Madras Agric.J.,2025; https://doi.org/10.29321/MAJ.10.9D1235

RESEARCH ARTICLE

Enhancing the Palatability of Fibrous and Overmatured Vegetables Using Papaya as a Tenderizer

Praneetha. S[1], Krishnaveni. T[1], Madhumitha. M[1], Manipriya. S[1], Mei Raghul A.V[1], Methini. P[1] and Ajay Raja. A[1]

[1]Department of Vegetable Science, Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore -641003, India

Received: 30 Jul 2025

Revised: 27 Sep 2025

Accepted: 05 Nov 2025

ABSTRACT

The present study explored the potential of raw matured papaya (*Carica papaya*) as a natural tenderizer to enhance the palatability of over-matured vegetables, which are often discarded due to fibrous texture and low consumer acceptability. Over-matured okra (*Abelmoschus esculentus*), banana pseudostem (*Musa* spp.), French bean (*Phaseolus vulgaris*), ridge gourd (*Luffa acutangula*), and amaranthus (*Amaranthus spp.*) were prepared with and without raw matured papaya, followed by organoleptic evaluation for appearance, texture, flavor, taste, and overall acceptability. Nutrient profiling, conducted at Tamil Nadu Agricultural University, Coimbatore using AOAC standard techniques, revealed that papaya addition significantly improved tenderness, juiciness, and sensory quality across all vegetables. These effects are attributed to papain, a proteolytic enzyme that hydrolyzes complex proteins and partially degrades fibrous tissues, thereby reducing chewiness caused by lignification. The nutritional analysis indicated slight reductions in crude fiber, marginal increases in moisture retention, and stable crude protein levels, suggesting potential improvement in protein digestibility. Sensory ranking placed okra highest in overall acceptability, followed by banana pseudostem, french bean, ridge gourd, and amaranthus. These findings highlight the efficacy of raw matured papaya as a cost-effective, eco-friendly tenderizing agent, offering a sustainable approach to reduce food waste, improve utilization of over-matured produce, and enhance dietary quality.

Keywords: *Papaya tenderization, Overmatured vegetables, Organoleptic evaluation, Palatability improvement, Nutraceutical analysis*

INTRODUCTION

Vegetables are vital to human nutrition, providing essential vitamins, minerals, fiber, and bioactive compounds. However, fibrous vegetables such as okra, beans, banana pseudostem, and certain leafy greens are rich in insoluble fiber and cellulose. They often become tough and unpalatable when overmatured, leading to reduced consumption and significant wastage. According to the Food and Agriculture

*Corresponding author mail: praneetha.s@tnau.ac.in

Organization, approximately 1.3 billion tonnes of food are wasted globally each year, with fibrous plant materials contributing substantially, particularly in developing countries where post-harvest losses and consumer rejection are common (Parfitt *et al.,* 2010).

The fibrous structure of these vegetables primarily consists of lignocellulosic biomass like cellulose, hemicellulose, and lignin, which provides rigidity but resists conventional cooking methods (Waldron *et al.,* 2003). Tenderization, widely used in meat processing, can improve the texture and palatability of vegetables; however, synthetic tenderizers pose health concerns. This has driven interest in natural enzymatic tenderizers.

Papaya (*Carica papaya*) contains the proteolytic enzyme papain, known for its ability to hydrolyse proteins and soften tissues by breaking down cell wall-associated proteins, making it an effective natural tenderizer (Aruoma and Halliwell, 1990; Lee *et al.,* 2007). Utilizing papain offers a safe, natural, and cost-effective approach to improving the texture and utilization of fibrous, overmatured vegetables.

This study aims to standardize the preparation of a dehydrated papaya-based tenderizer, enhance the palatability of fibrous vegetables, and conduct organoleptic evaluations of the treated samples.

MATERIALS AND METHODS

The experiment was conducted in 2025 at the Horticultural College and Research Institute, Tamil Nadu Agricultural University (TNAU), Coimbatore, located at 11° N latitude and 77° E longitude, with an elevation of 426.6 meters above mean sea level (MSL). The primary objective of the study was to evaluate the tenderizing efficacy of raw mature papaya in improving the palatability of fibrous and overmatured vegetables.

To assess the effect of papaya on texture modification, selected fibrous vegetables (Figure 1) were cooked both in the presence and absence of raw mature papaya. The cooked samples were subsequently subjected to organoleptic evaluation to determine differences in sensory attributes. Detailed descriptions of the sample preparation procedures, experimental design, and analytical methodologies adopted in the study are provided in the following sections.

Preparation of Experimental Samples

1) Preparation of Bhendi stir fry

Fresh okra (250 g) was procured from the local market in Coimbatore, sorted for uniform size and quality, thoroughly washed, patted dried to reduce surface moisture and sliminess, and then stored under refrigeration (4–5°C) for 3–4 days before

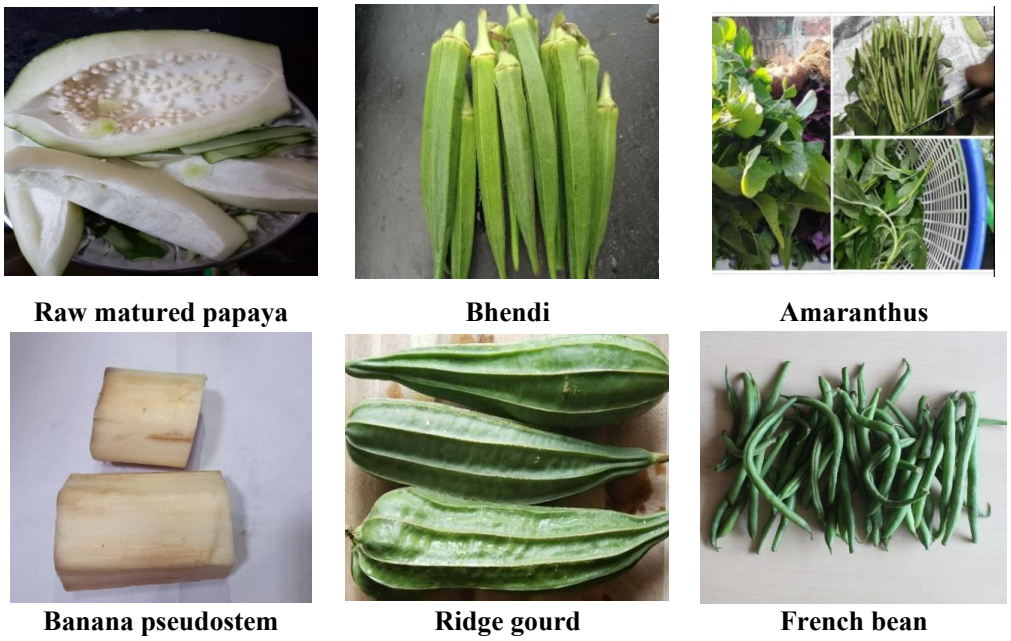

Figure 1. Over-matured vegetables collected for the study

cooking. Similarly, raw matured papaya (50 g) was sourced from the same market and used fresh without refrigeration. For preparation, the okra was cut into 2–3 cm pieces, while the papaya was peeled, deseeded, and chopped. A medium-sized onion (80 g) and two medium tomatoes (100 g) were also chopped. For the treatment sample, 2–3 tablespoons of oil were heated in a pan over medium flame; chopped onion was added and sautéed until soft and lightly golden. Chopped raw papaya was then added and cooked for 1–2 minutes to activate the tenderizing enzyme (papain). Turmeric powder (¼ tsp), red chili powder (1 tsp), and salt to taste were incorporated, followed by the addition of okra. The mixture was gently combined, covered, and cooked on a low flame for 8–10 minutes with occasional stirring until the okra became tender and most of the moisture evaporated. For the control sample, the same procedure was followed, omitting the papaya to assess the difference in texture and palatability.

2) Preparation of Amaranthus stir fry

Overmatured amaranthus (Thandu Keerai) with stems (250 g) was procured from the local market in Coimbatore. The plant material was sorted to remove damaged portions, cleaned, and thoroughly washed three times with clean water. The stems and leaves were separated; the stems were finely chopped, while the leaves were roughly chopped. Raw matured papaya (50 g), also obtained fresh from the same market, was peeled, deseeded and chopped before use. A medium-sized onion (80 g) was finely chopped, and grated coconut (50 g) was prepared in advance. For the treatment sample, 2–3 tablespoons of oil were heated in a pan over medium flame, followed by the addition of chopped onion, which was sautéed until soft and translucent. Chopped papaya was added and stirred for 1–2 minutes to ensure even distribution of the papain enzyme. Chopped amaranthus stems and leaves were then added along with red chili powder (1 tsp) and salt to taste. The mixture was stir-fried for 3–4 minutes, then covered and cooked on a low flame for 5–6 minutes with occasional stirring, until the stems turned tender and the excess moisture evaporated. Finally, grated coconut was added and mixed well before turning off the heat. For the control sample, the same procedure was followed, omitting the addition of papaya to evaluate its impact on the texture and tenderness of overmatured amaranthus.

3) Preparation of Banana pseudostem stir fry

Overmatured banana pseudostem (250 g) was harvested from the Orchard Unit at Tamil Nadu Agricultural University (TNAU), Coimbatore. The harvested pseudostem was stored under refrigeration (4–5°C) for 2 days to maintain freshness before processing. After removal from refrigeration, the outer fibrous sheaths were discarded, and the inner tender core was finely chopped. To prevent enzymatic browning, the chopped pieces were immediately soaked in clean water until use. Raw matured papaya (50 g), procured fresh from the local market, was peeled, deseeded, and chopped. A medium-sized onion (80 g) was finely chopped, and the grated coconut (50 g) was prepared beforehand. For the treatment sample, 2–3 tablespoons of oil were heated in a pan over a medium flame. The chopped onion was sautéed until soft and translucent, followed by the addition of raw papaya, which was cooked for 1–2 minutes to facilitate the uniform distribution of the papain enzyme. Chopped banana pseudostem was then added along with red chili powder (1 tsp) and salt to taste. The mixture was stirred thoroughly and cooked on a low flame for 8–10 minutes with occasional stirring until the pseudostem became soft and the moisture content was reduced significantly. Finally, grated coconut was added and mixed well before serving. The control sample was prepared using the same procedure, excluding the addition of raw matured papaya to assess its tenderizing effect on the banana pseudostem.

4) Preparation of Ridge gourd stir fry

Overmatured ridge gourd (250 g) was procured from the local market in Coimbatore, then sorted for quality, cleaned, and thoroughly washed with clean water to remove surface contaminants. Raw matured papaya (50 g), sourced from the same market, was used fresh on the day of preparation. The ridge gourd was peeled to remove the tough outer skin and then chopped into small, uniform cubes. Papaya was peeled, deseeded, and chopped. A medium-sized onion (80 g) was finely chopped, and grated coconut (50 g) was prepared in advance. For the treatment sample, 2–3 tablespoons of oil were heated in a pan over medium flame; chopped onion was added and sautéed until soft and translucent. The chopped papaya was then added and cooked for 1–2 minutes, allowing the papain enzyme to integrate with the cooking base. Chopped ridge gourd was added to the mixture, followed by red chili

powder (1 tsp) and salt to taste. The contents were stirred thoroughly and cooked on a low flame for 6–8 minutes with occasional stirring, until the ridge gourd became tender and excess moisture evaporated. Grated coconut was finally added and mixed uniformly with the cooked mixture. For the control sample, the same procedure was followed, omitting the addition of raw matured papaya to assess its tenderizing impact on overmatured ridge gourd.

5) Preparation of French bean stir fry

Overmatured French beans (250 g) were procured from the local market in Coimbatore, then sorted to remove damaged or immature pods, thoroughly cleaned, and washed with clean water to eliminate surface impurities. Raw matured papaya (50 g) was also purchased fresh from the same market and used immediately without refrigeration. The French beans were trimmed at both ends, washed again, and cut into small uniform pieces. Papaya was peeled, deseeded, and grated to ensure better enzymatic contact. A medium-sized onion (80 g) was finely chopped, and grated coconut (50 g) was prepared before cooking. For the treatment sample, 2–3 tablespoons of oil were heated in a pan over medium flame; chopped onion was sautéed until soft and translucent. Grated raw papaya was added to the onion and cooked for 1–2 minutes, allowing the papain enzyme to begin enzymatic tenderization. The chopped French beans were then added, followed by red chili powder (1 tsp) and salt to taste. The contents were mixed thoroughly, covered, and cooked on low flame for 8–10 minutes with occasional stirring until the beans became soft and most of the moisture evaporated. Grated coconut was added at the final stage and mixed evenly before removing the pan from the heat. The control sample was prepared using the same procedure, except for the addition of raw matured papaya, to compare its tenderizing effect on overmatured French beans.

Nutraceutical Analysis of Tender and Fibrous Vegetables

The nutraceutical analysis was carried out at the Laboratory, Horticultural College and Research Institute, TNAU, Coimbatore, during the academic year 2025. The nutrient profile of tender and overmatured vegetables was determined using standard AOAC methods (Latimer, 2023). Moisture content was estimated by oven drying the sample at 110°C using the Dean and Stark method (Veillet *et al.,* 2010). Crude protein was analyzed by the Lowry method using Folin-Ciocalteu reagent, with absorbance read at 660 nm (Satpathy *et al.,* 2020). Crude fiber was determined through acid and alkali digestion, followed by incineration. Phosphorus content was measured colorimetrically at 470 nm, while potassium was estimated using flame photometry. Magnesium was determined by titration with EDTA at pH 10 using Eriochrome Black T. Iron content was assessed colorimetrically at 490 nm using ortho-phenanthroline. Vitamin C was estimated by titration using 2,6-dichlorophenol indophenol dye and expressed as mg/100 g.

RESULTS AND DISCUSSION

Nutraceutical Analysis of tender and overmatured vegetables

The nutraceutical attributes of tender and overmatured vegetables were analysed using standard AOAC methods. The present study demonstrated that incorporation of raw unripe papaya as a tenderizer significantly altered the nutrient composition of tender and overmatured vegetable samples (Tables 1 and 2).

Table 1. Nutrient status of tender vegetables

Nutrients	Bhendi (per 100 g)	Amaranthus (per 100 g)	Banana pseudostem (per 100 g)	Ridge gourd (per 100 g)	French Bean (per 100 g)
Moisture (%)	88.00	90.00	92.00	95.00	89.00
Crude Protein (g)	2.54	4.52	1.22	1.64	2.58
Crude fibre (g)	3.20	1.99	2.54	1.47	2.67
Potassium (mg)	300.22	530.62	490.32	200.49	350.16
Magnesium (mg)	62.43	135.27	60.55	25.12	55.76
Phosphorous (mg)	66.12	80.31	30.22	35.85	52.79
Iron (mg)	1.23	3.46	0.92	0.54	1.59
Vitamin C (mg)	30.86	135.24	30.29	20.44	24.91

Table 2. Nutrient status of overmatured vegetables

Nutrients	Bhendi (per 100 g)	Amaranthus (per 100 g)	Banana pseudostem (per 100 g)	Ridge gourd (per 100 g)	French Bean (per 100 g)
Moisture (%)	82.00	84.00	88.00	85.00	82.00
Crude Protein (g)	1.53	3.16	0.69	0.92	1.54
Crude fibre (g)	8.28	5.54	7.29	12.67	7.56
Potassium (mg)	250.00	480.54	450.27	0.31	300.16
Magnesium (mg)	75.25	160.33	50.82	25.66	35.11
Phosphorous (mg)	50.82	70.32	25.63	28.22	45.19
Iron (mg)	1.00	2.53	0.89	0.48	0.24
Vitamin C (mg)	15.22	80.46	10.97	8.18	10.28

Moisture Content: Tender vegetables exhibited higher moisture content compared to overmatured counterparts. Tender bhendi recorded 88%, amaranthus 90%, banana pseudostem 92%, ridge gourd 95% and French bean 89%, whereas their overmatured forms showed reduced values of 82%, 84%, 88%, 85% and 82%, respectively. Moisture content generally increased with the addition of papaya, likely due to enhanced water retention from pectin solubilization during cooking, as observed by Koak *et al.,* (2011).

Crude Protein: Protein content declined with maturity. Tender bhendi contained 2.54 g, amaranthus 4.52 g, banana pseudostem 1.22 g, ridge gourd 1.64 g, and French bean 2.58 g, compared to 1.53 g, 3.16 g, 0.69 g, 0.92 g, and 1.54 g in overmatured samples, respectively. Crude protein content remained largely unaffected, consistent with Koak *et al.,* (2011), although enzymatic hydrolysis may have improved protein digestibility.

Crude Fibre: Overmatured vegetables demonstrated higher crude fibre content. Tender bhendi had 3.20 g, amaranthus 1.99 g, banana pseudostem 2.54 g, ridge gourd 1.47 g, and French bean 2.67 g, whereas overmatured samples contained 8.28 g, 5.54 g, 7.29 g, 12.67 g, and 7.56 g, respectively. Across all tested samples bhendi, amaranthus, banana pseudostem, ridge gourd, and French bean, papaya treatment consistently reduced crude fibre content, supporting findings by Kaur and Kapoor (2001) and Ashie *et al.,* (2002). This reduction is attributed to the proteolytic activity of papain, which hydrolyses structural proteins associated with cell wall polysaccharides, thereby softening lignified tissues and improving texture.

Minerals:

- *Potassium* decreased with maturity. Tender bhendi recorded 300.22 mg, amaranthus 530.62 mg, banana pseudostem 490.32 mg, ridge gourd 200.49 mg, and French bean 350.16 mg, compared to overmatured values of 250.00 mg, 480.54 mg, 450.27 mg, 180.31 mg, and 300.16 mg, respectively.
- *Phosphorus* also declined in overmatured vegetables. Tender bhendi had 66.12 mg, amaranthus 80.31 mg, banana pseudostem 30.22 mg, ridge gourd 35.85 mg, and French bean 52.79 mg, while overmatured samples showed 50.82 mg, 70.32 mg, 25.63 mg, 28.22 mg, and 45.19 mg, respectively.
- *Iron* content was higher in tender vegetables, with values of 1.23 mg (bhendi), 3.46 mg (amaranthus), 0.92 mg (banana pseudostem), 0.54 mg (ridge gourd), and 1.59 mg (French bean), compared to overmatured samples (1.00 mg, 2.53 mg, 0.89 mg, 0.48 mg, and 0.24 mg, respectively).
- *Magnesium* content varied; while some vegetables showed an increase in magnesium with maturity (bhendi: 62.43 mg to 75.25 mg, amaranthus: 135.27 mg to 160.33 mg), others recorded slight reductions (banana pseudostem: 60.55 mg to 50.82 mg, ridge gourd: 25.12 mg to 25.66 mg).

Vitamin C: Tender vegetables contained significantly higher vitamin C levels. Tender bhendi had 30.86 mg, amaranthus 135.24 mg, banana pseudostem 30.29

mg, ridge gourd 20.44 mg, and French bean 24.91 mg, while overmatured samples contained reduced levels of 15.22 mg, 80.46 mg, 10.97 mg, 8.18 mg, and 10.28 mg, respectively.

These results clearly indicate that maturity significantly affects the nutraceutical composition of vegetables. Tender samples generally having higher moisture, protein, vitamin C, and mineral contents, whereas overmatured samples exhibit elevated crude fibre levels, as reported by Barrett *et al.,* (2010) and Bhattacharya and Malleshi (2012). These nutritional modifications contribute not only to improved palatability but also to better functional quality of overmatured vegetables.

Organoleptic Evaluation

Overmatured and fibrous vegetables, cooked with and without papaya (Figure 2), were evaluated organoleptically by a panel comprising judges of different age groups using a 9-point hedonic scale to determine differences in appearance, texture, flavour, taste, and overall acceptability. The sensory attributes, viz., appearance, texture, flavour, taste, and overall acceptability were assessed and compared across treatments.

The mean organoleptic scores for each attribute of overmatured vegetables, cooked with and without papaya, are presented in Tables 3 and 4, respectively. Organoleptic evaluation revealed a distinct sensory advantage for vegetables cooked with papaya compared to untreated controls. Tenderness, mouthfeel, and overall acceptability were significantly improved in papaya-treated samples, likely due to papain, a proteolytic enzyme that softens fibrous tissues by breaking down proteins and cell wall components, thereby reducing chewiness in overmatured vegetables (Verma *et al.,* 2018). Results indicated that bhendi and banana pseudostem generally received the highest sensory scores among the evaluated samples.

Appearance: Bhendi cooked with papaya received the highest appearance score (8.92), followed closely by banana pseudostem (8.84), corroborating the observations of Sullivan and Calkins (2010). In contrast, the ridge gourd without papaya recorded a lower appearance score of 7.56.

Texture: The best texture score was observed in bhendi with papaya (8.82), followed by banana pseudostem (8.79). Among samples without papaya, amaranthus recorded the highest texture score of 7.26.

Flavour: French bean cooked with papaya achieved the highest flavour score of 8.64, followed by bhendi (8.58). Without papaya, French bean recorded a maximum flavour score of 7.55.

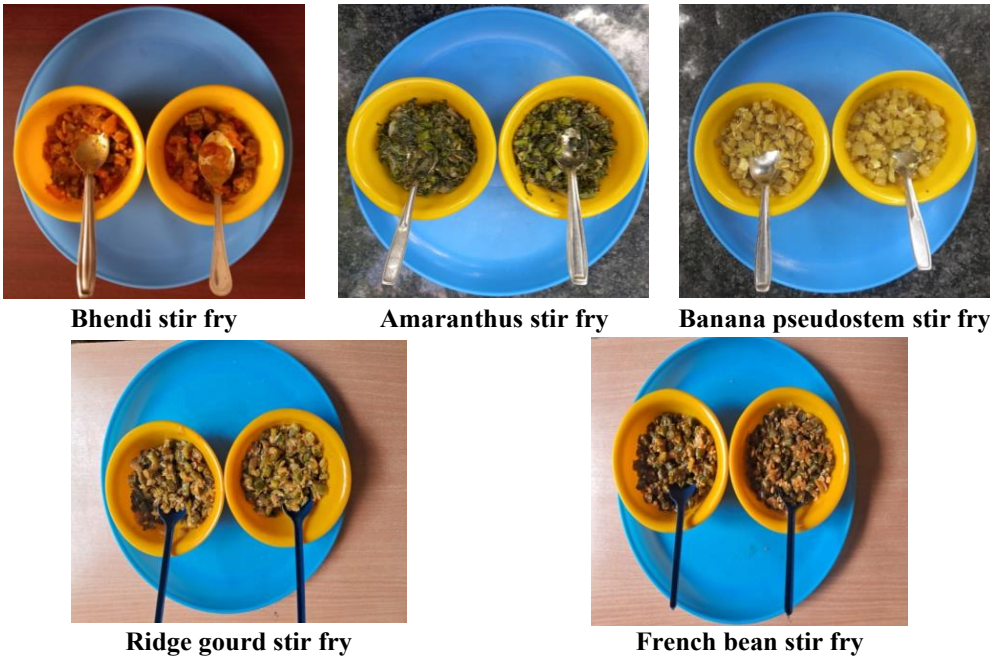

Figure 2. Sensory evaluation of the cooked products

Table 3. Organoleptic scores for the over-matured vegetables cooked with papaya

Vegetables	Appearance	Texture	Flavour	Taste	Overall acceptance	Mean Acceptance ±SD	Mean CV
Bhendi	8.92	8.82	8.58	8.72	8.81	0.20	2.84
Amaranthus	8.57	8.47	8.39	8.47	8.37	0.22	3.12
Banana Pseudostem	8.84	8.79	8.52	8.76	8.75	0.24	3.43
Ridge gourd	8.52	8.57	8.43	8.57	8.68	0.15	2.21
French bean	8.68	8.69	8.64	8.48	8.62	0.14	2.04
Mean	8.70	8.66	8.51	8.60	8.63	0.19	2.72

Table 4. Organoleptic scores for the over-matured vegetables cooked without papaya

Vegetables	Appearance	Texture	Flavour	Taste	Overall acceptance	Mean Acceptance ±SD	Mean CV
Bhendi	6.54	6.11	7.25	6.36	6.49	0.23	3.64
Amaranthus	7.32	7.26	6.76	6.64	7.22	0.13	1.93
Banana Pseudostem	6.97	6.63	6.33	6.99	6.61	0.12	1.89
Ridge gourd	7.56	6.45	7.44	6.49	6.23	0.30	4.61
French bean	6.82	7.14	7.55	7.27	7.37	0.17	2.63
Mean	7.04	6.71	7.06	6.75	6.78	0.19	2.94

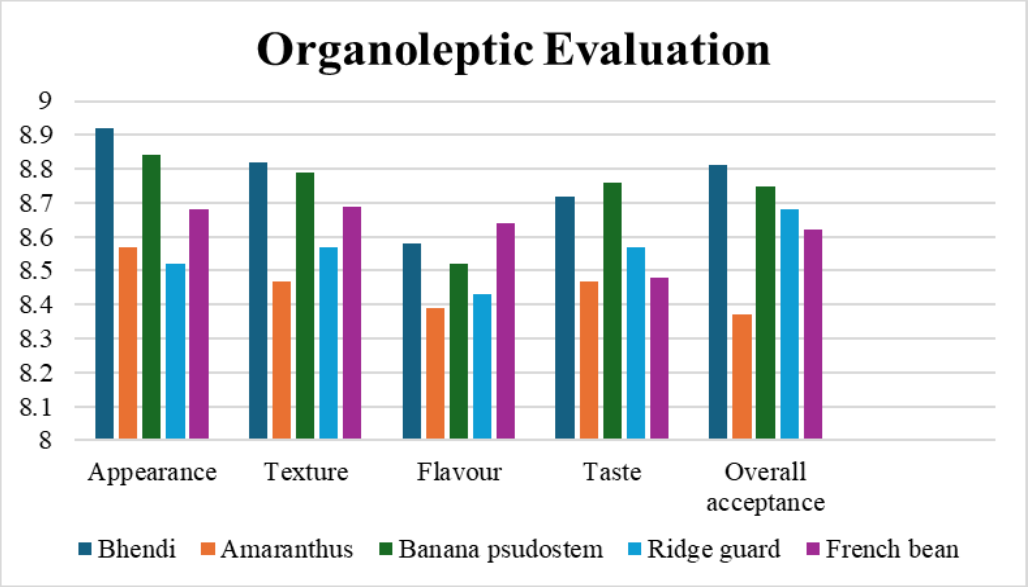

Figure 3. Organoleptic score for overmatured vegetables cooked with and without papaya

Taste: Banana pseudostem with papaya scored highest for taste (8.76), followed by bhendi (8.72). French bean without papaya recorded the highest taste score among untreated samples (7.27).

Overall Acceptance: Bhendi cooked with papaya attained the highest overall acceptance score (8.81), indicating superior sensory appeal. Across all evaluated attributes, appearance consistently received the highest scores. This highlights the visual enhancement provided by papaya treatment, indicating that visual appeal is a critical factor in consumer preference.

The bar chart (Figure 3) illustrates that overmatured vegetables cooked with papaya consistently scored higher in texture, flavour, taste, and overall acceptability than those prepared without

papaya. This underscores the effectiveness of papaya tenderization as a sustainable approach to enhance the utilization of fibrous, overmatured vegetables that are often discarded, thereby contributing to reduced food waste, improved dietary variety, and preservation of nutritional quality. The results further confirm the role of papain in softening fibrous tissues and improving palatability, supporting findings from earlier studies by Abdurrahman *et al.,* (2025) and Das and Prasad (2024).

CONCLUSION

Matured raw papaya proved to be a natural, cost-effective tenderizer that significantly enhanced the texture, flavor, and overall acceptability of fibrous and overmatured vegetables. Among the tested samples, bhendi showed the most significant improvement, followed by banana pseudostem, French bean, ridge gourd, and amaranthus. This simple culinary approach offers a sustainable solution to valorise overmatured produce, reduce food waste, and promote healthier, more appealing vegetable consumption.

Funding acknowledgement

No external funding was received to carry out this research.

Ethics Statement

There was no animal included in this research

Consent for publication

All the authors agreed to publish the content.

Competing interest

The author declares no conflict of interest for publishing this content.

Author contribution

The experiment was conducted under the guidance of Praneetha S. The experiment was conducted by Krishnaveni T, Madhumitha M, Manipriya S, Mei Raghul AV, and Methini P. The article manuscript was prepared by Ajay Raja A. Review and editing were conducted by Praneetha S.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to the Department of Vegetable Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, for providing the necessary facilities and support throughout the study.

REFERENCES

Abdurrahman, F., Omar, O. O. and I. Iswadi. 2025. Analysis of the effects of tropical fruit extracts on the physicochemical, tenderness and organoleptic characteristics of buffalo meat. *Biotik: J. Ilmiah Biol. Teknol. Kependidikan*, **13(2):** 141-161. https://doi.org/10.22373/biotik.v13i2.31661

Aruoma, O. I. and B. Halliwell. 1990. Papaya extracts and papain: applications in food technology. *Trends Food Sci. Technol.*, **1:** 110-113. https://doi.org/10.1002/jsfa.13776

Ashie, I. N. A., Sorensen, T. L. and P. M. Nielsen. 2002. Effects of papain and a microbial enzyme on meat proteins and beef tenderness. *J. Food Sci.*, **67(6):** 2138-2142. https://doi.org/10.1111/j.1365-2621.2002.tb09516.x

Barrett, D. M., Beaulieu, J. C. and R. Shewfelt. 2010. Color, flavor, texture and nutritional quality of fresh-cut fruits and vegetables: desirable levels, instrumental and sensory measurement and the effects of processing. *Crit. Rev. Food Sci. Nutr.*, **50(5):** 369-389. https://doi.org/10.1080/10408391003626322

Bhattacharya, S. and N. G. Malleshi. 2012. Physical, chemical and nutritional characteristics of premature-processed and matured green legumes. *J. Food Sci. Technol.*, **49(4):** 459-0466. https://doi.org/10.1007/s13197-011-0299-y

Das, U. and S. S. Prasad. 2024. Papaya waste as a nutraceuticals product. In Nutraceuticals from Fruit and Vegetable Waste, pp. 425–439. https://doi.org/10.1002/9781119803980.ch16

Kaur, C. and H. C. Kapoor. 2001. Antioxidants in fruits and vegetables–the millennium's health. *Int. J. Food Sci. Technol.*, **36(7):** 703-725. https://doi.org/10.1111/j.1365-2621.2001.00513.x

Koak, J. H., Kim, H. S., Choi, Y. J., Baik, M. Y. and B. Y. Kim. 2011. Characterization of a protease from over-matured fruits and development of a tenderizer using an optimization technique. *Food Sci. Biotechnol.*, **20(2):** 485-490. https://doi.org/10.1007/s10068-011-0067-9

Latimer, G. W., Jr. (Ed.). 2023. Official methods of analysis of AOAC INTERNATIONAL (22nd ed.). Oxford University Press. https://doi.org/10.1093/9780197610145.002.001

Lee, J. W., Kim, H. S. and Y. H. Kim. 2007. Enzymatic tenderization of plant-based foods using proteolytic enzymes. *Biotechnol. Bioprocess Eng.*, **12(5):** 495-501. https://doi.org/10.1007/s10068-011-0067-9

Parfitt, J., Barthel, M. and S. Macnaughton. 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philos. Trans. R. Soc. B*, **365(1554):** 3065-3081. https://doi.org/10.1098/rstb.2010.0126

Satpathy, L., Dash, D., Sahoo, P., Anwar, T. S. and S. P. Parida. 2020. Quantitation of total protein content in some common edible food sources by lowry protein assay. *Letters in Applied Nano Bio Science*, ***9*(3),** 1275-1283. https://doi.org/10.33263/LIANBS93.12751283

Sullivan, G. A. and C. R. Calkins. 2010. Application of exogenous enzymes to beef muscle of high and low-connective tissue. *Meat Sci.*, **85(4):** 730-734. https://doi.org/10.1016/j.meatsci.2010.03.033

Veillet, S., Tomao, V., Ruiz, K. and F. Chemat. 2010. Green procedure using limonene in the Dean–Stark apparatus for moisture determination in food products. *Analytica chimica acta*, ***674*(1),** 49-52. https://doi.org/10.1016/j.aca.2008.11.008

Verma, S., Biswas, S., Rindhe, S. N., Kumari, B. and V. H. Kumbha. 2018. Effect of tenderization on histological, physico-chemical and properties of raw and cooked emu meat treated with natural tenderizers. *Int. J. Pure Appl. Biosci.*, **6(1):** 322-332. http://dx.doi.org/10.18782/2320-7051.5995

Waldron, K. W., Parker, M. L. and A. C. Smith. 2003. Plant cell walls and food quality. *Compr. Rev. Food Sci. Food Saf.*, **2(4):** 128–146. https://doi.org/10.1111/j.1541-4337.2003.tb00019.x