5	84.42
T ₁₉	15	90	1.5	85.88
T ₂₀	10	95	2.4	85.68
Std. Dev.	0.2191			
Mean	85.81			
C.V. %	0.2554			

An examination of Table 4.5 reveals that the moisture content (87.08 %) was recorded in T₂, where the minimum moisture content (84.42 %) was recorded in T₁₈ and second minimum moisture content (84.67 %) was recorded in T₅.

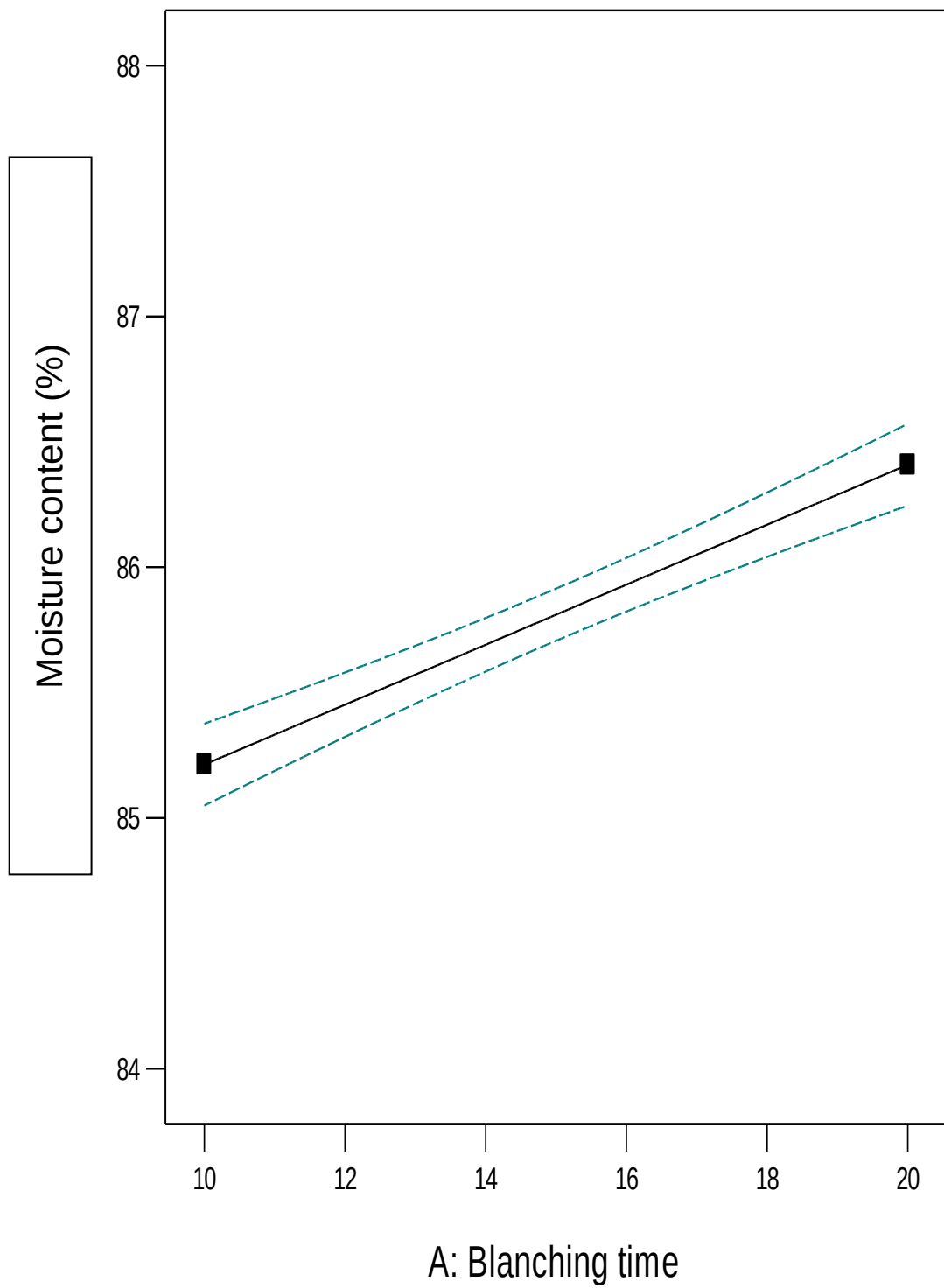


Fig. 4.11 Effect of blanching time (Sec.) on moisture content (%) of purslane leaves.

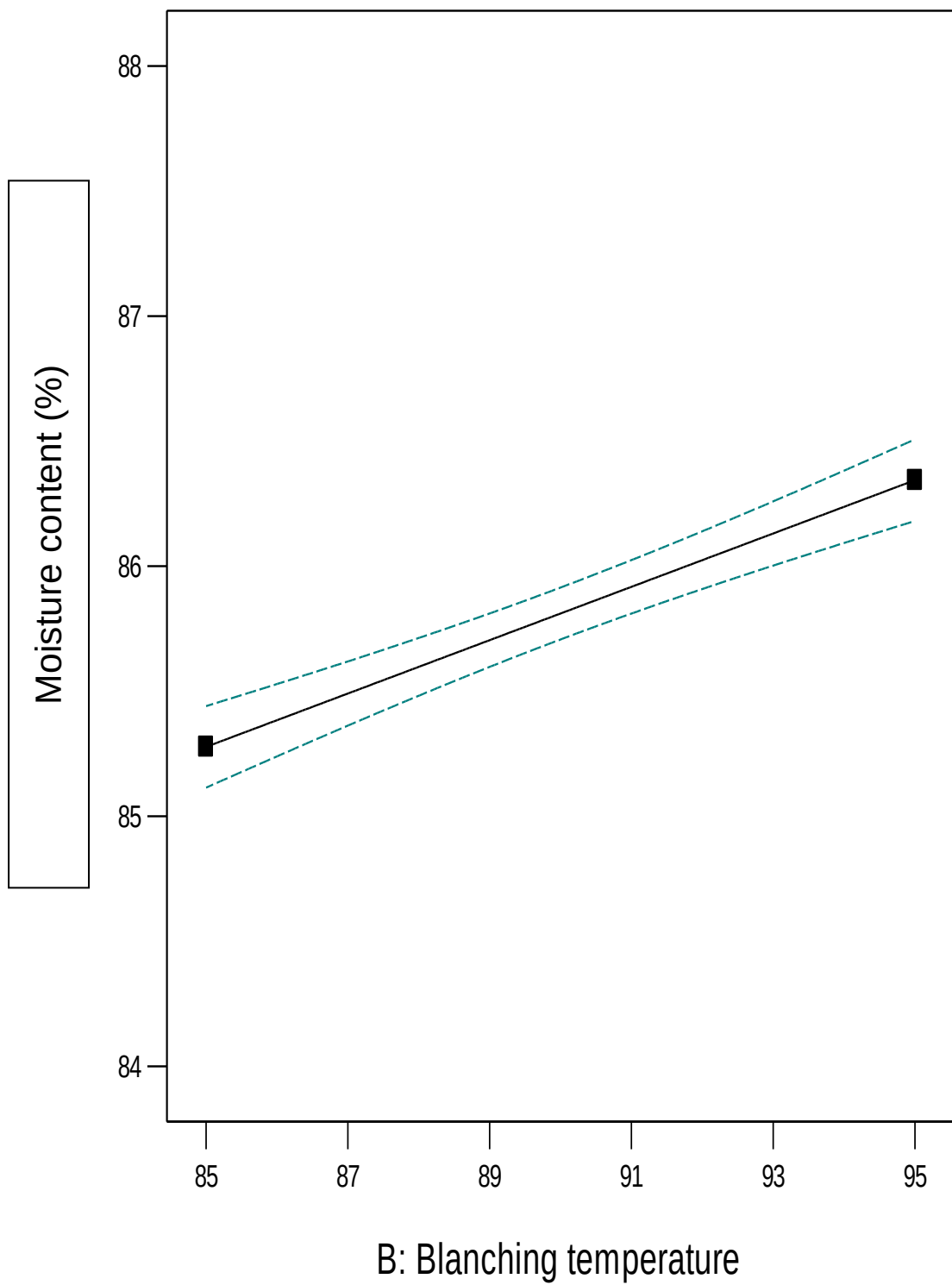


Fig. 4.12 Effect of blanching temperature (°C) on moisture content (%) of purslane leaves.

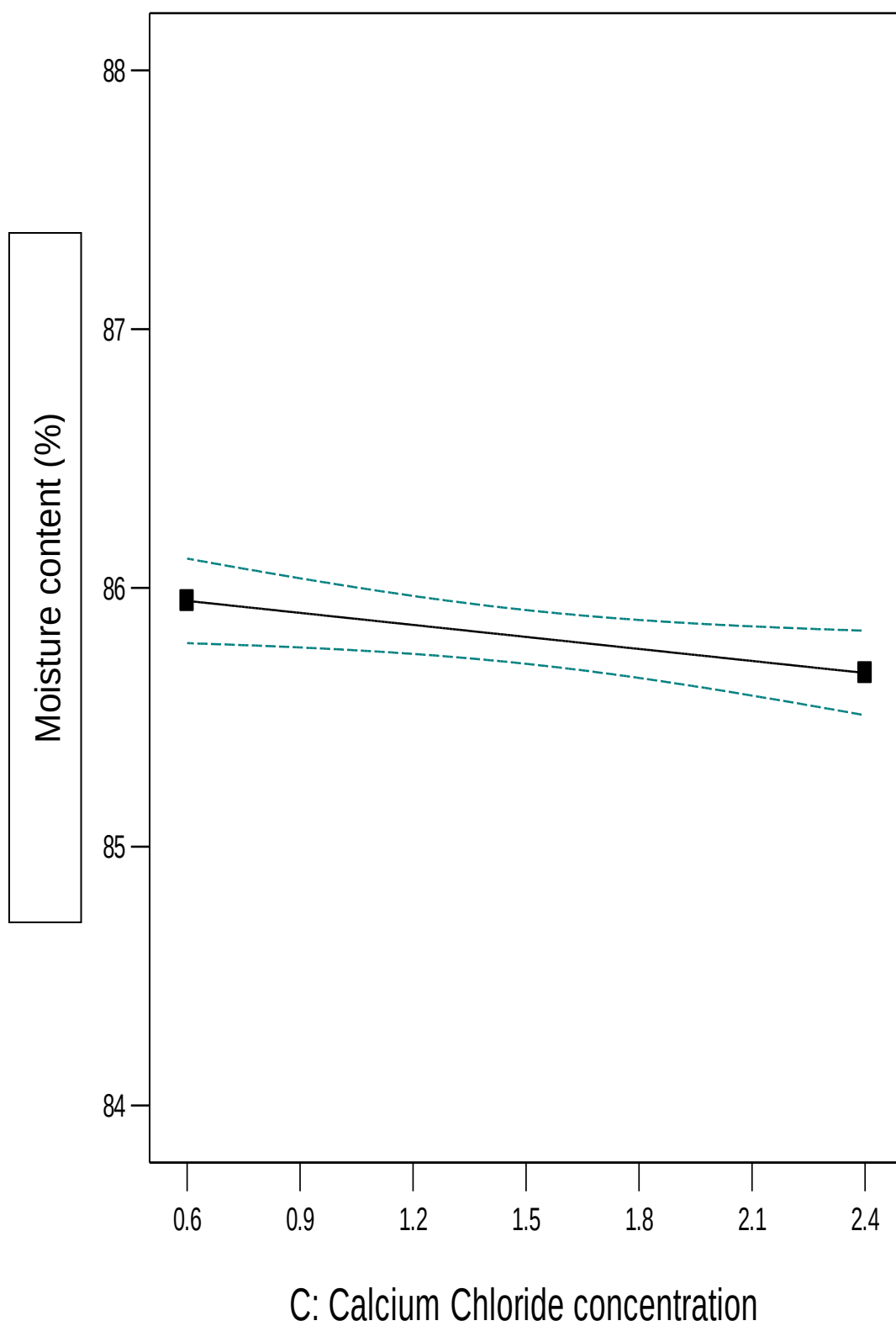


Fig. 4.13 Effect of CaCl_2 concentration (%) on moisture content (%) of purslane leaves.

4.1.1.5 Rehydration ratio:-

The result pertaining to the reckoning for rehydration ratio of purslane leaves as affected by the different blanching treatment (i.e. time, temperature and CaCl_2 %) is presented in Table 4.6 and depicted in Figure 4.14, 4.15 and 4.16. The analysis of variance is given in Appendix-V

Table 4.6 Effect of blanching parameters on rehydration ratio of purslane leaves powder

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) ($^{\circ}\text{C}$)	CaCl_2 concentration(C) (%)	Rehydration ratio
T ₁	15	90	3	4.1
T ₂	20	95	0.6	3.1
T ₃	10	85	2.4	3.7
T ₄	15	90	1.5	3.4
T ₅	15	81.6	1.5	3.6
T ₆	20	85	0.6	3.2
T ₇	10	85	0.6	3.3
T ₈	15	98.4	1.5	3.7
T ₉	10	95	0.6	3.1
T ₁₀	20	95	2.4	3.9
T ₁₁	23.4	90	1.5	3.8
T ₁₂	15	90	1.5	3.7
T ₁₃	20	85	2.4	3.3
T ₁₄	15	90	1.5	3.5
T ₁₅	15	90	0	3.2
T ₁₆	15	90	1.5	3.4
T ₁₇	15	90	1.5	3.7
T ₁₈	6.6	90	1.5	3.3
T ₁₉	15	90	1.5	3.4
T ₂₀	10	95	2.4	4
Std. Dev.	0.1973			
Mean	3.52			
C.V. %	5.60			

An examination of Table 4.6 reveals that the maximum rehydration ratio (4.1) was recorded in T₁ and the second maximum rehydration ratio (4) was recorded in T₂₀, whereas the minimum rehydration ratio (3.1) was recorded in T₂ and T₉.

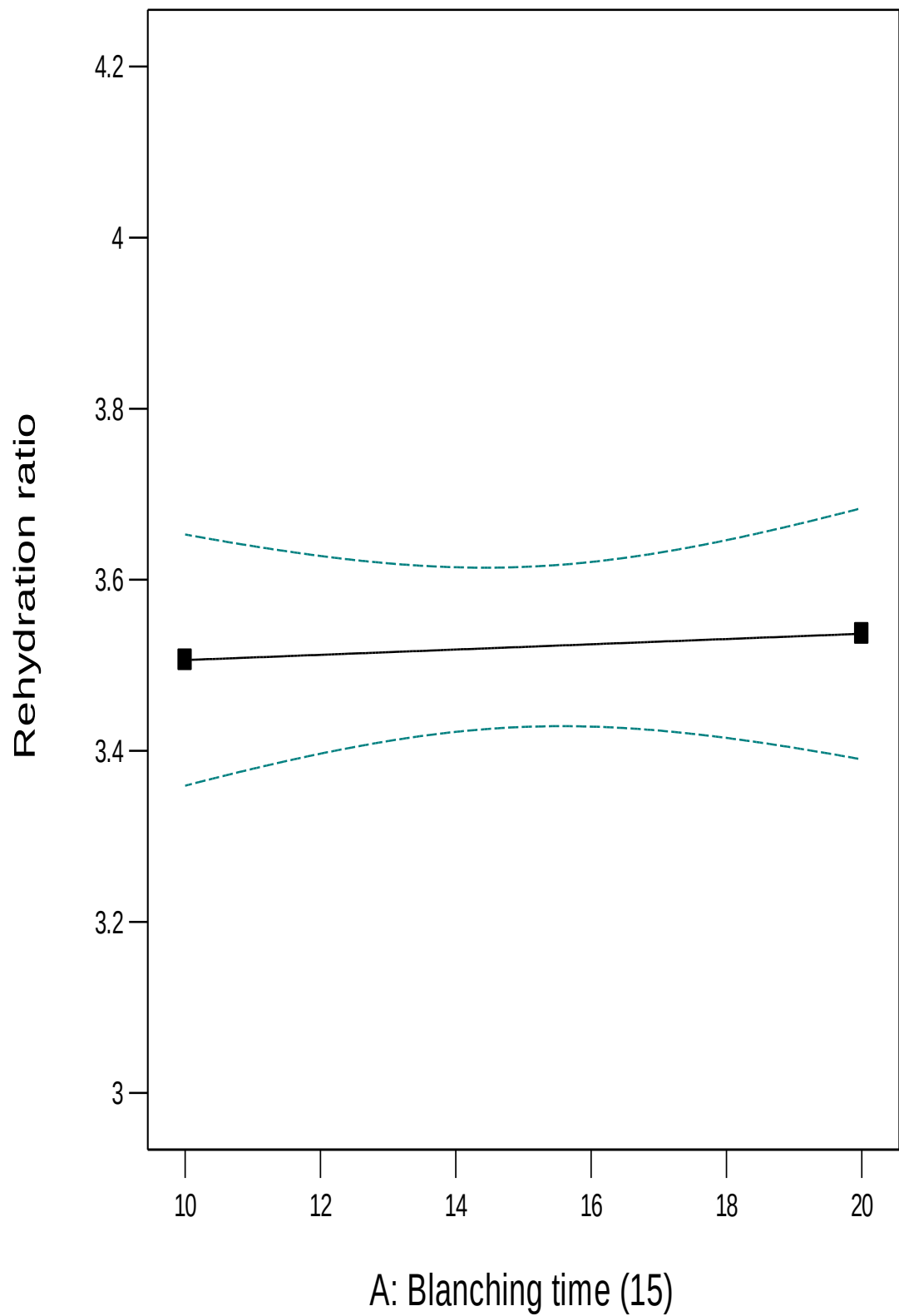


Fig. 4.14 Effect of blanching time (Sec.) on rehydration ratio of purslane leaves powder.

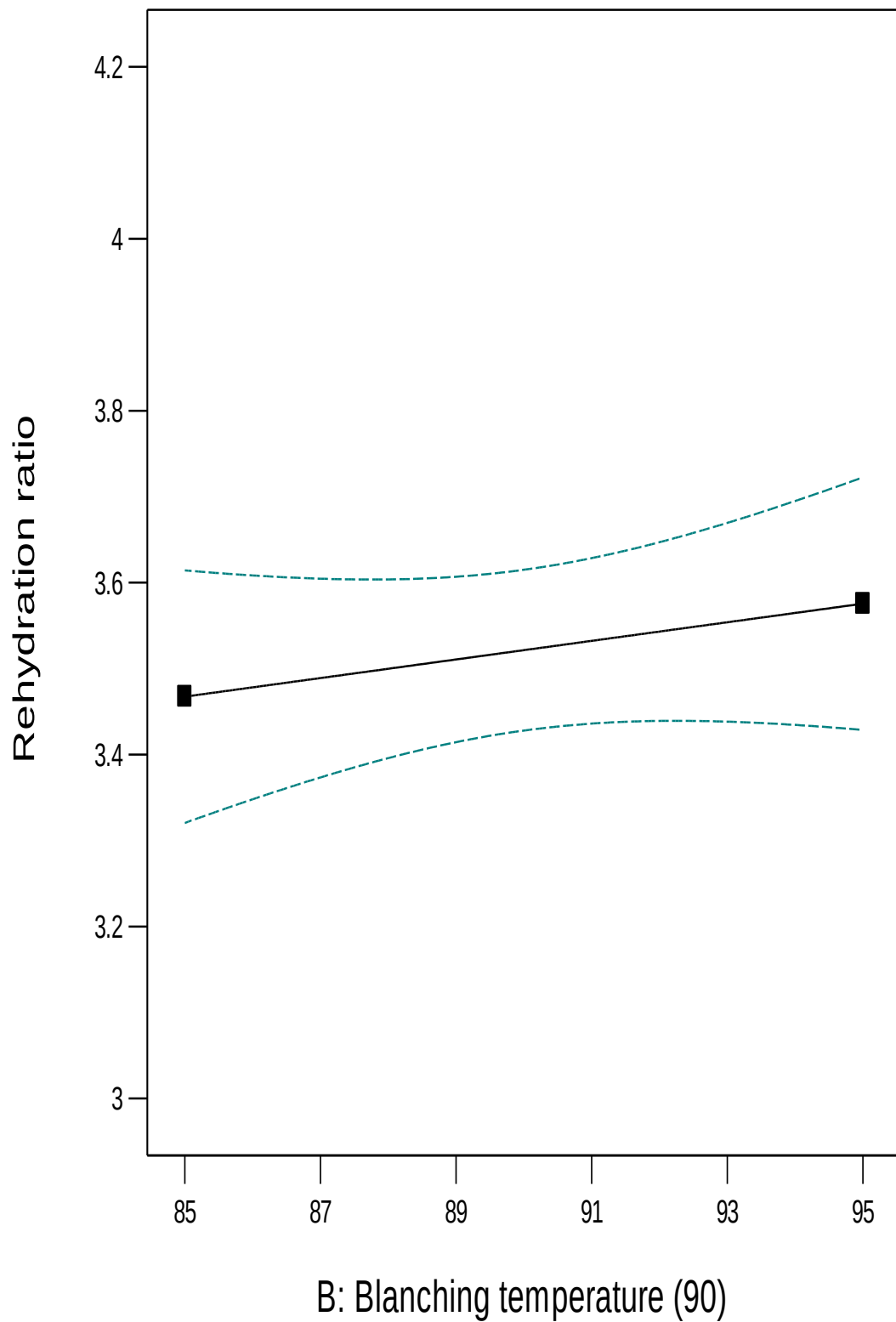
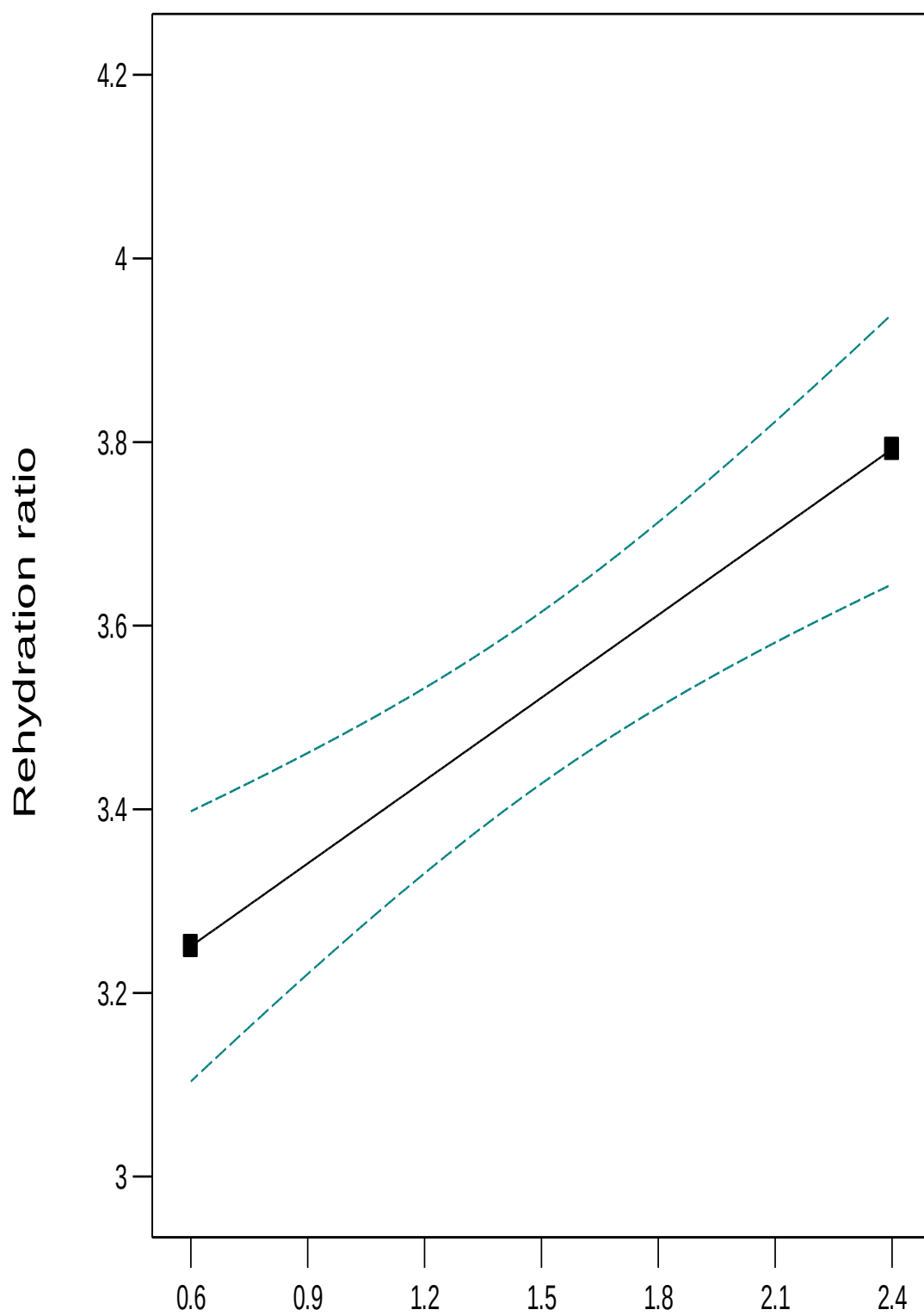


Fig. 4.15 Effect of blanching temperature (°C) on rehydration ratio of purslane leaves powder.



C: Calcium Chloride concentration (1.5)

Fig. 4.16 Effect of CaCl_2 concentration (%) on rehydration ratio of purslane leaves powder.

4.1.2 Analysis of nutritional estimation of purslane powder.

4.1.2.1 Vitamin-C (Ascorbic acid) estimation (mg/100g DW):-

The result pertaining to the reckoning for ascorbic acid content of purslane leaves powder as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.7 and depicted in Figure 4.17, 4.18 and 4.19. The analysis of variance is given in Appendix-VI

Table 4.7 Effect of blanching parameters on Vitamin-C (mg/100g) content of purslane leaves

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration(C) (%)	Ascorbic acid mg/100g DW
T ₁	15	90	3	232.55
T ₂	20	95	0.6	171.01
T ₃	10	85	2.4	226.67
T ₄	15	90	1.5	197.44
T ₅	15	81.6	1.5	206.78
T ₆	20	85	0.6	180.45
T ₇	10	85	0.6	192.34
T ₈	15	98.4	1.5	182.09
T ₉	10	95	0.6	184.77
T ₁₀	20	95	2.4	212.34
T ₁₁	23.4	90	1.5	188.46
T ₁₂	15	90	1.5	200.49
T ₁₃	20	85	2.4	217.90
T ₁₄	15	90	1.5	201.33
T ₁₅	15	90	0	170.13
T ₁₆	15	90	1.5	199.32
T ₁₇	15	90	1.5	201.34
T ₁₈	6.6	90	1.5	207.22
T ₁₉	15	90	1.5	204.33
T ₂₀	10	95	2.4	222.22
Std. Dev.	3.33			
Mean	199.96			
C.V. %	1.67			

An examination of Table 4.7 reveals that the maximum ascorbic acid (232.55 mg/100g DW basis) was recorded in T₁ and second maximum availability of ascorbic acid (226.67 mg/100g DW) was recorded in T₃, where the minimum contained of ascorbic acid (170.13 mg/100g DW) was recorded in T₁₅.

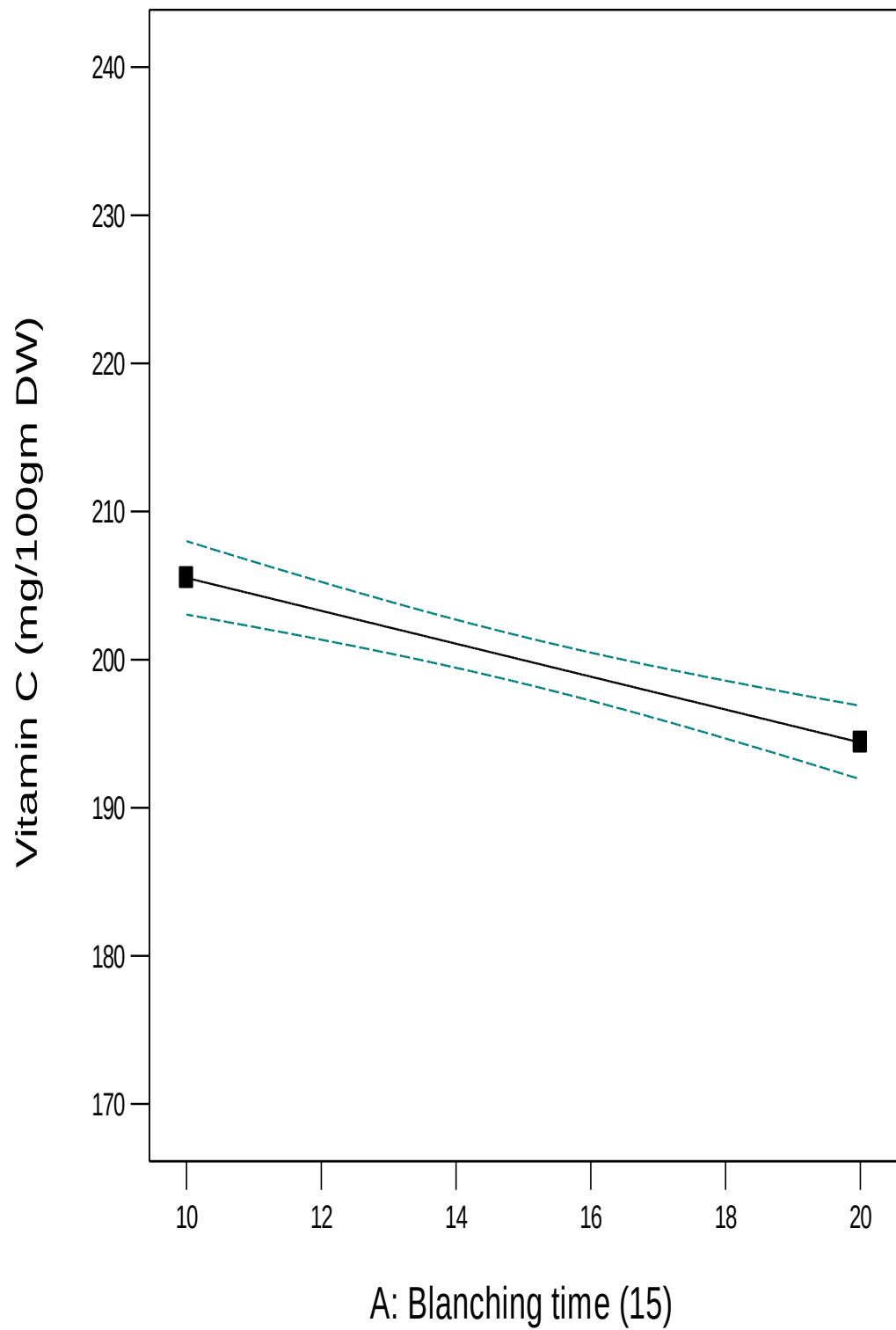


Fig. 4.17 Effect of blanching time (Sec) on vitamin-C content (mg/100g DW) of purslane leaves.

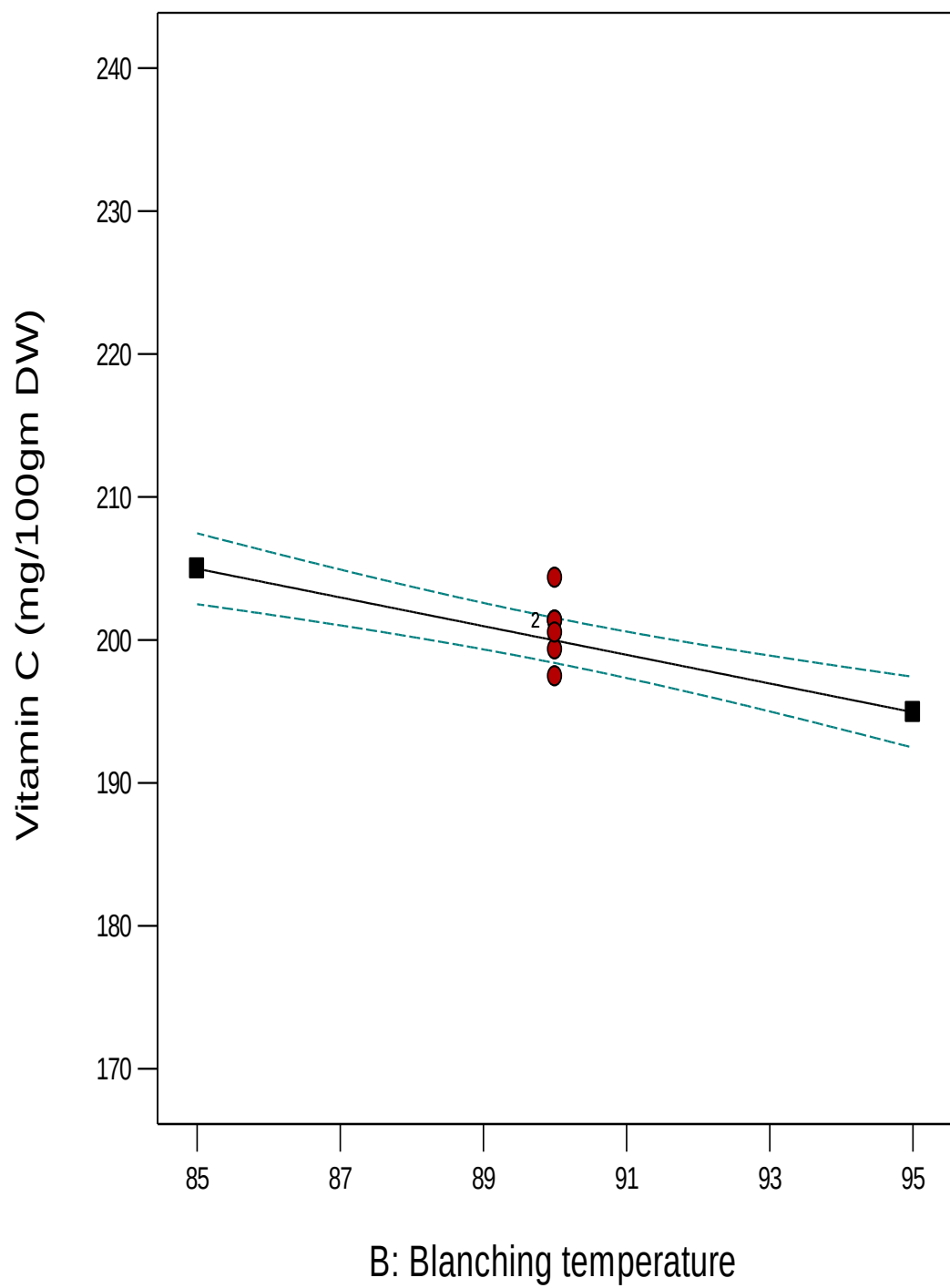


Fig. 4.18 Effect of blanching temperature (°C) on vitamin-C content (mg/100g DW) of purslane leaves.

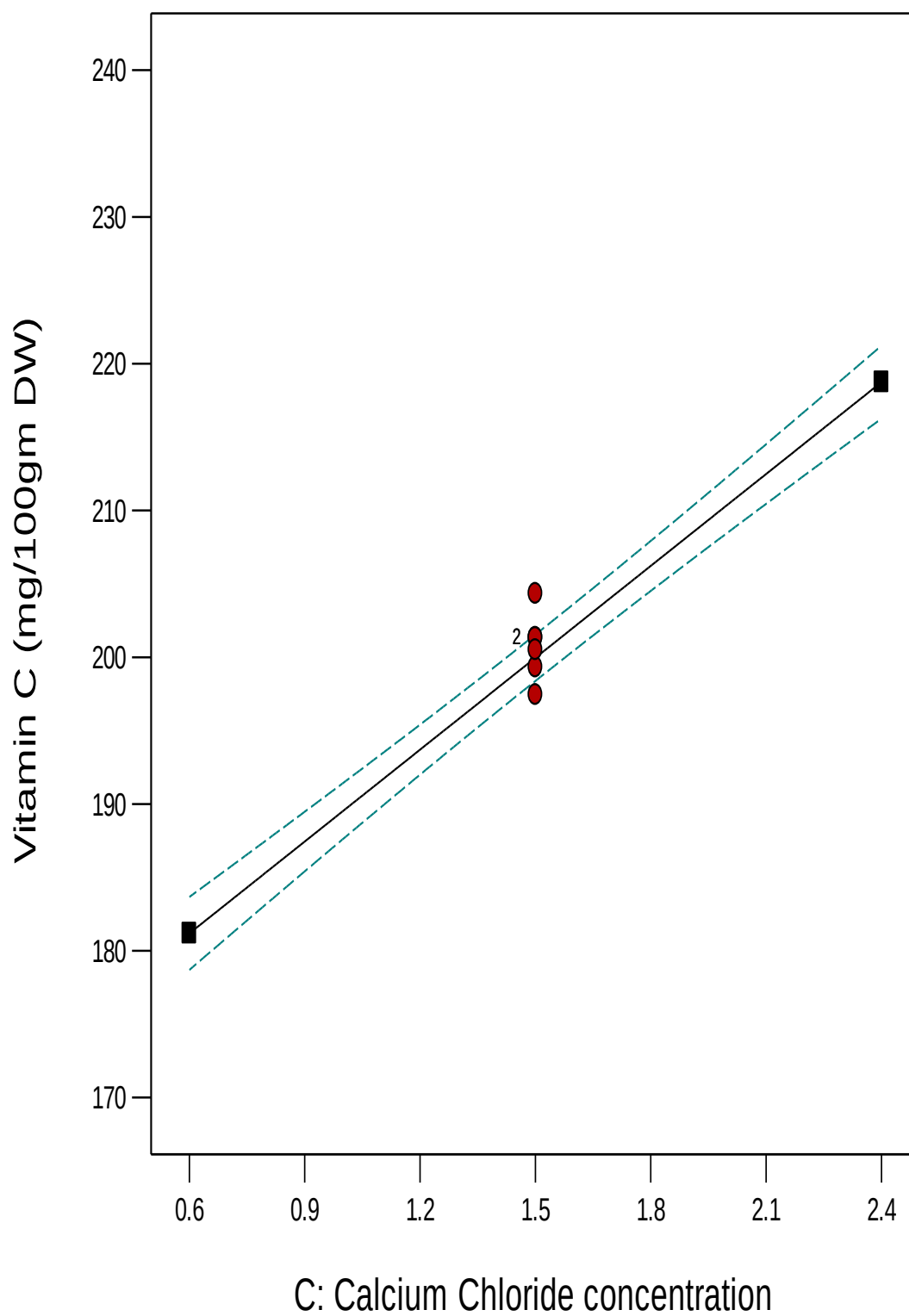


Fig. 4.19 Effect of CaCl_2 concentration (%) on vitamin-C content (mg/100g DW) of purslane leaves.

4.1.3 Analysis of anti-nutritional estimation of purslane powder.

4.1.3.1 Oxalic acid estimation (mg/100g DW):-

The result pertaining to the reckoning for oxalic acid content of purslane leaves powder as affected by the different blanching treatment (i.e. time, temperature and CaCl₂ %) is presented in Table 4.8 and depicted in Figure 4.20, 4.21 and 4.22. The analysis of variance is given in Appendix-VII

Table 4.8 Effect of blanching parameters on oxalic acid (mg/100g) content of purslane leaves.

Treatment No.	Blanching time (A) (sec)	Blanching temperature(B) (°C)	CaCl ₂ concentration(C) (%)	Oxalic acid mg/100g DW
T ₁	15	90	3	339.27
T ₂	20	95	0.6	505.63
T ₃	10	85	2.4	444.61
T ₄	15	90	1.5	496.12
T ₅	15	81.6	1.5	501.09
T ₆	20	85	0.6	544.12
T ₇	10	85	0.6	572.49
T ₈	15	98.4	1.5	410.34
T ₉	10	95	0.6	535.81
T ₁₀	20	95	2.4	354.73
T ₁₁	23.4	90	1.5	470.26
T ₁₂	15	90	1.5	496.92
T ₁₃	20	85	2.4	410.70
T ₁₄	15	90	1.5	495.41
T ₁₅	15	90	0	582.43
T ₁₆	15	90	1.5	496.92
T ₁₇	15	90	1.5	496.32
T ₁₈	6.6	90	1.5	523.41
T ₁₉	15	90	1.5	495.71
T ₂₀	10	95	2.4	375.24
Std. Dev.	0.553			
Mean	478.08			
C.V. %	0.115			

An examination of Table 4.8 reveals that the minimum availability of oxalic acid (339.27 mg/100g DW basis) was recorded in T₁ and the second minimum availability of oxalic acid (354.73 mg/100g DW basis) was recorded in T₁₀, Whereas maximum availability of oxalic acid (582.43 mg/100g DW basis) was recorded in T₁₅.

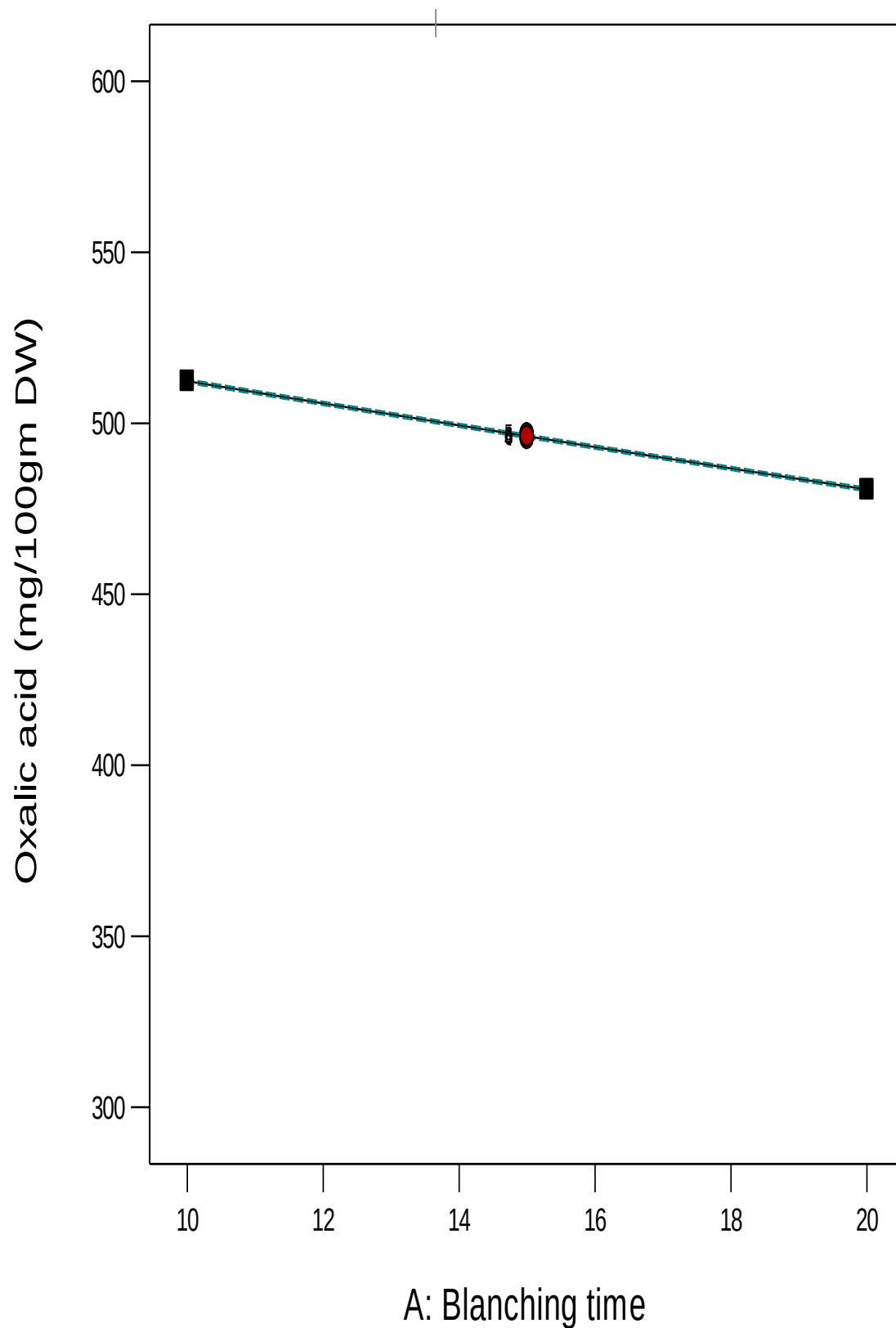


Fig. 4.21 Effect of blanching time (sec) on oxalic acid content (mg/100g DW) of purslane leaves.

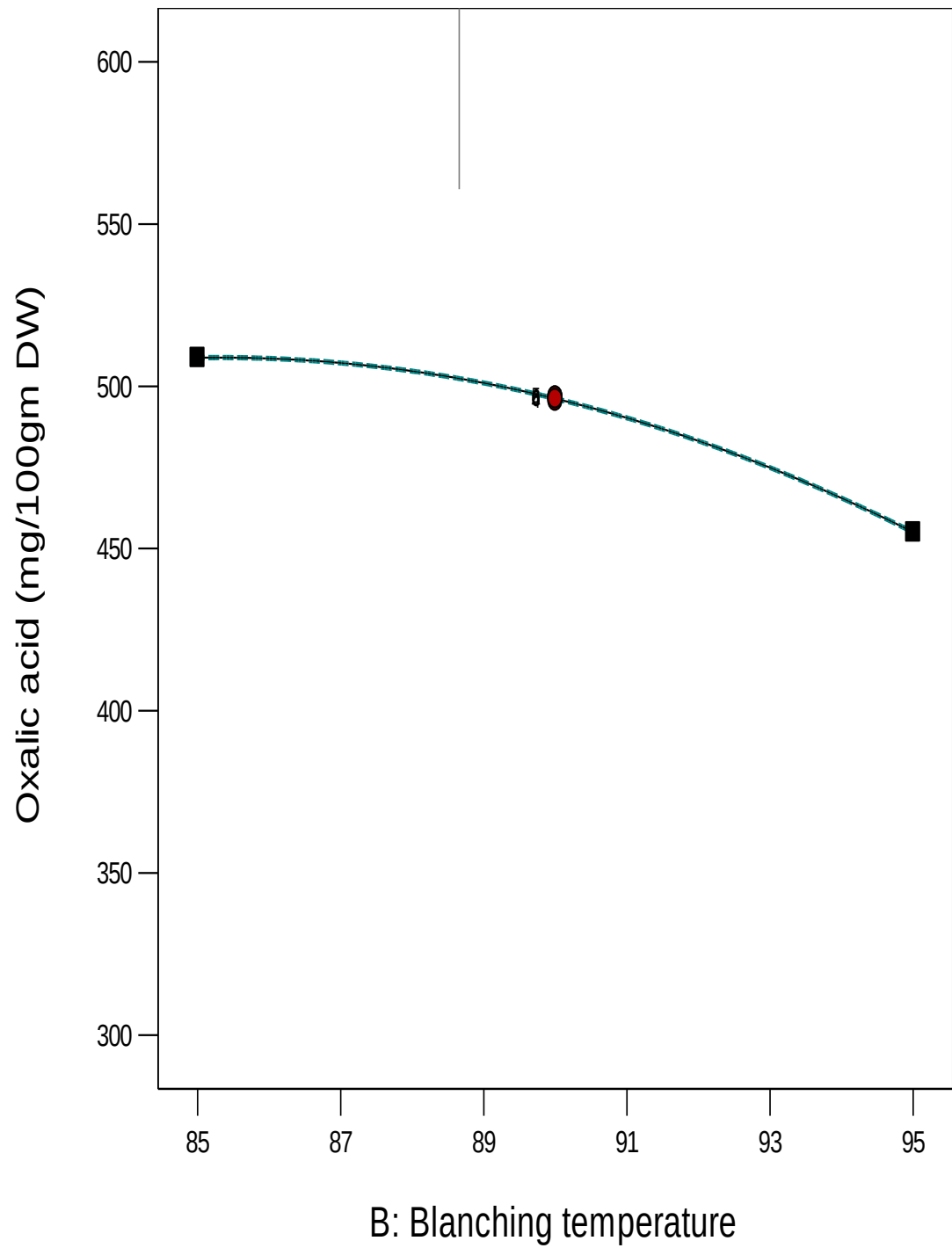


Fig. 4.21 Effect of blanching temperature (°C) on oxalic acid content (mg/100g DW) of purslane leaves.

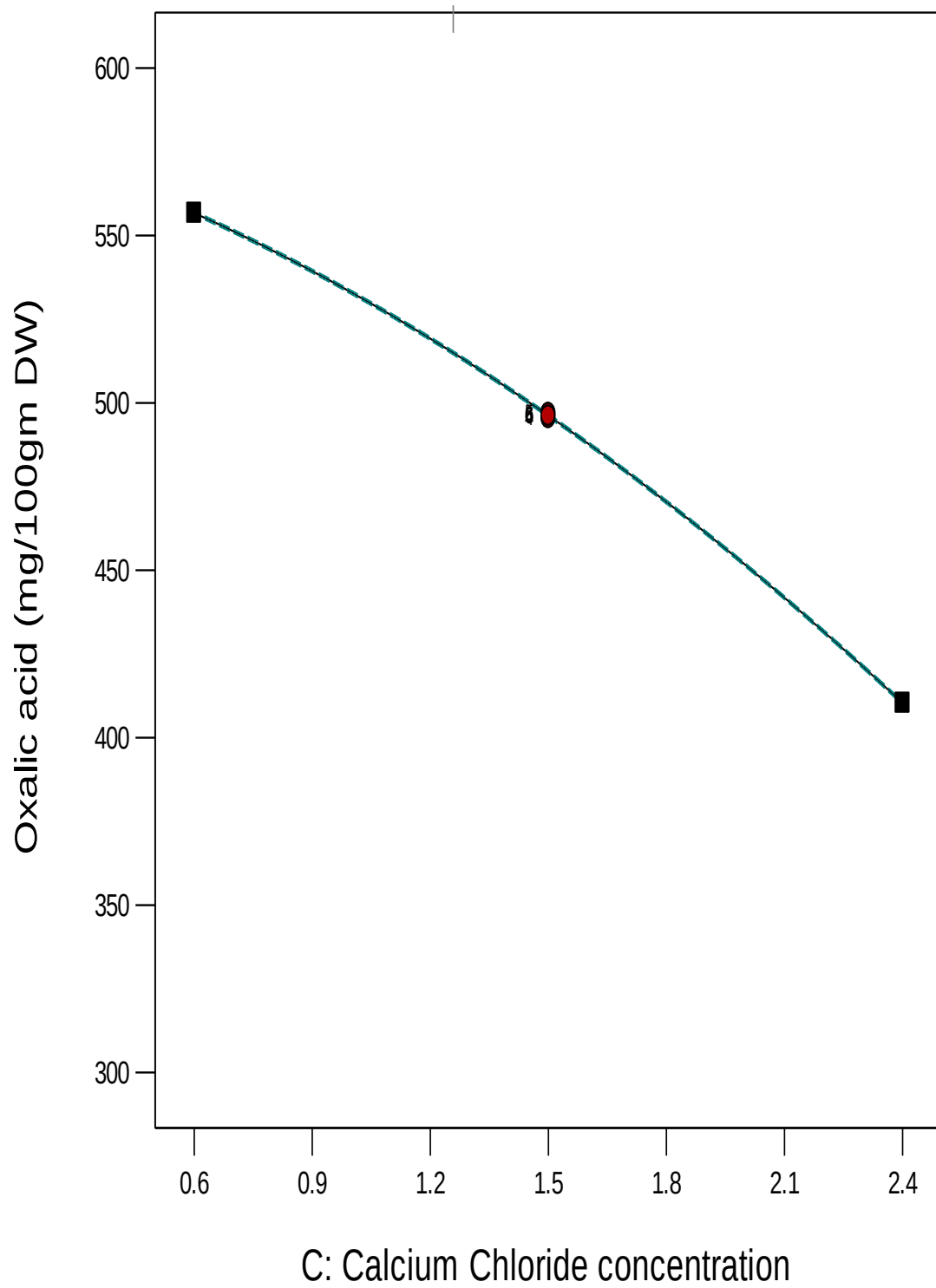


Fig. 4.21 Effect of CaCl_2 concentration (%) on oxalic acid content (mg/100g DW) of purslane leaves.

4.2 Organoleptic evaluation of developed product incorporated with Purslane Powder.

The organoleptic evaluation of the entire prepared product were evaluated and statistically analyzed on five parameters as follow:

- I. Appearance
- II. Color
- III. Taste
- IV. Aroma
- V. Over all acceptability

Three products were prepared with the methods as described in chapter III.

- 1) Curry with (5%, 10% and 15%) purslane powder incorporation.
- 2) Indian bread with (4%, 8% and 122%) purslane powder incorporation.
- 3) Tea with (0.5%, 1% and 1.5%) purslane powder incorporation

Details of treatment and replication for all the three products of this study are given below (Table 4.9 and Table 4.10 respectively):

Table 4.9 Details of treatments for products incorporated with purslane powder

Sr. No.	Treatment Symbol	Purslane powder incorporation (%)		
		Curry	Indian Bread	Tea
1	T ₁	5	4	0.5
2	T ₂	10	8	1.0
3	T ₃	15	12	1.5

Table 4.10 Details of replication for products incorporated with purslane powder

S.N.	1	2	3	4	5	6	7	8	9	10
Replication	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀
Panelists Number	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth

4.2.1 Organoleptic evaluation of curry prepared with purslane powder incorporation.

This part deals with results obtained by sensory score of curry with different combination of purslane powder.

4.2.1.1 Sensory score for appearance of curry:-

The result pertaining to the score for appearance of curry as affected by the different combination of purslane powder is presented in Table 4.11 and depicted in Figure 4.23. The analysis of variance is given in Appendix-VIII

Table 4.11 Effect of purslane powder incorporation on sensory score for appearance of curry.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	6	7	7	8	7	6.7
T2	8	7	8	7	8	7	8	6	8	8	7.5
T3	7	6	6	5	6	6	8	5	6	5	6
CV%	11.6451										
S.Em	0.24795										
CD 5%	0.71837										

An examination of Table 4.11 reveals that the significantly maximum score for appearance (7.5) was recorded in T₂, where the minimum score (6.0) for appearance was recorded in T₃. Score for appearance of curry was significantly affected by percentage of purslane powder incorporated in curry.

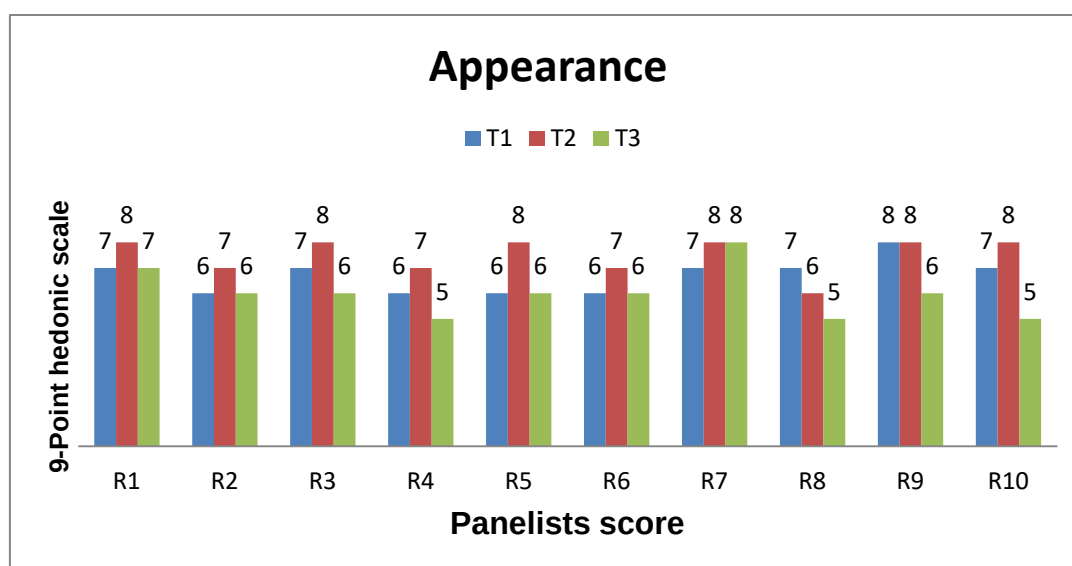


Fig. 4.23 Effect of purslane powder incorporation on sensory score for appearance of curry.

4.2.1.2 Sensory score for color of curry:-

The result pertaining to the score for color of curry as affected by the different combination of purslane powder is presented in Table 4.12 and depicted in Figure 4.24. The analysis of variance is given in Appendix-IX

Table 4.12 Effect of purslane powder incorporation on sensory score for color of curry.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	6	7	7	8	7	6.3
T2	8	7	8	7	8	7	8	6	8	8	7.3
T3	7	6	6	5	6	6	8	5	6	5	6
CV%	10.28876										
S.Em	0.212568										
CD 5%	0.615849										

An examination of Table 4.12 reveals that the significantly maximum score for color (7.3) was recorded in T₂, where the minimum score (6) for color was recorded in T₃. Score for color of curry was significantly affected by percentage of purslane powder incorporated in curry.

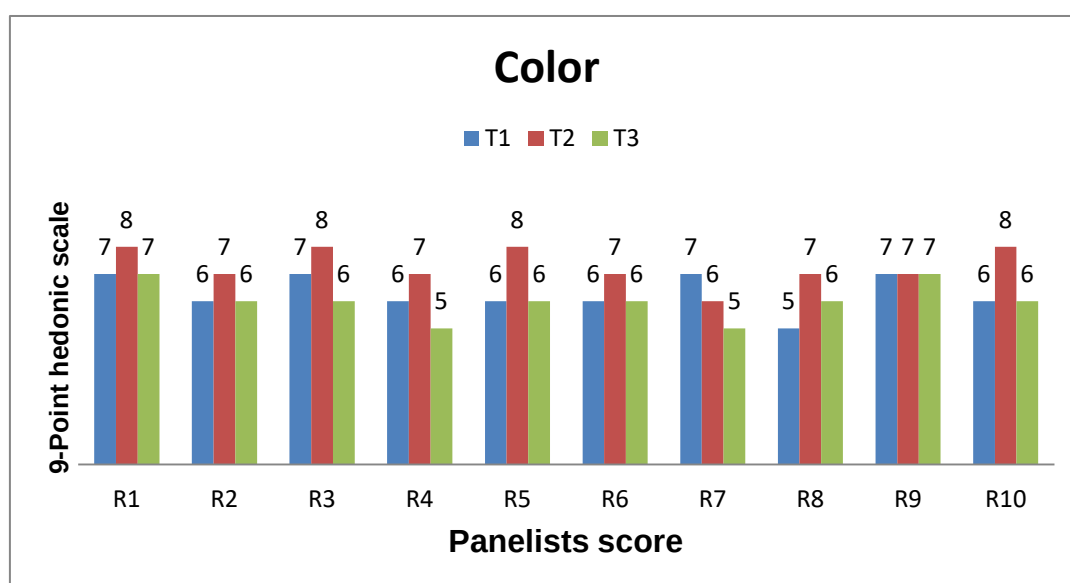


Fig. 4.24 Effect of purslane powder incorporation on sensory score for color of curry.

4.2.1.3 Sensory score for taste of curry:-

The result pertaining to the score for taste of curry as affected by the different combination of purslane powder is presented in Table 4.13 and depicted in Figure 4.25. The analysis of variance is given in Appendix-X

Table 4.13 Effect of purslane powder incorporation on sensory score for taste of curry.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T ₁	7	6	7	6	6	6	5	6	7	6	6.2
T ₂	8	7	8	7	8	8	9	8	7	8	7.8
T ₃	7	6	6	5	6	7	6	8	6	7	6.4
CV%	10.43707										
S.Em	0.224433										
CD 5%	0.650225										

An examination of Table 4.13 reveals that the significantly maximum score for taste (7.8) was recorded in T₂, where the minimum score (6.2) for taste was recorded in T₁. Score for taste of curry was significantly affected by percentage of purslane powder incorporated in curry.

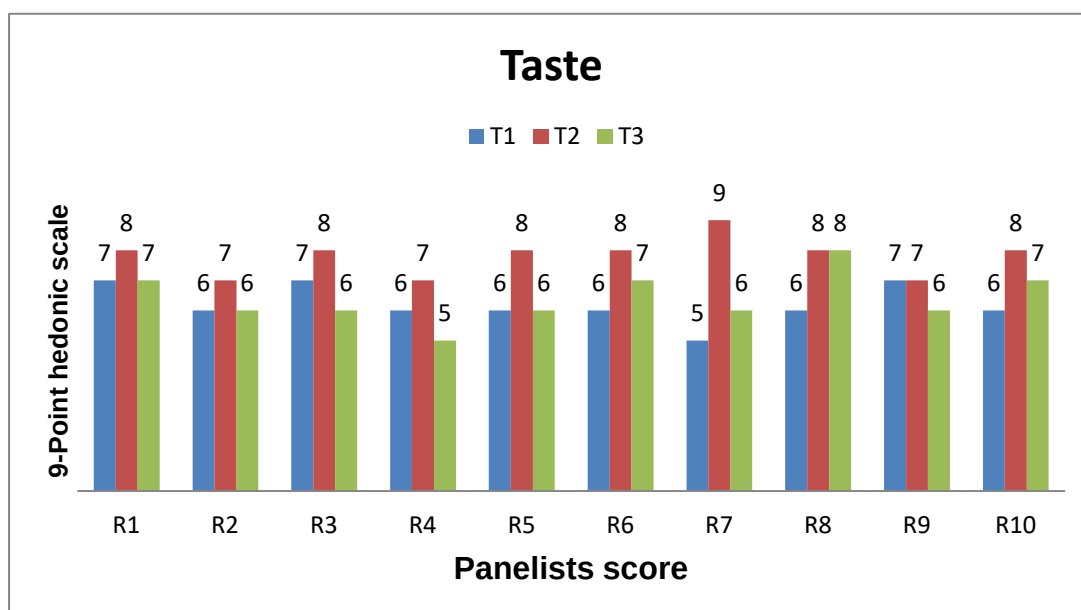


Fig. 4.25 Effect of purslane powder incorporation on sensory score for taste of curry.

4.2.1.4 Sensory score for aroma of curry:-

The result pertaining to the score for aroma of curry as affected by the different combination of purslane powder is presented in Table 4.14 and depicted in Figure 4.26. The analysis of variance is given in Appendix-XI

Table 4.14 Effect of purslane powder incorporation on sensory score for aroma of curry.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	6	8	6	5	6	6.3
T2	8	7	8	7	8	7	6	7	8	8	7.4
T3	7	6	6	7	6	6	7	6	8	7	6.6
CV%	10.97833										
S.Em	0.234915										
CD 5%	0.680593										

An examination of Table 4.14 reveals that the significantly maximum score for aroma (7.4) was recorded in T₂, where the minimum score (6.3) for aroma was recorded in T₁. Score for aroma of curry was significantly affected by percentage of purslane powder incorporated in curry.

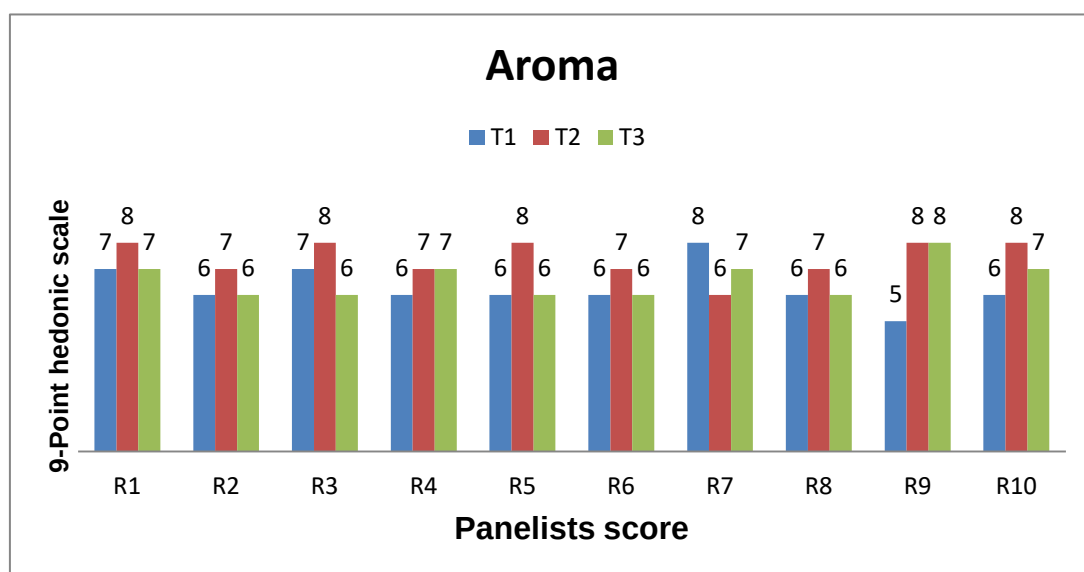


Fig. 4.26 Effect of purslane powder incorporation on sensory score for aroma of curry.

4.2.1.5 Sensory score for over all acceptability of curry:-

The result pertaining to the score for over all acceptability of curry as affected by the different combination of purslane powder is presented in Table 4.15 and depicted in Figure 4.27. The analysis of variance is given in Appendix-XII

Table 4.15 Effect of purslane powder incorporation on sensory score for over all acceptability of curry.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	6	7	7	6	7	6.5
T2	8	7	8	7	8	7	8	7	8	8	7.6
T3	7	7	6	5	6	6	8	6	6	5	6.2
CV%	10.05538										
S.Em	0.215166										
CD 5%	0.623375										

An examination of Table 4.15 reveals that the significantly maximum score for over all acceptability (7.6) was recorded in T₂, where the minimum score (6.2) for over all acceptability was recorded in T₃. Score for over all acceptability of curry was significantly affected by percentage of purslane powder incorporated in curry.

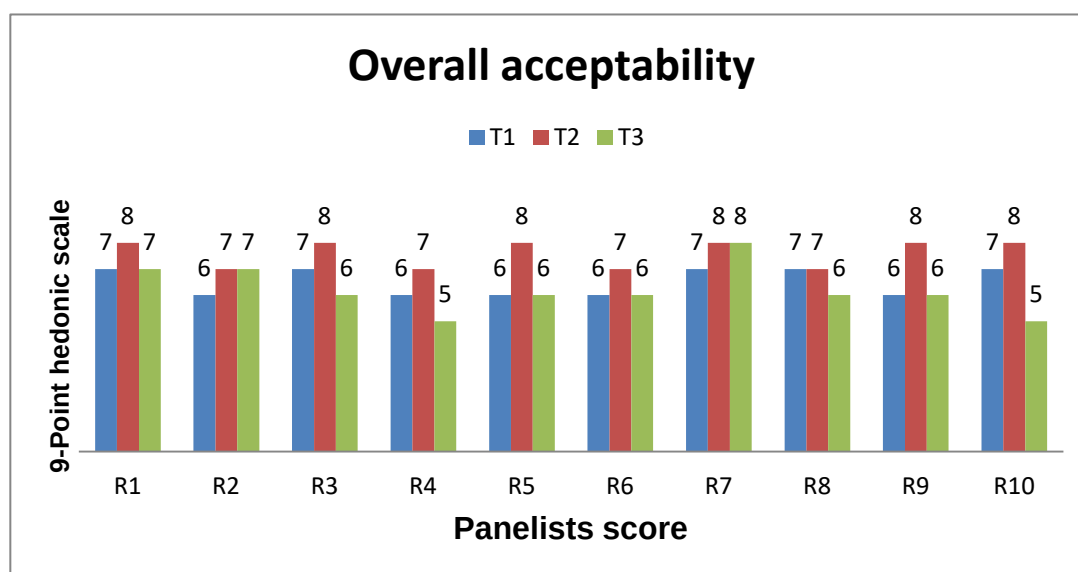


Fig. 4.27 Effect of purslane powder incorporation on sensory score for over all acceptability of curry.

4.2.2 Organoleptic evaluation of Indian bread prepared with purslane powder incorporation.

4.2.2.1 Sensory score for appearance of Indian bread:-

The result pertaining to the score for appearance of Indian bread as affected by the different combination of purslane powder is presented in Table 4.16 and depicted in Figure 4.28. The analysis of variance is given in Appendix-XIII

Table 4.16 Effect of purslane powder incorporation on sensory score for appearance of Indian bread.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	7	7	6	7	8	6.7
T2	8	7	8	7	6	8	8	7	7	8	7.4
T3	7	7	9	8	8	7	8	9	8	7	7.8
CV%	9.899307										
S.Em	0.228522										
CD 5%	0.66207										

An examination of Table 4.16 reveals that the significantly maximum score for appearance (7.8) was recorded in T₃, where the minimum score (6.7) for appearance was recorded in T₁. Score for appearance of Indian bread was significantly affected by percentage of purslane powder incorporated in Indian bread.

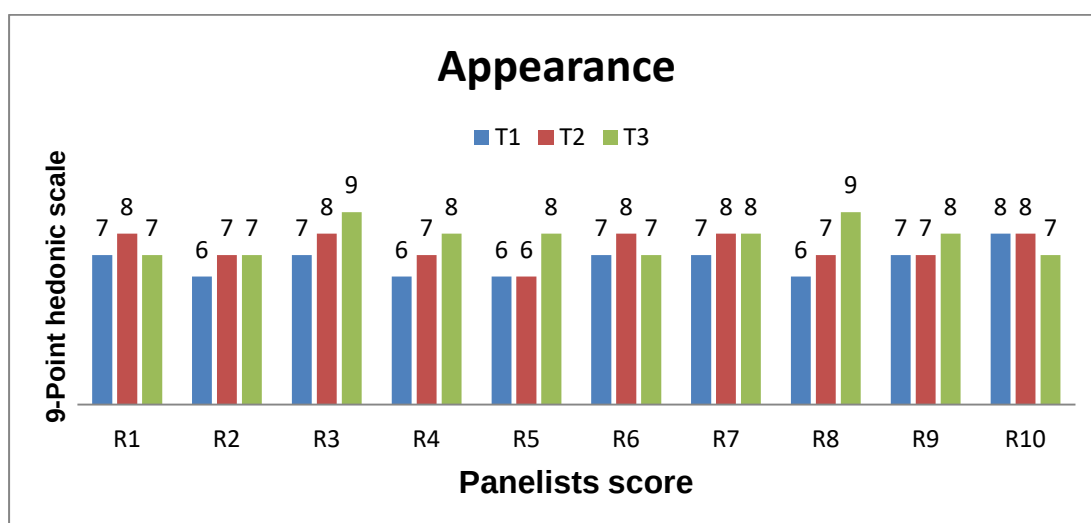


Fig. 4.28 Effect of purslane powder incorporation on sensory score for appearance of Indian bread.

4.2.2.2 Sensory score for color of Indian bread:-

The result pertaining to the score for color of Indian bread as affected by the different combination of purslane powder is presented in Table 4.17 and depicted in Figure 4.29. The analysis of variance is given in Appendix-XIV

Table 4.17 Effect of purslane powder incorporation on sensory score for color of Indian bread.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	7	6	7	7	6	6.5
T2	8	7	8	7	8	8	9	8	8	7	7.8
T3	7	6	6	5	6	6	5	7	6	8	6.2
CV%	10.42427										
S.Em	0.225257										
CD 5%	0.652611										

An examination of Table 4.17 reveals that the significantly maximum score for color (7.8) was recorded in T₂, where the minimum score (6.2) for color was recorded in T₃. Score for color of Indian bread was significantly affected by percentage of purslane powder incorporated in Indian bread.

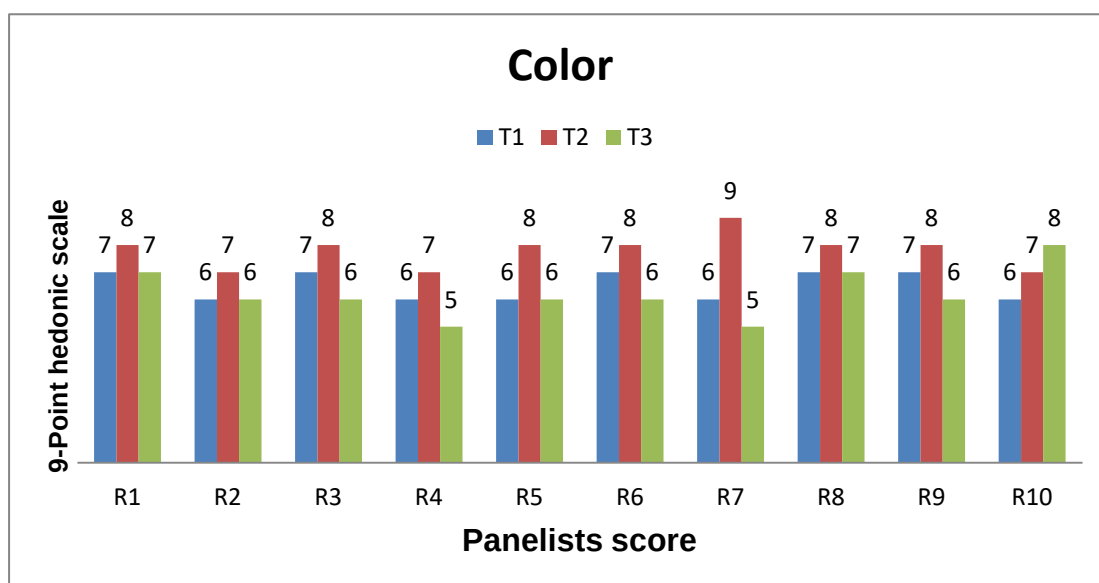


Fig. 4.29 Effect of purslane powder incorporation on sensory score for color of Indian bread.

4.2.2.3 Sensory score for taste of Indian bread:-

The result pertaining to the score for taste of Indian bread as affected by the different combination of purslane powder is presented in Table 4.18 and depicted in Figure 4.30. The analysis of variance is given in Appendix-XV

Table 4.18 Effect of purslane powder incorporation on sensory score for taste of Indian bread.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	7	6	8	7	6	6.6
T2	8	7	6	7	8	8	7	8	9	7	7.5
T3	7	6	6	5	6	6	7	6	6	7	6.2
CV%	10.82997										
S.Em	0.231741										
CD 5%	0.671395										

An examination of Table 4.18 reveals that the significantly maximum score for taste (7.5) was recorded in T₂, where the minimum score (6.2) for taste was recorded in T₃. Score for taste of Indian bread was significantly affected by percentage of purslane powder incorporated in Indian bread.

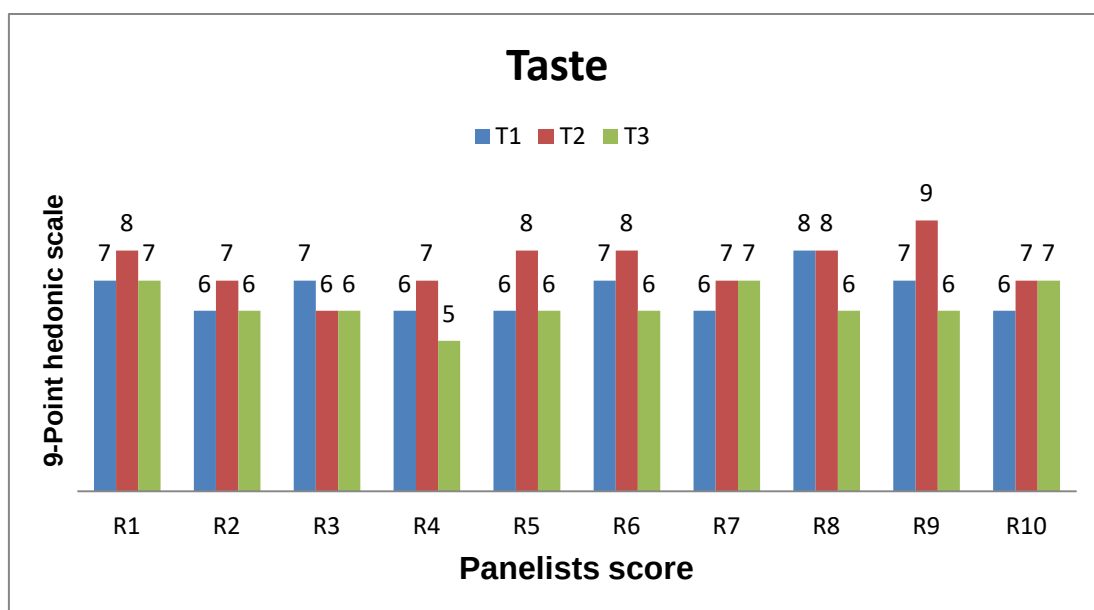


Fig. 4.30 Effect of purslane powder incorporation on sensory score for taste of Indian bread.

4.2.2.4 Sensory score for aroma of Indian bread:-

The result pertaining to the score for aroma of Indian bread as affected by the different combination of purslane powder is presented in Table 4.19 and depicted in Figure 4.31. The analysis of variance is given in Appendix-XVI

Table 4.19 Effect of purslane powder incorporation on sensory score for aroma of Indian bread.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	7	7	6	7	6	6.5
T2	8	7	8	7	6	7	8	7	8	8	7.4
T3	7	6	6	5	6	6	7	5	6	5	5.9
CV%	10.0164813										
S.Em	0.20905431										
CD 5%	0.60566893										

An examination of Table 4.19 reveals that the maximum score for aroma (7.4) was recorded in T₂, where the minimum score (5.9) for aroma was recorded in T₃. Score for aroma of Indian bread was significantly affected by percentage of purslane powder incorporated in Indian bread.

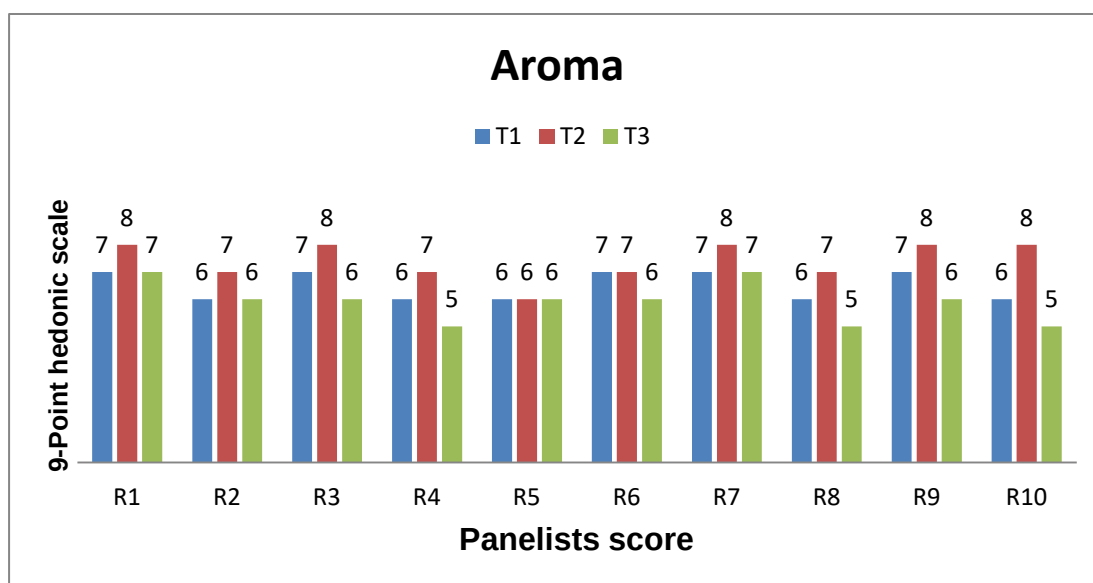


Fig. 4.31 Effect of purslane powder incorporation on sensory score for aroma of Indian bread.

4.2.2.5 Sensory score for over all acceptability of Indian bread:-

The result pertaining to the score for over all acceptability of Indian bread as affected by the different combination of purslane powder is presented in Table 4.20 and depicted in Figure 4.32. The analysis of variance is given in Appendix-XVII

Table 4.20 Effect of purslane powder incorporation on sensory score for over all acceptability of Indian bread.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	6	7	6	6	7	6	7	7	6	6.5
T2	8	7	8	7	9	7	8	9	8	8	7.9
T3	7	6	6	5	6	6	7	6	6	5	6
CV%	9.555681										
S.Em	0.20548										
CD 5%	0.595315										

An examination of Table 4.20 reveals that the significantly maximum score for over all acceptability (7.9) was recorded in T₂, where the minimum score (6.0) for over all acceptability was recorded in T₃. Score for over all acceptability of Indian bread was significantly affected by percentage of purslane powder incorporated in Indian bread.

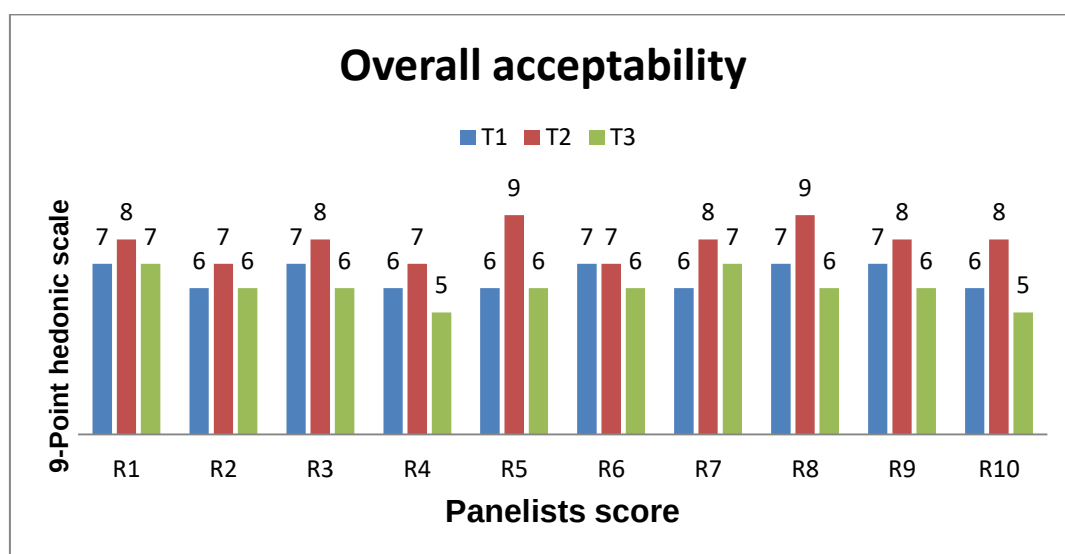


Fig. 4.32 Effect of purslane powder incorporation on sensory score for over all acceptability of Indian bread.

4.2.3 Organoleptic evaluation of tea prepared with purslane powder incorporation.

4.2.3.1 Sensory score for appearance of tea:-

The result pertaining to the score for appearance of tea as affected by the different combination of purslane powder is presented in Table 4.21 and depicted in Figure 4.33. The analysis of variance is given in Appendix-XVIII

Table 4.21 Effect of purslane powder incorporation on sensory score for appearance of tea.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	7	8	9	7	8	8	9	7	8	7	7.8
T2	6	7	6	6	7	6	8	7	5	6	6.4
T3	5	5	6	6	8	7	6	8	5	6	6.2
CV%	13.74881										
S.Em	0.295647										
CD 5%	0.845092										

An examination of Table 4.21 reveals that the maximum score for appearance (7.8) was recorded in T₁, where the minimum score (6.2) for appearance was recorded in T₃. Score for appearance of tea was significantly affected by percentage of purslane powder incorporated in tea.

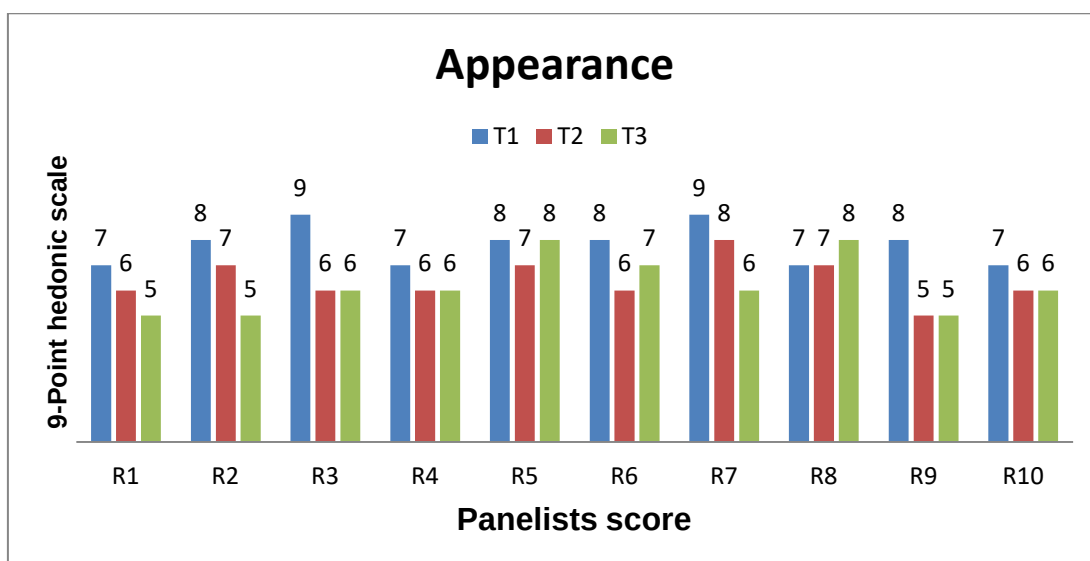


Fig. 4.33 Effect of purslane powder incorporation on sensory score for appearance of tea.

4.2.3.2 Sensory score for color of tea:-

The result pertaining to the score for color of tea as affected by the different combination of purslane powder is presented in Table 4.22 and depicted in Figure 4.34. The analysis of variance is given in Appendix-XIX

Table 4.22 Effect of purslane powder incorporation on sensory score for color of tea.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	6	7	7	5	6	7	8	6	6	7	6.5
T2	8	6	8	8	7	8	8	7	8	8	7.6
T3	7	5	5	6	5	6	6	7	6	5	5.8
CV%	11.78496										
S.Em	0.247207										
CD 5%	0.706626										

An examination of Table 4.22 reveals that the maximum score for color (7.6) was recorded in T₂, where the minimum score (5.8) for color was recorded in T₃. Score for color of tea was significantly affected by percentage of purslane powder incorporated in tea.

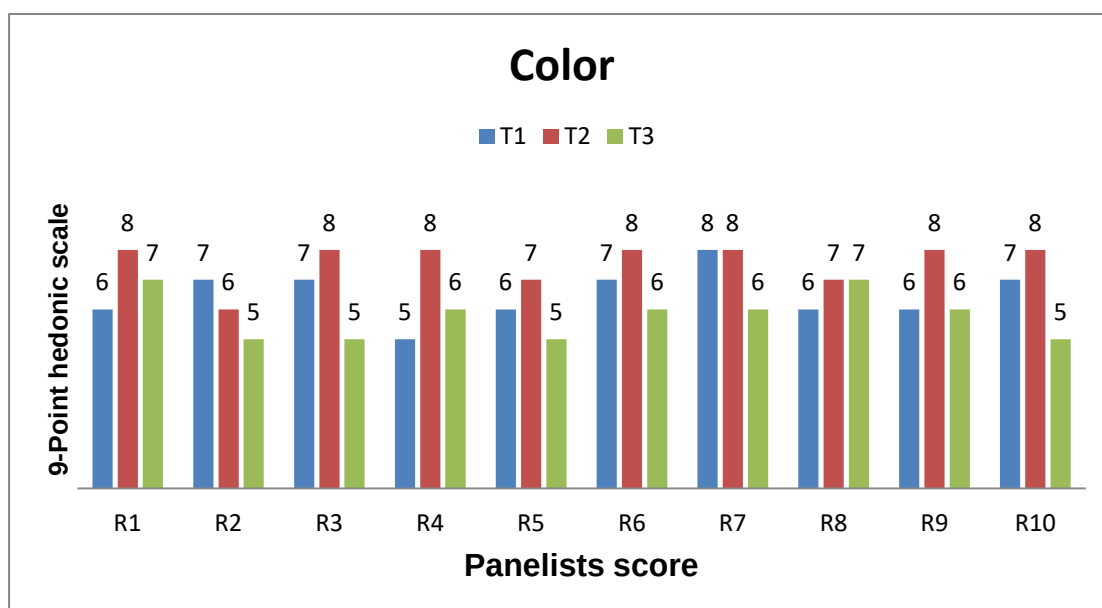


Fig. 4.34 Effect of purslane powder incorporation on sensory score for color of tea.

4.2.3.3 Sensory score for taste of tea:-

The result pertaining to the score for taste of tea as affected by the different combination of purslane powder is presented in Table 4.23 and depicted in Figure 4.35. The analysis of variance is given in Appendix-XX

Table 4.23 Effect of purslane powder incorporation on sensory score for taste of tea.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	8	9	8	8	9	9	8	9	8	8	8.4
T2	6	5	7	6	6	6	7	6	6	7	6.2
T3	5	4	7	3	6	3	5	4	6	6	4.9
CV%	14.16846										
S.Em	0.29123										
CD 5%	0.832464										

An examination of Table 4.23 reveals that the significantly maximum score for taste (8.4) was recorded in T₁, where the minimum score (4.9) for taste was recorded in T₃. Score for taste of tea was significantly affected by percentage of purslane powder incorporated in tea.

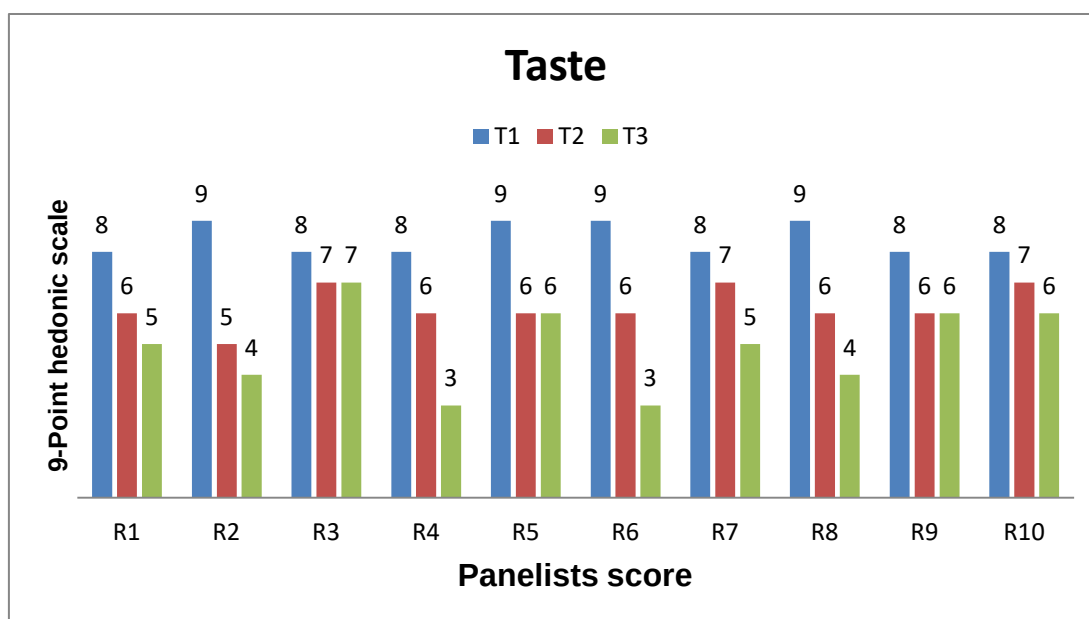


Fig. 4.35 Effect of purslane powder incorporation on sensory score for taste of tea.

4.2.3.4 Sensory score for aroma of tea:-

The result pertaining to the score for aroma of tea as affected by the different combination of purslane powder is presented in Table 4.24 and depicted in Figure 4.36. The analysis of variance is given in Appendix-XXI

Table 4.24 Effect of purslane powder incorporation on sensory score for aroma of tea.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T1	8	7	7	8	7	6	5	8	6	8	7
T2	6	7	6	4	6	5	4	7	5	6	5.6
T3	4	5	3	5	4	5	5	6	8	5	5
CV%	19.79144										
S.Em	0.367171										
CD 5%	1.049539										

An examination of Table 4.24 reveals that the maximum score for aroma (7) was recorded in T₁, where the minimum score (5) for aroma was recorded in T₃. Score for aroma of tea was significantly affected by percentage of purslane powder incorporated in tea.

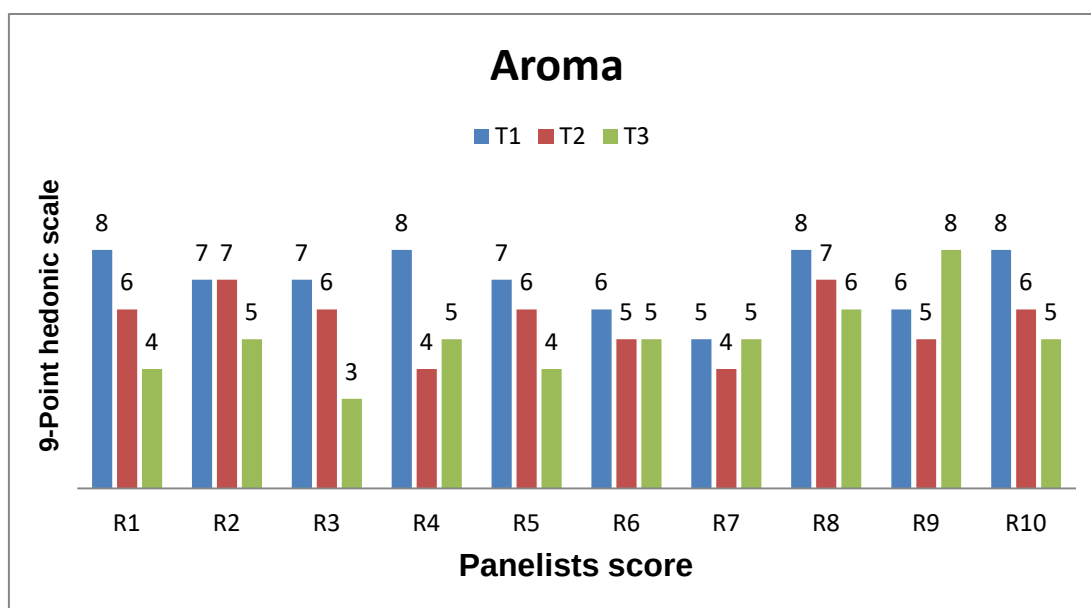


Fig. 4.36 Effect of purslane powder incorporation on sensory score for aroma of tea.

4.2.3.5 Sensory score for over all acceptability of tea:-

The result pertaining to the score for over all acceptability of tea as affected by the different combination of purslane powder is presented in Table 4.25 and depicted in Figure 4.37. The analysis of variance is given in Appendix-XXII

Table 4.25 Effect of purslane powder incorporation on sensory score for over all acceptability of tea.

	Sensory score by panelist										
Treatment	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	mean
T ₁	9	8	8	6	8	7	8	8	9	6	7.7
T ₂	7	5	6	5	5	7	5	6	6	7	5.9
T ₃	5	4	4	5	4	6	4	3	5	6	4.6
CV%	15.46303										
S.Em	0.29502										
CD 5%	0.843299										

An examination of Table 4.25 reveals that the significantly maximum score for over all acceptability (7.7) was recorded in T₁, where the minimum score (4.6) for over all acceptability was recorded in T₃. Score for over all acceptability of tea was significantly affected by percentage of purslane powder incorporated in tea.

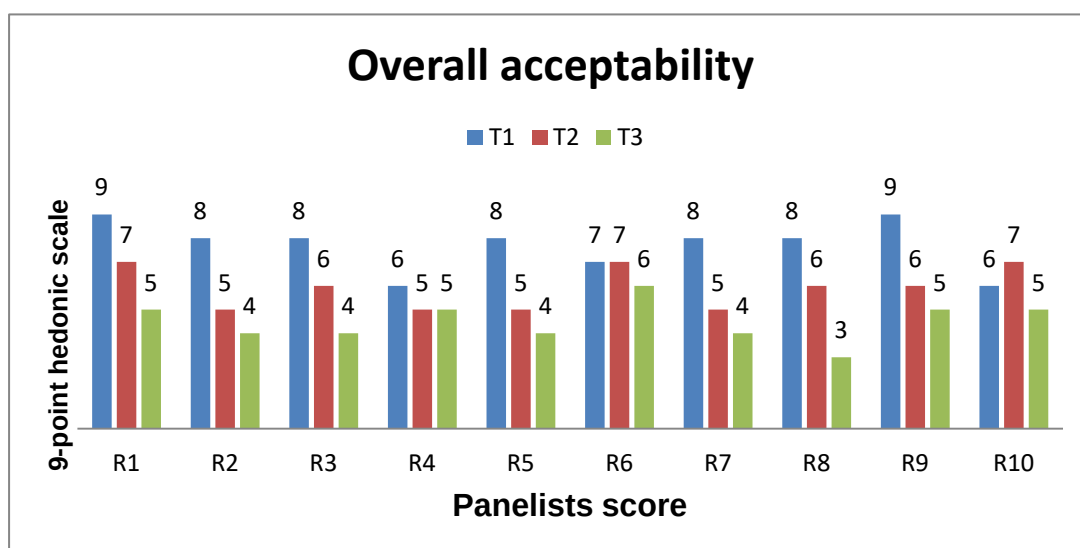


Fig. 4.37 Effect of purslane powder incorporation on sensory score for over all acceptability of tea.

CHAPTER-V

DISCUSSION

In this chapter, an attempt has been made to evaluate the possible reason of the variability obtained due to treatment differences in the present investigation entitled “**Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)**” On the basis of the findings described in the preceding chapters, results have been critically discussed here in the light of literature pertaining to finding of other researchers for different characters.

5.1 Physical and quality parameters of unblanched and blanched (treated and untreated) purslane leaves:-

The physical and quality parameters of samples viz., the leaves weight of sample (100 g), final weight (21 g DW), loss in weight (79 g DW), product recovery (21 %) moisture content (79 %), rehydration ratio (4.3), ascorbic acid (296.68 mg/100 g DW), and oxalic acid (642.37 mg/100 g DW) was recorded for unblanched samples, physical and quality parameters of samples viz., the leaves weight of sample (100 g), final weight (13.86 g DW), loss in weight (86.14 g DW), product recovery (13.86 %) moisture content (86.14 %), rehydration ratio (3.2), ascorbic acid (170.13 mg/100 g DW), and oxalic acid (582.43 mg/100 g DW) was recorded for blanched (without CaCl_2 treatment at 90°C temperature for 15 sec) samples and physical and quality parameters of samples viz., the leaves weight of sample (100 g), final weight (14.36 g DW), loss in weight (85.63 g DW), product recovery (14.36 %) moisture content (85.63 %), rehydration ratio (4.1), ascorbic acid (232.55 mg/100 g DW), and oxalic acid (339.27 mg/100 g DW) was recorded for blanched treated (Treatment with CaCl_2 3 % solution, at 90°C temperature for 15 sec) samples and have been shown in Table 4.1. Patcha *et al.* (2016) reported that the moisture content of purslane leaves ranged from (76 to 81 wet basis), Uddin *et al.* (2014) the oxalate content of purslane leaves was reported as 637–869mg/100 g fresh weight, Sarvanan and Mishra (2018) reported that purslane leave contained ascorbic acid ranges from 271.56 mg/100g to

327.72 mg/100g (DW), Shanker and Debnath (2015) reported that the rehydration ratio of purslane leaves ranges from 3.2 to 4.3. After proper examination of previous literature it is cleared that the similar data were observed in this study.

5.2 Effect of blanching parameters on final weight (g) of purslane leaves:-

Final weight (g) differed significantly with respect to the blanching treatments (time, temperature and CaCl_2) data in Table 4.2. In the present study the final weight of dried purslane leaves was found maximum in T_{18} (15.57 g/100g) and minimum under T_2 (12.91 g/100g). The mean value of final weight was recorded 14.19g. After examined Table 4.2, a clear contradiction was shown between final weight with blanching time and temperature, with the increase of blanching time and temperature final weight was slightly reduced. A correlation was also shown between final weight and CaCl_2 treatment, with increases in CaCl_2 concentration final weight was also increased. The mean value of final weight was recorded 14.19 g. Present investigation was agreed with Kikon and Eliza (2013) the leave treated with low temperature and high CaCl_2 retained the dry weight (6%), Waleed *et al.* (2018) also reported that the high blanching time and high temperature reduces the product recovery percentage.

5.3 Effect of blanching parameters on loss in weight (g) of purslane leaves:-

Data of loss in weight differed with respect to the blanching treatments (time, temperature and CaCl_2) (Table 4.3). In the present study weight loss (g/100g) of purslane leaves was found maximum in T_2 (87.08 g/100g) and the minimum value found in T_{18} (84.42 g/100g). In this study a correlation was shown between weight loss with blanching time and temperature, whereas a clear contradiction was shown between weight loss and CaCl_2 treatment. With increases in blanching time and temperature, weight loss was also increased and with increases in CaCl_2 percentage the weight loss was decreased. The mean value of weight loss was recorded 85.81 g/100g. Similar results were reported by Sarkar *et al.* (2015).

5.4 Effect of blanching parameters on product recovery (%) of purslane leaves:-

Product recovery (%) differed significantly with respect to the blanching treatments (time, temperature and CaCl_2) data in Table 4.4. In the present study the product recovery of dried purslane leaves was found maximum in T_{18} (15.57 %) and minimum under T_2 (12.91 %). The mean value of product recovery was recorded 14.19%. After examined Table 4.4, a clear contradiction was shown between product recovery with blanching time and temperature, with the increase of blanching time and temperature product recovery was slightly reduced. A correlation was also shown between product recovery and CaCl_2 treatment, with increases of CaCl_2 concentration, product recovery was also increased. Present investigation was agreed with Sarkar *et al.* (2015).

5.5 Effect of blanching parameters on moisture content (%) of purslane leaves:-

Data for moisture content (%) differed with respect to the blanching treatments (time, temperature and CaCl_2) (Table 4.5). In the present study moisture content (%) of purslane leaves was found maximum in T_2 (87.08 %) and the minimum value found in T_{18} (84.42 %). In this study a correlation was shown between moisture content with blanching time and temperature, and clear contradiction was shown between moisture content and CaCl_2 treatment. With increases of blanching time and temperature, moisture content was also increased and with increases of CaCl_2 percentage the moisture was decreased. The mean value of moisture content was recorded 85.81 %. Moisture content of all the blanched samples were ranges from 84.42 to 87.08%. The present investigation was similarly agreed with Sarvanan and Mishra (2018) that reported moisture content of purslane leaves ranges from 81% to 88%.

5.6 Effect of blanching parameters on rehydration ratio of purslane:-

Rehydration ratio differed significantly with respect to the blanching treatments (time, temperature and CaCl_2) data in Table 4.6. In the present study the rehydration ratio of dried purslane leaves was found maximum in T_1 (4.1) and minimum under T_2 and T_9 (3.1). The mean value of rehydration ratio

was recorded 3.52. After examined Table 4.6, a clear correlation was shown between rehydration ratio with blanching time, temperature and CaCl_2 concentration with the increase of blanching time, temperature and CaCl_2 % rehydration ratio was also slightly increased. Present investigation agreed with Shanker and Debnath (2015) they reported that the rehydration ratio of purslane leaves ranges from 3.2 to 4.3.

5.7 Effect of blanching parameters on ascorbic acid (Vitamin-C) content (mg/100g DW) of purslane leaves:-

Data in vitamin-C content differed significantly with respect to the blanching treatments (time, temperature and CaCl_2) (Table 4.7). In the present study, the maximum ascorbic acid was recorded in T_1 (232.55 mg/100g DW), and the minimum ascorbic acid was recorded in T_{15} (170 mg/100g DW). The mean value of ascorbic acid was found (199.96 mg/100g). In the present investigation a contradiction was shown between ascorbic acid retention with blanching time and temperature, with the increases of blanching time and temperature, the ascorbic acid retention capacity was decreases and with reduction in blanching time, temperature the ascorbic acid retention was increased, whereas a correlation between $\text{CaCl}_2\%$ and ascorbic acid was shown, as increases in CaCl_2 % the ascorbic acid retention was also increased, and with decreasing the $\text{CaCl}_2\%$ the ascorbic acid retention capacity was also decreased. Similar value for ascorbic acid content (from 197 to 249mg/100g) was reported by Negi and Roy (2000), Acho *et al.* (2015) also reported that the blanching effect on losses of ascorbic acid in purslane leaves was ranges from 4.75 – 73.21 %.

5.5 Effect of blanching parameters on oxalic acid content (mg/100g DW) of purslane leaves:-

Data in oxalic acid content differed significantly with respect to the blanching treatments (time, temperature and CaCl_2 %) (Table 4.8). In the present study, the maximum oxalic acid was recorded in T_{15} (582.43 mg/100g DW), and the minimum oxalic acid was recorded in T_1 (339.27 mg/100g DW). The mean value of oxalic acid was reported (478.08 mg/100g). In the present investigation a correlation was found between oxalic acid reduction with blanching time, temperature and % of CaCl_2 , with the increases of blanching

time, temperature and CaCl_2 %, oxalic acid reduction was also increased, but in interception of treatment the maximum reduction was found in CaCl_2 treatment, with increases in CaCl_2 % oxalic acid content reduction found more in relation to other treatments, whereas the blanching temperature treatment reduces more oxalate than blanching time. Maximum reduction of oxalic acid was found 47 % in T_1 , and result agreed with Weiwen and Michael (2005) that reported the blanching reduce the oxalate content of purslane by 30 to 87%, similar result was also reported by Kikon and Eliza 2013.

5.6 Effect of purslane powder incorporation on sensory score for curry:-

Curry prepared with incorporation of purslane powder at different levels was found to be acceptable by the panelists. Mean score for appearance, color, taste, aroma and overall acceptability ranged from 6 to 7.5, 6 to 7.3, 6.2 to 7.8, 6.3 to 7.4 and 6.2 to 7.6 respectively (Table 4.23 to 4.27). However, the score for appearance, color, taste, aroma and overall acceptability was found significantly maximum in T_2 (curry incorporated with 10 % purslane powder). Mean score indicates that curry prepared with different level of purslane powder incorporation were in the category “liked moderately” to “liked very much”. Similar results were reported by Sawai and Singh (2014), Debnath and Verma (2014) also reported that the curry prepared with 10 % purslane powder incorporation was most acceptable.

5.7 Effect of purslane powder incorporation on sensory score for Indian bread:-

Indian bread prepared with incorporation of purslane powder at different levels was found to be acceptable by the panelists. Mean score for appearance, color, taste, aroma and overall acceptability ranged from 6.7 to 7.8, 6.2 to 7.8, 6.2 to 7.5, 5.9 to 7.4 and 6 to 7.9 respectively (Table 4.28 to 4.32). However, the score found for appearance was found maximum in T_3 (bread incorporated with 12 % purslane powder). The score for color, taste, aroma and overall acceptability was found maximum in T_2 (Indian bread incorporated with 8 % purslane powder). Present investigation found that all the samples were acceptable but the most acceptable sample was T_2 (Indian bread incorporated with 8 % purslane powder). Mean score indicates that Indian bread prepared with different level of purslane powder incorporation

were in the “liked moderately” to “liked very much” category. Similar results were reported by Delvarianzadeh *et al.* (2020), Sawai and Singh (2014) also reported that the Indian bread prepared with 10 % purslane powder incorporation was most acceptable.

5.6 Effect of purslane powder incorporation on sensory score for tea:-

Tea prepared with incorporation of purslane powder at 0.5% and 1% was found to be acceptable by the panelists. Mean score for appearance, color, taste, aroma and overall acceptability ranged from 6.2 to 7.8, 5.8 to 7.6, 4.9 to 8.4, 5 to 7 and 4.4 to 7.7 respectively (Table 4.33 to 4.37). However, the score obtained for color was slightly high in T₂ (Tea incorporated with 1 % purslane powder). The score for appearance, taste, aroma and overall acceptability was found maximum in T₁ (tea incorporated with 0.5 % purslane powder). Mean score indicates that tea prepared with 0.5 % level of purslane powder incorporation (T₁) was in the “moderately liked” category, whereas both treatments (T₂ and T₃) were in the “not liked or nor dislike” to “disliked slightly” categories. Similar results were reported by Minh *et al.* (2019) the study showed that the tea prepared with purslane powder had much nutritive value but the sensory score was not much acceptable.

CHAPTER – VI

SUMMARY, CONCLUSIONS AND SUGGETIONS FOR FURTHER WORK

6.1 Summary

The present investigation entitled “**Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)**” was carried out in the year 2020-21 at Fruit Research Station, Entkhedi of Department of Horticulture, Collage of Agriculture, Sehore (M.P.).

The main objectives of the existing study were:

- (i) To study the effect of CaCl_2 , blanching time, Blanching temperature on quality attributes of Purslane.
- (ii) To optimize the blanching parameters.
- (iii) To study the organoleptic properties of developed product incorporated with Purslane Powder at different composition.

To optimize the blanching parameters, there were twenty treatments conducted at different parameters. Treatments were designed with response surface methodology with the help of design expert software. The experimental material for the organoleptic properties of developed products comprise of three treatments. These treatments were in Completely Randomized Design with ten replications to observe sensory evaluation of products on the basis of results; the present investigation is summarized as follows:

The results obtained from the investigation were summarized in this part:

- ❖ Final weight (g/100g) of blanched purslane was recorded maximum in T_{18} (Sample treated with 1.5% CaCl_2 at 90°C temp for 6.6 sec) i.e.15.57 g, and the minimum final weight (g/100g) was found in T_2 (Sample treated with 0.6% CaCl_2 at 95°C temp for 20 sec) i.e. 12.91 g.
- ❖ Loss in weight (g/100g) of blanched purslane was recorded maximum in T_2 (Sample treated with 0.6% CaCl_2 at 95°C temp for 20 sec) i.e.87.08 g, and the minimum loss in weight (g/100g) was found in T_{18} (Sample treated with 1.5% CaCl_2 at 90°C temp for 6.6 sec) i.e. 84.42 g.

- ❖ Product recovery (%) of blanched purslane was recorded maximum in T_{18} (Sample treated with 1.5% CaCl_2 at 90°C temp for 6.6 sec) i.e.15.57%, and the minimum product recovery (%) was found in T_2 (Sample treated with 0.6% CaCl_2 at 95°C temp for 20 sec) i.e. 12.91%.
- ❖ Moisture content (%) of blanched purslane was recorded maximum in T_2 (Sample treated with 0.6% CaCl_2 at 95°C temp for 20 sec) i.e.87.08%, and the minimum moisture content (%) was found in T_{18} (Sample treated with 1.5% CaCl_2 at 90°C temp for 6.6 sec) i.e. 84.42%.
- ❖ Rehydration ratio of blanched purslane was recorded maximum in T_1 (Sample treated with 3% CaCl_2 at 90°C temp for 15 sec) i.e.4.1, and the minimum rehydration ratio was found in T_2 and T_9 (Sample treated with 0.6% CaCl_2 at 95°C temp for 20 sec and with 0.6% CaCl_2 at 95°C temp for 10 sec) i.e. 3.1.
- ❖ Ascorbic acid (mg/100g DW) of blanched purslane was recorded maximum in T_1 (Sample treated with 3% CaCl_2 at 90°C temp for 15 sec) i.e. 232.55 mg, and the minimum ascorbic acid (mg/100g DW) was found in T_{15} (Sample treated with 0% CaCl_2 at 90°C temp for 15 sec) i.e. 170.13 mg.
- ❖ Ascorbic acid (mg/100g DW) of blanched purslane was recorded minimum in T_1 (Sample treated with 3% CaCl_2 at 90°C temp for 15 sec) i.e. 339.27 mg, and the maximum ascorbic acid (mg/100g DW) was found in T_{15} (Sample treated with 0% CaCl_2 at 90°C temp for 15 sec) i.e. 582.43 mg.
- ❖ Curry prepared with incorporation of purslane powder at different levels was found to be acceptable for all the three treatments, but the most acceptable scores were found in T_2 (curry incorporated with 10 % purslane powder). Sensory scores for curry incorporated with 10 % purslane powder (T_2) were recorded in the category of “liked very much”.
- ❖ Indian bread prepared with incorporation of purslane powder at different levels was found to be acceptable for all the three treatments, but the most acceptable scores were found in T_2 (Indian bread incorporated with 8 % purslane powder). Sensory scores for Indian

bread incorporated with 8 % purslane powder (T_2) were recorded in the category of “liked very much”.

- ❖ Tea prepared with incorporation of 0.5% purslane powder(T_1) and 1% purslane powder (T_2) were found to be acceptable, but the most acceptable scores were found in T_1 (Tea incorporated with 0.5 % purslane powder) and sensory scores for T_1 were recorded in the category of “liked very much”.

6.2 Conclusion:

It can be concluded from the study blanching of purslane leaves with high CaCl_2 concentration, at low temperature for less time is better for the quality parameters compared to high temperature, more time and less CaCl_2 concentration, because high concentration of CaCl_2 retained ascorbic acid and reduces the oxalate content from the purslane leaves. In addition less time and low temperature not affect the ascorbic acid content of leaves. From the results obtained from sensory evaluation of products, it can be concluded that the purslane powder incorporated in Curry, Indian bread and Tea should be ranges from 8 to 12 %, 6 to 8 % and 0.4 to 0.6 % for obtaining better sensory score.

6.3 Suggestion for further work:

1. Other drying techniques and the comparison of their effect on quality of purslane powder should be included in further experiment.
2. Along with the quality parameters, microbiological testing can be included to know the blanching effect on microbiological activity.
3. More quality parameters can be included along with ascorbic acid estimation in further investigations.
4. Other products like baked food and snacks product will be investigated in further experiments.

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APPENDICES

Appendices ANOVA table for the all parameters studied.

**Appendix-I
ANOVA for final weight (g)**

Sources	Sum of Squares	DF	Mean Squares	F-value	P-value	
Model	9.02	3	3.01	62.62	< 0.001	significant
A-Blanching time	4.88	1	4.88	101.55	< 0.001	
B-Blanching temperature	3.88	1	3.88	80.81	< 0.001	
C-Calcium Chloride concentration	0.26	1	0.2632	5.48	0.0325	
Residual	0.76	16	0.048			
Lack of Fit	0.39	11	0.036	0.4829	0.8539	not significant
Pure Error	0.37	5	0.0745			
Cor Total	9.79	19				

**Appendix-II
ANOVA for loss in weight (g)**

Source	Sum of Squares	Df	Mean Square	F-value	p-value	
Model	9.02	3	3.01	62.62	< 0.0001	significant
A-Blanching time	4.88	1	4.88	101.55	< 0.0001	
B-Blanching temperature	3.88	1	3.88	80.81	< 0.0001	
C-Calcium Chloride concentration	0.2632	1	0.2632	5.48	0.0325	
Residual	0.7683	16	0.0480			
Lack of Fit	0.3958	11	0.0360	0.4829	0.8539	not significant
Pure Error	0.3725	5	0.0745			
Cor Total	9.79	19				

Appendix-III

ANOVA for product recovery (%)

Sources	Sum of Squares	DF	Mean Squares	F-value	P-value	
Model	9.02	3	3.01	62.62	< 0.001	significant
A-Blanching time	4.88	1	4.88	101.55	< 0.001	
B-Blanching temperature	3.88	1	3.88	80.81	< 0.001	
C-Calcium Chloride concentration	0.2632	1	0.2632	5.48	0.0325	
Residual	0.7683	16	0.048			
Lack of Fit	0.3958	11	0.036	0.4829	0.8539	not significant
Pure Error	0.3725	5	0.0745			
Cor Total	9.79	19				

Appendix-IV

ANOVA for moisture content (%)

Source	Sum of Squares	Df	Mean Square	F-value	p-value	
Model	9.02	3	3.01	62.62	< 0.0001	significant
A-Blanching time	4.88	1	4.88	101.55	< 0.0001	
B-Blanching temperature	3.88	1	3.88	80.81	< 0.0001	
C-Calcium Chloride concentration	0.2632	1	0.2632	5.48	0.0325	
Residual	0.7683	16	0.0480			
Lack of Fit	0.3958	11	0.0360	0.4829	0.8539	not significant
Pure Error	0.3725	5	0.0745			
Cor Total	9.79	19				

Appendix-V
ANOVA for rehydration ratio

Source	Sum of Squares	Df	Mean Square	F-value	p-value	
Model	1.04	3	0.3456	8.88	0.0011	significant
A-Blanching time	0.0032	1	0.0032	0.0830	0.7769	
B-Blanching temperature	0.0399	1	0.0399	1.03	0.3263	
C-Calcium Chloride concentration	0.9936	1	0.9936	25.52	0.0001	
Residual	0.6229	16	0.0389			
Lack of Fit	0.5146	11	0.0468	2.16	0.2041	not significant
Pure Error	0.1083	5	0.0217			
Cor Total	1.66	19				

Appendix-VI
ANOVA for ascorbic acid content (mg/100 g DW)

Source	Sum of Squares	DF	Mean Square	F-value	p-value	
Model	5546.61	3	1848.87	166.65	< 0.0001	significant
A-Blanching time	421.34	1	421.34	37.98	< 0.0001	
B-Blanching temperature	343.65	1	343.65	30.97	< 0.0001	
C-Calcium Chloride concentration	4781.63	1	4781.63	430.99	< 0.0001	
Residual	177.51	16	11.09			
Lack of Fit	150.93	11	13.72	2.58	0.1527	not significant
Pure Error	26.58	5	5.32			
Cor Total	5724.13	19				

Appendix-VII

ANOVA for oxalic acid content (mg/100 g DW)

Source	Sum of Squares	DF	Mean Square	F-value	p-value	
Model	91019.64	9	10113.29	33025.44	< 0.0001	significant
A-Blanching time	3427.01	1	3427.01	11191.07	< 0.0001	
B-Blanching temperature	9868.18	1	9868.18	32225.01	< 0.0001	
C-Calcium Chloride concentration	72597.76	1	72597.76	2.371E+05	< 0.0001	
Residual	3.06	10	0.3062			
Lack of Fit	1.15	5	0.2294	0.5990	0.7062	not significant
Pure Error	1.92	5	0.3830			
Cor Total	91022.70	19				

Appendix-VIII

ANOVA for appearance score of curry

source	DF	SS	MS	F	result
treat	2	11.2667	5.63333	9.16265	sig
error	27	16.6	0.61481		
total	14	27.8667			

Appendix-IX

ANOVA for color score of curry

source	DF	SS	MS	F	result
treat	2	9.266667	4.633333	10.2541	sig
error	27	12.2	0.451852		
total	14	21.46667			

Appendix-X
ANOVA for taste score of curry

source	DF	SS	MS	F	result
treat	2	15.2	7.6	15.08824	sig
error	27	13.6	0.503704		
total	14	28.8			

Appendix-XI
ANOVA for aroma score of curry

source	DF	SS	MS	F	result
treat	2	6.466667	3.233333	5.85906	sig
error	27	14.9	0.551852		
total	14	21.36667			

Appendix-XII
ANOVA for overall acceptability score of curry

source	DF	SS	MS	F	result
treat	2	10.86667	5.433333	11.736	sig
error	27	12.5	0.462963		
total	14	23.36667			

Appendix-XIII
ANOVA for appearance score of Indian bread

source	DF	SS	MS	F	result
treat	2	6.2	3.1	5.93617	sig
error	27	14.1	0.522222		
total	14	20.3			

Appendix-XIV

ANOVA for color score of Indian bread

source	DF	SS	MS	F	result
treat	2	14.46667	7.233333	14.25547	sig
error	27	13.7	0.507407		
total	14	28.16667			

Appendix-XV

ANOVA for taste score of Indian bread

source	DF	SS	MS	F	result
treat	2	8.866667	4.433333	8.255172	sig
error	27	14.5	0.537037		
total	14	23.36667			

Appendix-XVI

ANOVA for aroma score of Indian bread

source	DF	SS	MS	F	result
treat	2	11.4	5.7	13.04237	sig
error	27	11.8	0.437037		
total	14	23.2			

Appendix-XVII

ANOVA for overall acceptability score of Indian bread

source	DF	SS	MS	F	result
treat	2	19.4	9.7	22.97368	sig
error	27	11.4	0.422222		
total	14	30.8			

Appendix-XVIII

ANOVA for appearance score of tea

source	DF	SS	MS	F	result
treat	2	15.2	7.6	8.694915	sig
error	27	23.6	0.874074		
total	14	38.8			

Appendix-XIX

ANOVA for color score of tea

source	DF	SS	MS	F	result
treat	2	16.46667	8.233333	13.47273	sig
error	27	16.5	0.611111		
total	14	32.96667			

Appendix-XX

ANOVA for taste score of tea

source	DF	SS	MS	F	result
treat	2	62.6	31.3	36.90393	sig
error	27	22.9	0.848148		
total	14	85.5			

Appendix-XXI

ANOVA for aroma score of tea

source	DF	SS	MS	F	result
treat	2	21.06667	10.53333	7.813187	sig
error	27	36.4	1.348148		
total	14	57.46667			

Appendix-XXII

ANOVA for overall acceptability score of tea

source	DF	SS	MS	F	result
treat	2	51.46667	25.73333	29.56596	sig
error	27	23.5	0.87037		
total	14	74.96667			

VITA

The author of this manuscript Mr. Rakesh Rajput S/o Shri Anar Singh Rajput born on 12th January 1998 at District. Rajgarh(M.P.) He completed his High School (10th) in 2013 with 72.66 % marks from Gyan Sagar Public High School, Boda and Higher Secondary (12th) in 2015 with 78% marks from Gyan Sagar Higher Secondary School, Boda Rajgarh(MP.).

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After completing graduation he joined department of Horticulture, at RVSKVV R.A.K. College of Agriculture Sehore, Sehore (M.P.) for the post graduation programme. He is submitting his thesis for M.Sc. (Ag) in VEGETABLE SCIENCE Degree for the partial fulfilment of the degree. He has conducted a research problem entitled **“Effect of Blanching parameters on quality attributes of Purslane (*Portulaca oleracea* L.)”** which is duly completed by him and is presented in the form of thesis.