International Journal of Advanced Biochemistry Research 2024; 8(7): 380-385

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(7): 380-385
www.biochemjournal.com
Received: 30-04-2024
Accepted: 10-06-2024

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Thermal blanching strategies for prolonged shelf life and quality of garden peas

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DOI: https://doi.org/10.33545/26174693.2024.v8.i7e.1498

Abstract
This study investigates the impact of hot water blanching on the shelf life and quality of garden peas (*Pisum sativum* L.). Garden peas, significant for their nutritional value and adaptability, have a limited postharvest shelf life, typically lasting only a few days. The research aimed to optimize blanching conditions by evaluating the effects of varying temperatures and durations on physical and biochemical attributes. The results revealed that treatment at 90 °C for 4 minutes (T_5) consistently outperformed other treatments, showing the highest fruit weight retention and minimal size reduction over time. Additionally, T_5 maintained the highest levels of chlorophyll a, chlorophyll b, and ascorbic acid throughout the observation period, demonstrating the efficacy of milder blanching conditions in preserving nutritional quality. Conversely, higher temperatures and longer durations negatively impacted these attributes. These findings underscore the importance of tailored blanching procedures in enhancing the shelf life and nutritional value of garden peas. The study provides valuable insights into optimizing postharvest handling practices, promoting sustainable food preservation, and supporting consumer access to nutrient-rich foods. This research aligns with global efforts towards food security and sustainability, ensuring the continued availability and quality of pulse crops.

Keywords: Garden pea, shelf life, temperature, blanching, hot water

Introduction

Pulses are essential sources of affordable protein in the human diet and play a critical role in enhancing soil health through nitrogen fixation and organic matter addition. Among pulses, peas (*Pisum sativum*) are significant for their nutritional value and adaptability to diverse agro-climatic conditions. They are cultivated extensively in states like Uttar Pradesh, Punjab, Haryana, Rajasthan, Jammu & Kashmir, and Madhya Pradesh, contributing significantly to India's pulse production. Globally, peas rank third among pulse crops and are vital in mixed cropping systems due to their short lifecycle and nutrient contribution (Directorate of Pulses Development, Department of Agriculture and Farmers Welfare, 2016-17). Pea plants, belonging to the genus Pisum, are characterized by herbaceous winter annuals with angular stems, glaucous leaves, and distinctive flowers that range from white to purple. They produce pods containing smooth or wrinkled seeds, consumed both as fresh vegetables and dried pulses rich in protein, carbohydrates, minerals, and vitamins (Directorate of Pulses Development, Department of Agriculture and Farmers Welfare, 2016-17). This versatility makes them suitable for human and livestock diets, as well as for green manure and cover crops. Despite their nutritional benefits and culinary versatility, the shelf life of garden peas is limited, typically lasting only 3-4 days after harvest. Preservation methods such as drying and freezing are crucial to extend their availability beyond the harvest season. Drying, a traditional preservation technique, reduces moisture content in vegetables, minimizing microbial spoilage and chemical reactions while preserving taste, flavor, and color. Similarly, freezing after blanching—a process of scalding vegetables in hot water or steam—helps inactivate enzymes that cause deterioration, thereby preserving quality during storage. Hot water blanching, a critical pre-treatment step in freezing, involves exposing vegetables to hot water for a specific duration. This process not only deactivates enzymes but also reduces microbial load and preserves the sensory attributes of vegetables.

The efficacy of hot water blanching depends significantly on temperature and duration, influencing the final quality of preserved products. This study focuses on investigating the impact of hot water blanching at different temperatures and durations on the shelf-life extension of garden peas. By optimizing blanching parameters, the research aims to identify conditions that maintain the sensory and nutritional qualities of peas while prolonging their shelf life. Insights gained from this study will contribute to enhancing storage practices and consumption of garden peas, benefiting both consumers and the food processing industry. Thus, the primary objective of this research is to "Study the Effect of Hot Water Blanching at Various Temperatures and Times on the Shelf-Life Extension Attributes of Garden Pea (*Pisum sativum*)." Specific objectives include evaluating physico-chemical changes induced by blanching, studying the relationship between blanching temperature and duration, and standardizing optimal blanching procedures for garden peas. In conclusion, this research addresses the critical need for effective preservation methods for garden peas, aiming to extend their availability and maintain their nutritional value and sensory attributes. By advancing knowledge on hot water blanching techniques, the study contributes to sustainable food preservation practices and enhances the utilization of this valuable pulse crop.

Materials and Methods

The study was conducted during the academic year 2023-24 at the Laboratory of the Horticulture Department, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, Department of Horticulture. Fresh vegetable peas were procured from the local market near the city center of Gwalior, Madhya Pradesh, and the experiments were performed at 26.21240° North latitude and 78.17720° East longitude, at an altitude of 478 meters above mean sea level. Only undamaged, mature, and dry pods were manually selected, and peas of average diameter were chosen using required sieves, with information gathered from farmers, local markets, processors, and traders. The experimental design employed was a Completely Randomized Design (CRD) with ten treatments and three replications per treatment, including control (T0) and various hot water blanching treatments at temperatures of 85 °C, 90 °C, and 100 °C for durations of 2, 4, and 6 minutes. Physical parameters such as fruit weight (g), polar and equatorial fruit diameter (cm), and weight loss (%), along with biochemical parameters like moisture content (%), total soluble solids (˚Brix), titratable acidity (%), pH, ascorbic acid content (mg/100g), and chlorophyll content (mg/100g), were measured. Statistical analysis involved ANOVA in a CRD framework, with post-hoc analysis using Duncan's Multiple Range Test (DMRT) for mean comparisons.

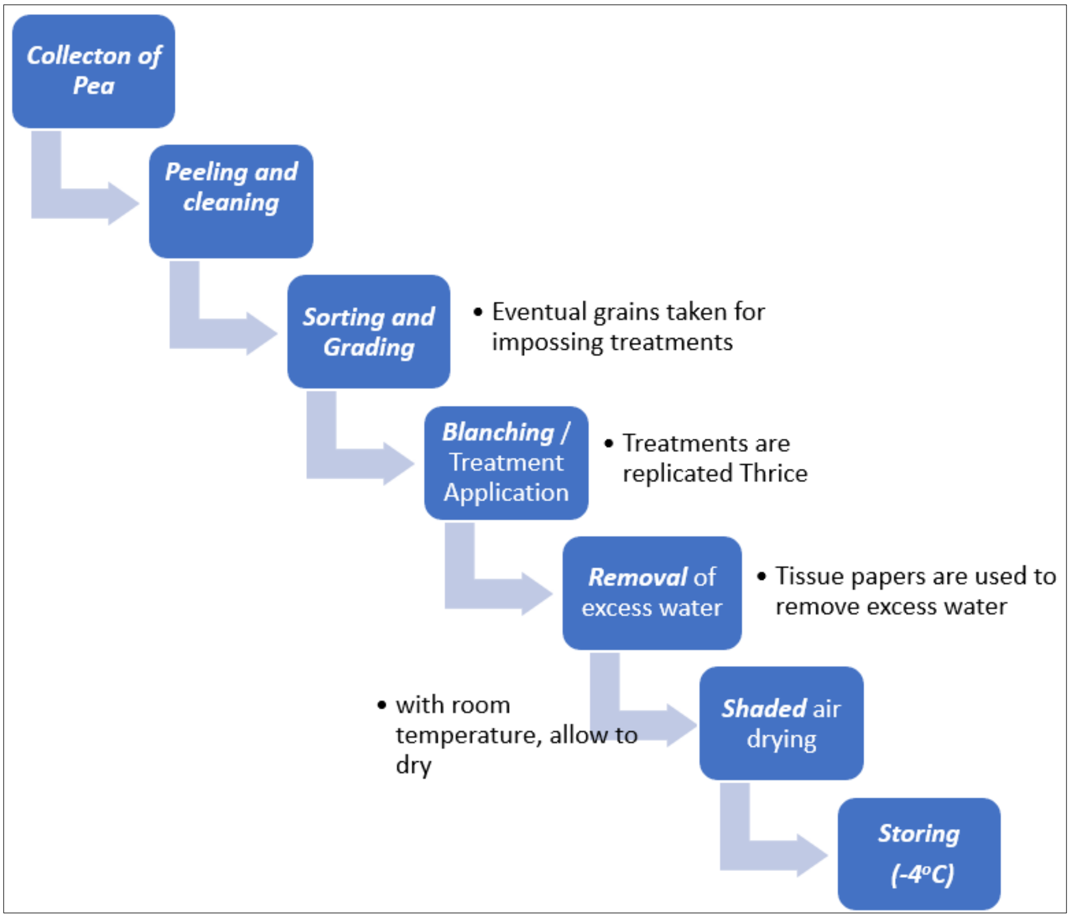

Fig 1: Process diagram undertaken during research

Results and Discussion

Comprehensive Evaluation of the Physical Attributes of Garden Pea

On the 0th day of observation, equal weights of garden pea were taken for different treatments, and observations were subsequently made on the 8th, 16th, 24 and 32 days subsequently. On the 0th day, there was no significant effect observed among the treatments. By the 4th day, the maximum weight retention was observed in the 90 °C for 4 min treatment (T_5) with 0.48 g, followed by 90 °C for 6 min the (T_6) with 0.46 g, and the 100 °C for 6 min (T_7) with 0.45 g. The 90 °C for 4 min treatment (T_5) continued to show the best results on the 8th day with 0.59 g and on the 16th day with 0.57g and on 24th day with 0.51g. Continuing into the eighth day, the 90 °C for 4 minutes treatment (T_5) maintained superior results with 0.59 g, and this trend persisted on the 16th day with 0.57 g and on the 24th day with 0.51 g. The progression of results supports the claim that T_5 showed the best results overall, despite initial competition from T_6 and T_7 on the 4th day. By the 8th day of observation, the pea with 90 °C for 4 min treatment (T_5) exhibited the highest fruit polar diameter value at 0.48 cm. This trend continued with the highest values recorded at 0.56 cm on the 8th day and 0.53 cm on the 16th day and 0.51 cm on the 24th day, indicating the lowest reduction in size over time. Which have followed by T_3, i.e., 85 °C for 6 min. The treatment T_5 (90 °C for 4 min) resulted in the highest fruit polar diameter values over multiple observation days, indicating that this treatment caused the least reduction in size over time compared to other treatments, including T_3 (85 °C for 6 min). Continuing into the eighth day, the 90 °C for 4 minutes treatment (T_5) maintained superior results with 10.61%, and this trend persisted on the 16th day with 13.64% and on the 24th day with 22.73%. However, by the 8th, 16th and 24th day, the peas under the 90 °C for 4 min (T_5) retaining moisture till 32th days and exhibited the highest moisture content of 73.46% at 32th days as well. Conversely, the control treatment (T_0) consistently resulted in the lowest moisture content and highest moisture loss throughout the observation period. The sustained advantage of T_5 in maintaining moisture content throughout the study period affirms the efficacy of the 90 °C for 4 minutes treatment in moisture preservation.

Comprehensive Evaluation of the Bio-chemical Attributes of Garden Pea

On the different treatments and on the different days of observations, it found that all of the treatments are at par and significant differences were observed among the treatments. However, by the 32th day, the highest TSS content was recorded in fruits treated with 90 °C for 4 min (T_5) at 9.61°Brix. However, by the 32th day, the highest TSS content was recorded in fruits treated with 90 °C for 4 min (T_5) at 9.61°Brix. This treatment continued to maintain the highest TSS value on the 8th day, 16th day, and 24th day fruits treated with 90 °C for 4 min (T_5) as 10.57, 10.17, and 9.90° Brix. exhibited the highest TSS value. In contrast, the control treatment (T_0) consistently showed the lowest TSS content throughout the observation period. In the context of titratable acidity, no significant differences were observed among the treatments on the 0th day of observation. However, by the T_5, 90 °C for 4 min is the best treatment among other treatments at 0, 8, 16, 24 and 32 days, (0.192% 0.188% 0.178% 0.172% 0.168%), however the T_0 i.e., control showed the highest titratable acidity content at 0.205%, on the 0th day but in subsequent days, the TA value is drastically decreases to 0.113% in respected 8, 16, 24, 32 days. The result reported that there was no significant difference found in treatments at 0 days after beginning of treatment. The maximum pH of garden pea (7.89) at 32 days was noted in treatment T_5; 90 °C for 4 min, The T_5 is subsequently showing the increasing pH values by 0, 8, 16, 24, 32 days as well. However, the minimum pH (7.32) at 32 and 0, 8, 16, 24 days after treatments impose was recorded in treatment T_0 (control). In the context of ascorbic acid content, significant differences were observed among the treatments on the different day of observation. However, by the 32th day, pea under the 90 °C for 4 min, treatment (T_5) exhibited the highest ascorbic acid content at 21.55 mg/100g. This trend continued, with T590 °C for 4 min, treatment treated peas maintaining the highest ascorbic acid levels on the 8th day (26.50 mg/100g), the 16th day (25.28 mg/100g) and 24th day (24.39 mg/100g) of observation. However, by the 32th day, pea under the 90 °C for 4 min, treatment (T_5) exhibited the highest Chlorophyll a content at 12.09 mg/100g. This trend continued, with T_5, 90 °C for 4 min, treatment treated peas maintaining the highest ascorbic acid levels on the 8th day (14.19 mg/100g), the 16th day (13.76 mg/100g) and 24th day (12.85 mg/100g) of observation. In contrast, the control treatment (T_0) 100 °C for 6 min, consistently showed the lowest Chlorophyll a content throughout the observation period. This pattern continued, with T5-treated peas maintaining the highest levels of ascorbic acid on the 8th day (14.19 mg/100g), 16th day (13.76 mg/100g), and 24th day (12.85 mg/100g) of observation. However, by the 32th day, pea under the 90 °C for 4 min, treatment (T_5) exhibited the highest Chlorophyll b content at 6.98 mg/100g. In the context of Total Chlorophyll content, significant differences were observed among the treatments on the different day of observation. However, by the 32th day, pea under the 90 °C for 4 min, treatment (T_5) exhibited the highest Total Chlorophyll content at 19.98 mg/100g. This trend continued, with T_5, 90 °C for 4 min. In contrast, the control treatment (T_0) 100 °C for 6 min, consistently showed the lowest Total Chlorophyll content throughout the observation period.

Discussion

The progression of results supports the claim that T_5 showed the best results overall, despite initial competition from T_6 and T_7 on the 4th day. This may be due to the blanching effects may be moisture renting on the cell membrane on the outer layer and Material resistant to temperature and transportation vibrations exhibited the highest (Halpin, 1987; Lin and Brewer, 2005) [1, 4]. These findings suggest that T_5 had a beneficial effect on maintaining pea fruit size compared to T_4 under the experimental conditions described. These finding are supported. By the exceeding the days of observation the diameter is reduced, it may be due to the reduction of moisture and shrinkage of the cell wall (Sualeh *et al.* 2016) [3]. The progression of results supports the claim that T_5 showed the best results overall, despite initial competition from T_6 and T_7 on the 4th day. This may be due to the blanching effects may be moisture renting on the cell membrane on the outer layer and material resistant to temperature and transportation vibrations exhibited the highest and the significant results among the treatments are there which indicate the possibilities reason of moisture loss and removal of some nutrients and minerals (Kumar *et al.* 2021; He *et al.* 2022 and Thole *et al.* 2021) [5, 6, 7]. Conversely, the inadequate performance of the control treatment (T_0) highlights the critical role of thermal treatments in preventing moisture loss in peas. It may be due to formation of plasma membrane of grains are translocate the content inside the nucleus which may help to retain the moisture on the grains and other nutrient translocation of the nutrients. The blanching which are responsible for the reduction of enzymatic reduction which will retain the moisture and retain the nutritional quantities inside the grain. Similarly, Shams and Thompson (1987) [8] and

Shepherd and Bhardwaj (1986) [9] found same results. The increase in soluble solids is attributed to processes involving the synthesis or breakdown of polysaccharides as fruits mature. The quality and shelf life appear to correlate with air circulation and fruit firmness. Airflow was crucial in enhancing biochemical parameters across various packaging materials, although the firmness of the material had a detrimental impact on quality indicators. The increase of pH level is may be due to the they undergo biochemical changes that reduce their organic acid content, leading to an increase in pH. During ripening, sugars increase while acids decrease, resulting in a sweeter taste and higher pH (Thole *et al.* (2021) [7]. These conditions help maintain low acidity, and stable concentrations of soluble solids, while also delaying the development of lycopene in the fruit (Wang *et al.* 2024) [11].

Table 1: Effect of hot water blanching on fruit weight of garden pea.

Treatments	0 Days	8 Days	16 Days	24 Days	32 Days
T_0: Control	0.59	0.48	0.43	0.37	0.29
T_1: 85 °C for 2 min	0.61	0.54	0.49	0.42	0.39
T2: 85 °C for 4 min	0.63	0.57	0.52	0.46	0.41
T_3: 85 °C for 6 min	0.65	0.61	0.55	0.49	0.43
T_4: 90 °C for 2 min	0.64	0.58	0.54	0.47	0.44
T_5: 90 °C for 4 min	0.66	0.59	0.57	0.51	0.48
T_6: 90 °C for 6 min	0.66	0.57	0.52	0.49	0.46
T_7: 100 °C for 2 min	0.64	0.59	0.56	0.52	0.43
T_8: 100 °C for 4 min	0.65	0.58	0.51	0.49	0.44
T_9: 100 °C for 6 min	0.68	0.62	0.57	0.53	0.45
CD (at 0.05)	N/A	0.06	0.05	0.06	0.07
S. Em. (±)	0.07	0.02	0.02	0.03	0.03

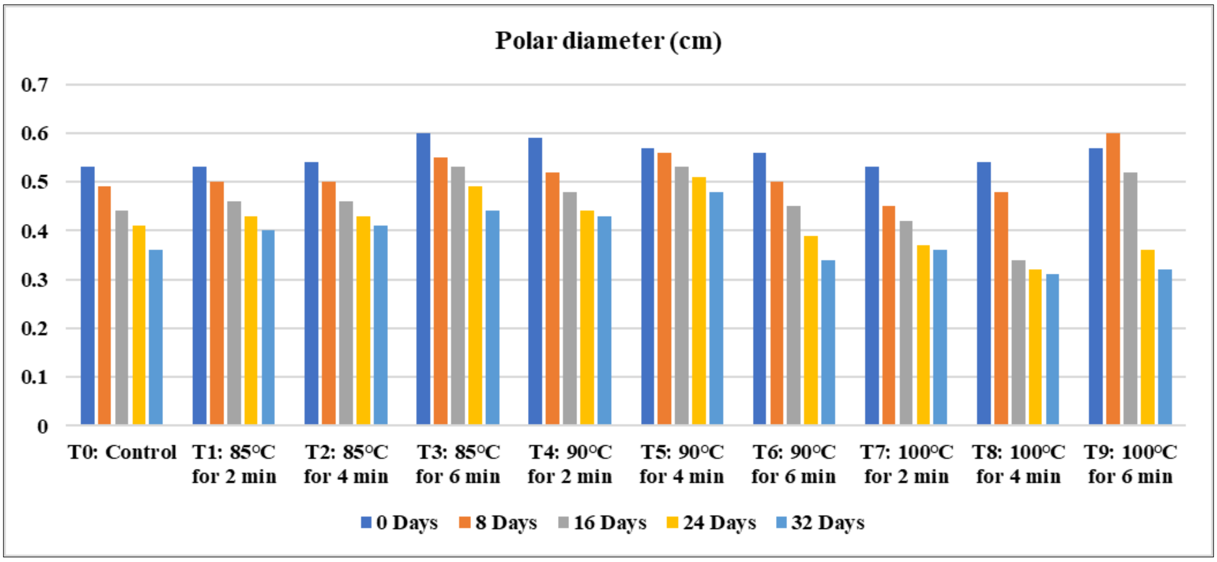

Fig 1: Effect of hot water blanching on polar diameter of garden pea.

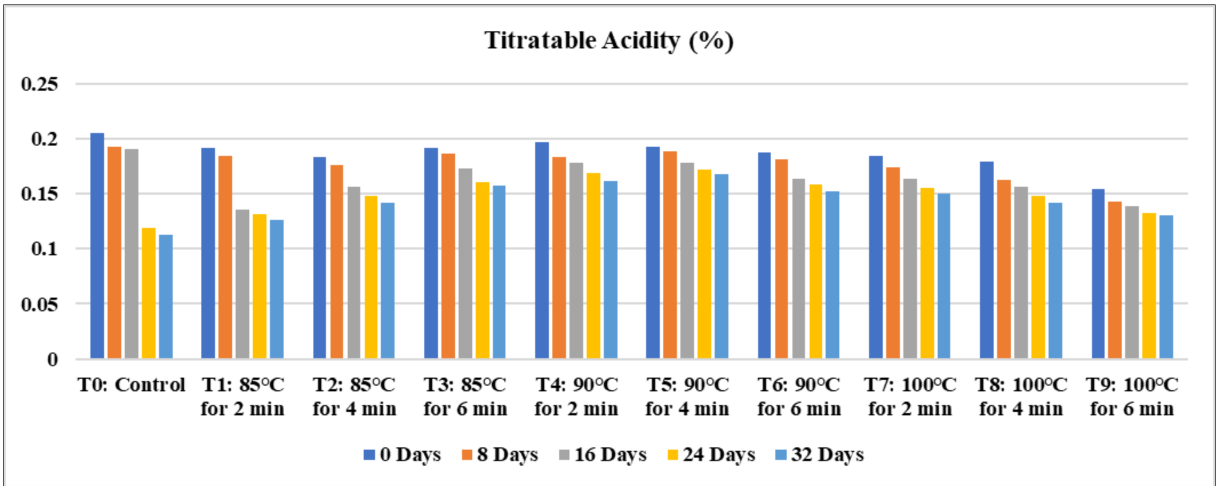

Fig 2: Effect of hot water blanching on Titratable acidity % of garden pea.

Table 2: Effect of hot water blanching on Total soluble solid (º Brix) of garden pea.

Treatments	0 Days	8 Days	16 Days	24 Days	32 Days
T_0: Control	12.35	9.82	9.07	8.82	7.85
T_1: 85 °C for 2 min	10.50	10.38	9.85	9.76	9.35
T2: 85 °C for 4 min	10.45	10.25	9.68	8.90	8.89
T_3: 85 °C for 6 min	10.41	10.21	9.45	9.24	8.59
T_4: 90 °C for 2 min	10.34	10.06	9.28	8.73	8.43
T_5: 90 °C for 4 min	10.83	10.57	10.17	9.90	9.61
T_6: 90 °C for 6 min	10.40	9.88	9.61	8.79	8.49
T_7: 100 °C for 2 min	10.22	9.91	8.84	8.35	8.20
T_8: 100 °C for 4 min	10.29	9.86	9.15	8.88	8.19
T_9: 100 °C for 6 min	10.81	10.00	9.31	8.41	8.16
CD (at 0.05)	0.28	0.12	0.14	0.38	0.20
S. Em. (±)	0.095	0.042	0.048	0.051	0.067

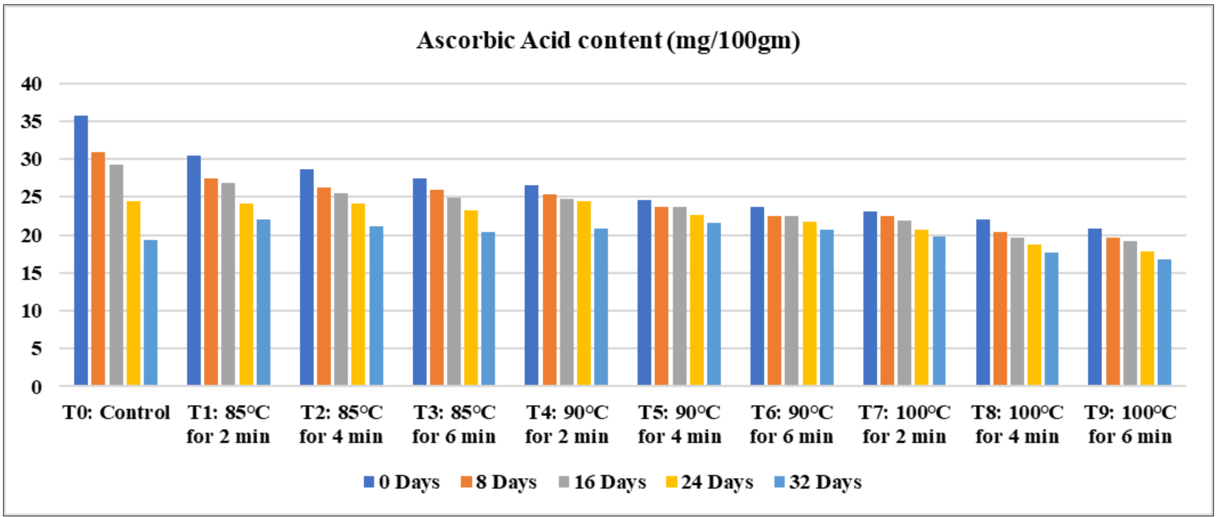

Fig 3: Effect of hot water blanching on Ascorbic Acid content /Vitamin C (mg/100 gm) of garden pea.

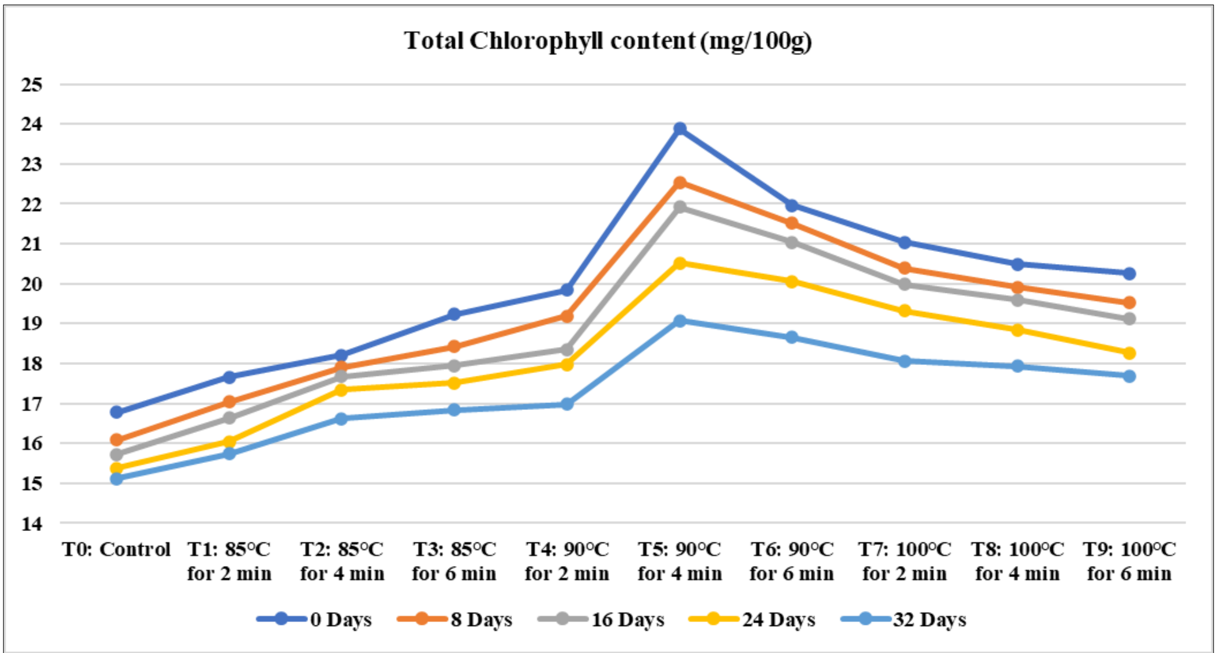

Fig 4: Effect of hot water blanching on Total Chlorophyll content (mg/100 gm) of garden pea.

Conclusion

The study on thermal blanching strategies for garden peas (*Pisum sativum*) highlights the efficacy of hot water blanching in extending shelf life and preserving quality attributes essential for both consumer satisfaction and market viability. The research focused on evaluating the impact of hot water blanching at varying temperatures and durations. Key findings included significant improvements in physical attributes such as fruit weight retention and minimal size reduction over time with optimal blanching conditions (90 °C for 4 minutes, T_5). This treatment consistently outperformed others, demonstrating superior preservation of visual appeal and market quality. Biochemical analyses revealed that milder blanching conditions preserved higher levels of chlorophyll and ascorbic acid compared to more intense treatments, highlighting the critical role of temperature control in maintaining nutritional integrity. These results underscore the importance of tailored blanching procedures in enhancing the shelf life and nutritional value of garden peas, thereby supporting sustainable food preservation practices and promoting consumer access to nutrient-rich foods. Overall, the study contributes valuable insights into enhancing postharvest handling practices for garden peas, aligning with global efforts towards food security and sustainability.

Acknowledgement
We extend our sincere gratitude to everyone who contributed to the successful completion of this research. First and foremost, we thank our institution ITM University, Department of Horticulture for providing the necessary facilities and support. We are deeply indebted to our advisor, Dr. Kunal Adhikary, for their invaluable guidance, insightful feedback, and constant encouragement throughout the research process. We also express our appreciation to our colleagues and fellow researchers for their collaboration and constructive discussions. Special thanks go to the laboratory staff for their technical assistance and support, without which this research would not have been possible.

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