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Comparative Study of Conventional and Microwave Blanching on Peroxidase Activity and Color of *Ehretia Asperula* Leaves

Minh Vuong Kieu[a], Uyen Nhi Le[a], Thai Danh Luu[b], Yanbin Hua[c], Chi Nhan Tran[a,*]

[a]Institute of Food and Biotechnology, Can Tho University, Can Tho City, Vietnam
[b]College of Agriculture, Can Tho University, Can Tho City, Vietnam
[c]Farmland Protection and Ecological Station, Jiexiu Bureau of Agriculture and Rural Affairs, China
tcnhan@ctu.edu.vn

This study aimed to investigate the effects of blanching methods on peroxidase (POD) activity and color of *Ehretia asperula* (*E. asperula*) leaves. *E. asperula* leaves were blanched for 0-180 s at 70-90 °C using a water bath or at 300-500 W using a microwave oven. The results showed that POD inactivation rate constants increased with temperature/microwave power, whereas the D-value showed an opposite trend. The highest k and lowest D-value were observed in hot water blanching (HWB) at 90 °C (0.0258 s^{-1} and 101 s) and microwave blanching (MWB) at 500 W (0.0271 s^{-1} and 86 s) ($p > 0.05$). HWB and MWB also showed similar effects on L*a*b* coordinates, which was characterized with the increase in L* and b*, and the decline in a*. However, HWB at 90 °C (k for a* = 0.1034 s^{-1}) showed a double quicker changes in a* coordinate compared to MWB at 500 W (k for a* = 0.0506 s^{-1}) to reach the equillibrium a* value of -4.19. These findings indicate that both HWB and MWB show similar impacts on POD activity and color of *E. asperula* leaves in most cases. HWB can be more useful in the industrial scale, where requires a larger capacity; while the laboratory preparation of blanched *E. asperula* leaves can benefit from MWB due to minimal preparation and lower water consumption.

1. Introduction

E. asperula leaves have been utilized in Vietnam as a traditional medicine to treat gastritis, hepatitis, liver cirrhosis, and cancer (Hoang et al., 2021). Fresh *E. asperula* leaves encounter a short shelf-life of less than a week due to enzymatic and spoilage microbial activities, leading to a substantial post-harvest loss. Polyphenol oxidase (PPO) and peroxidase (POD) can induce phenolic compound oxidation and color changes. In the presence of oxygen, PPO oxidizes mono- and di-phenols into o-quinones, which subsequently polymerize with other substances (e.g., o-quinones, phenolics, protein) to produce brown pigments (Singh et al., 2018). POD can combine with hydrogen peroxide to form free radicals, which further react with other components, such as chlorophyll and ascorbic acid (Xiao et al., 2017). Therefore, pretreatment is needed to preserve the bioactive compounds and appearance before drying.

Blanching is a mild heating with the primary purpose of inactivating endogenous enzymes in vegetables and some fruits before processing (Xiao et al., 2017). POD is usually used as an enzyme indicator to evaluate blanching efficacy due to its high heat resistance (Ruiz-Ojeda and Penas, 2013). The color of blanched materials is also a good indicator and expected to be similar to that of raw materials due to its strong association with other quality attributes, such as freshness, sensory, and nutrition (Tang et al., 2019). Hot water blanching (HWB) is the oldest and simplest blanching (70-95 °C for 45-720 s); however, this method requires clean water and generates a large amount of effluent, as well as has a high risk of thermophilic bacteria contamination. Microwave blanching (MWB) is an alternative method providing faster heating, lower energy consumption, and fewer nutrient losses (Xiao et al., 2017). However, a high initial investment and careful control requirements should be considered. In addition, the optimal blanching condition strongly depends on the food's physical and chemical properties and the method used. Hence, the determination of the optimal time-temperature profile of each blanching method is essential to sufficiently inactivate endogenous enzymes with minimal quality loss and energy consumption. Lin et al. (2012) recommended that *Rabdosia serra* leaves should be blanched at 90 °C (water) or 100 °C (steam) for 90 s to retain phenolics. MWB water dropwort at 600 W for 1 min is preferable to

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meet sensory acceptability (Tang et al., 2019). However, studies on changes in POD and color of *E. asperula* leaves during blanching have yet to be found in the literature. Therefore, this study aims to provide optimal HWB and MWB conditions as a preliminary treatment of *E. asperula* leaves by analysis of POD inactivation and color change kinetics.

2. Materials and methods

2.1 Materials

E. asperula leaves were collected from Hoa Binh province, Vietnam, transported to the laboratory under cold air conditioning within a day, and stored in a cold room (4 °C) until blanching.

2.2 Blanching of *Ehreia asperula* leaves

Fresh *E. asperula* leaves (20 g) were blanched by means of a water bath (10124-25, Cole-Parmer, Germany) or a microwave oven (R-G52XVN-ST, Sharp, Japan) for 0-180 s. The leaves were treated at 70-90 °C in a capped beaker of 500 mL distilled water during HWB or 300-500 W in a capped bowl (21x18x 8.5 cm) without water during MWB. Blanched leaves were promptly subjected to cold water (4 °C), drained for 120 s, and excessive water was removed with tissue papers. Blanching was carried out three times at each condition.

2.3 Peroxidase assay

POD was extracted as described in Koohi et al. (2020) with minor modifications. The leaves were cut into 2-3 mm slices and mixed thoroughly with the 3-fold volume of pre-warmed acetate buffer (50 °C, 0.05 M, pH 5) containing 6 % polyvinylpyrrolidone and 5 % Tween® 80 using an Ultra-Turrax (T-18 digital, IKA, Germany) for 2 min. The mixture was filtered through a filter paper (Whatman No. 1), and the filtrate was centrifuged at 4 °C and 3,000 rpm for 30 min using a centrifuge (D-500, DLAB, China). The extract was stored at 4 °C until analysis. The POD assay was conducted in triplicates according to the procedure of Furumo & Furutani (2008). Briefly, the reaction mixture consisted of 2.70 mL of phosphate buffer (100 mM, pH 6.8), 0.10 mL of 3 % hydrogen peroxide, and 0.15 mL of 4 % guaiacol. After incubation for 3 min, 50 µL of the extract was added, and the absorbance was observed at 470 nm using a spectrophotometer (UV-1900i, Shimadzu, Japan) for 2 min.

2.4 Color measurement

The color of *E. asperula* leaves was determined using a portable colorimeter (CR-410, Konica Minolta Measuring Instruments, Japan). A CIE standard illuminant C was used to determine CIE color space coordinates (L*, a*, and b* values). Measurements were done in triplicate at different positions of the leaf surface.

2.5 Data analysis

The thermal inactivation of POD in raw materials could be modeled by a first-order model (Eq(1)) as described in Goncalves et al. (2007), Lin et al. (2012), Ruiz-Ojeda and Penas (2013), and Kachhadiya et al. (2018) for various fruit and vegetables. The decimal reduction time (D-value) is the required time to reduce the initial POD activity by 90 % at a certain temperature (Eq(2)). The fractional conversion model (Eq(3)) was selected to describe the color changes as in Goncalves et al. (2007) and Ruiz-Ojeda and Penas (2013). The coefficients of models were estimated by nonlinear regression with the Marquart method using the Statgraphics Centurion software (version 19.1, Statgraphics Technologies Inc., Virginia, USA). This software was also used to analyse the difference in means of kinetic parameters using the Least Significant Difference test at a significance level of 5 %. Results were shown as mean±standard deviation.

$$A_t = A_0 e^{-kt} \quad (1)$$

$$D = \frac{\ln(10)}{k} \quad (2)$$

$$\frac{C_t - C_e}{C_0 - C_e} = e^{-kt} \quad (3)$$

Where: A and C are the POD activity and color coordinates (L*, a*, or b*); subscription of 0, t, and e are used to indicate the value at initial, certain, and equilibrium times; and k is reaction rate constant.

3. Results and discussion

3.1 Effect of blanching methods on POD activity of *Ehretia asperula* leaves

The fitted inactivation curves and experimental data were presented in Figure 1, where the residual enzyme activity was normalised in relation to the initial POD activity. There was a remarkable gap between the inactivation curve at 80 and 90 °C or 300 and 400 W, while the curves at 90 °C and 500 W were overlapping. This observation indicated that HWB at 90 °C and MWB at 500 W were efficient for POD inactivation. The determination coefficients (R^2) and standard error estimate (SE) of the model ranged in 86.80-97.00 and 0.05-0.15. This result implied that the first-order model adequately described the changes in POD activity during blanching of *E. asperula* leaves under all tested conditions. The inactivation of browning enzymes from different fruit and vegetables, such as *Rabdosia serra* (Maxim.) Hara leaves (Lin et al., 2012), green bean pods (Ruiz-Ojeda and Penas, 2013), sweet corn (Kachhadiya et al., 2018), and pumpkin (Goncalves et al., 2007), has been reported to follow the first-order model. Others concluded that the first-order reaction was exceedingly simple to describe the complex changes in POD activity from coriander leaves and mint leaves, especially at lower processing temperatures (Rudra et al., 2008). The poor fitting is due to the presence of labile and heat stable fraction and complex changes in structure of POD during heat treatments (Singh et al., 2018). Thus, enzymes origin and treatment conditions affect the goodness of fit of selected models.

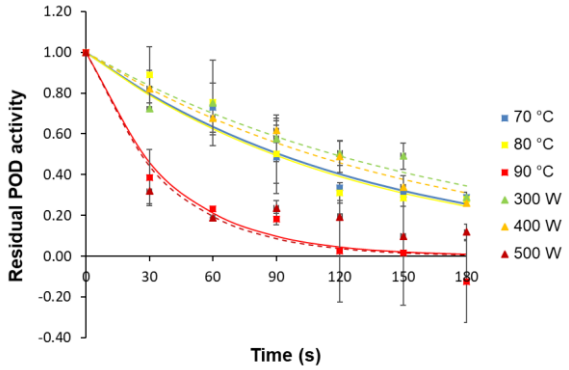

Figure 1: POD inactivation kinetics under different conditions of HWB and MWB

We found that the inactivation rate constants increased as an increase in temperature of HWB, while D-values decreased significantly at high temperatures (Table 1). The effect of temperatures on POD could be explained as the thermal denaturation, which was severer at higher temperatures (Latorre et al., 2013). Goncalves et al. (2007) suggested pumpkin should be blanched at 90 °C for 5.8 min or at 95 °C for 3.9 min to reduce POD activity by 90 %. However, there was an insignificant difference in kinetic parameters at low temperatures. Indeed, the inactivation rate constants or D-values were identical at 70 °C (0.0076 s^{-1} and 306 s) and 80 °C (0.0076 s^{-1} and 297 s) ($p > 0.05$). MWB also showed similar phenomena with an insignificant difference between inactivation rate constants and D-values at 300 W (0.0059 s^{-1} and 406 s) and 400 W (0.0065 s^{-1} and 363 s) ($p > 0.05$) (Table 1).

Table 1: Kinetic parameters of POD inactivation under different conditions of HWB and MWB

Method	Temperature (°C)/Power (W)	k (s^{-1})	R^2	SE	D (s)
HWB	70	0.0076±0.0007^{a}	91.56±6.28	0.09±0.04	306±28.22^{b}
	80	0.0078±0.0008^{a}	93.11±4.48	0.08±0.04	297±30.61^{b}
	90	0.0258±0.0123^{b}	90.07±6.07	0.12±0.06	101±47.38^{a}
MWB	300	0.0059±0.0013^{a}	88.85±6.90	0.08±0.03	406±101.28^{c}
	400	0.0065±0.0012^{a}	97.00±0.50	0.05±0.01	363±64.21^{bc}
	500	0.0271±0.0041^{b}	86.80±6.28	0.15±0.03	86±13.01^{a}

Different superscripts in each column show a significant difference ($p < 0.05$)

These conclusions also could be seen in Figure 1 with unclearly distinct curves at 70 °C and 80 °C or 300 and 400 W. Ruiz-Ojeda & Penas (2013) showed that POD activity of green bean pods decreased with an increase in processing power and time, even it was undetectable at powers tested (650-900 W) for intervals above 200 s. The effectiveness of HWB of Indian gooseberry was also enhanced by increasing microwave power levels and time (Mandliya et al., 2023). Mandliya et al. (2023) suggested MWB of Indian gooseberry at 500 W for 100 s was the optimal condition to inhibit browning enzymes. Despite similar inactivation rate constants, MWB at 300 W required a longer inactivation time than HWB at 70 °C (406 s and 306 s). We also observed activation

points at 70 °C for 30 s of HWB and 300 W for 30 s (not shown in Figure 1). Our results indicated that the low temperatures or microwave powers ineffectively terminated POD activity in *E. asperula* leaves. The importance of rapid heating to inactivate enzymes was also stressed in various plants, such as red beet root (Latorre et al., 2013), sweet corn (Kachhadiya et al., 2018), water dropwort (Tang et al., 2019), and pumkin (Tran et al., 2024). The highest inactivation rate constant was observed at 90 °C of HWB (0.0258 s^{-1}) or 500 W of MWB (0.0271 s-1), coresponding with the shortest inactivation time (101 or 86 s) (Table 1). A significant different blanching time was observed in sweet corn using HWB at 100 °C and MWB at 900 W (148 and 81 s) with k values of 0.016 and 0.024 s^{-1}; indicating that MWB is superior (Kachhadiya et al., 2018). HWB induces an temperature increase by convection from water to sample and conduction within sample, thus generating a uniform heat distribution. The intermolecular friction by the vibration of dipoles (e.g., water molecules) is the main driving force for the temperatue increase during MWB. Microwave heating can have non-uniformi heating due to an uneven spatial distribution of electromagnetic field inside the cavity (Xiao et al., 2017). In order to minimize this, Latorre et al. (2013) involved water for immersion of red beet cylinders during blanching. For some materials, dry MWB can be superior in terms of quality retention due to shorter processing time (Mandliya et al., 2023). In our study, *E. asperula leaves* were thin and light, so the involvement of water is unnecessary. The moisture loss during dry MWB was also minimal owing to the relative short blanching.

3.2 Effects of blanching methods on color coordinates of *Ehretia asperula* leaves

3.2.1 Effect of blanching methods on L* coordinate of *Ehretia asperula* leaves

Figure 2a showed the increases in brightness (L*) of *E. asperula* leaves as increasing in temperature or microwave power, which was supported by kinetic parameters in Table 2. The fractional conversion model sufficiently projected the changes in brightness of *E. asperula* leaves with 85.29-98.87 R^2 and 0.65-1.82 SE. HWB at 80 and 90 °C showed the highest increase rate constant (0.1561 and 0.1300 s^{-1}, $p > 0.05$). Tang et al. (2019) assumed the chlorophyll degradation resulted in the increase in L* values of water dropwort as heat intensity increased. However, this trend would not hold true for every plants. The decrease in brightness was usually observed in other materials as a result of pigment degradation such as carotenoids and betacyanins (Latorre et al., 2013), chlorophyll (Ruiz-Ojeda & Penas, 2013) or starch leaching (Goncalves et al., 2007). The highest increase rate constant was only observed at 500 W during MWB (0.0872 s^{-1}), which is slight lower than HWB at 80 and 90 °C. Notably, the lowest value of equilibrium L* was only recorded at 70 °C of HWB (Table 2). This difference could due to the formation of brown pigments established during early time of HWB at 70 °C.

Table 2: Kinetic parameters of changes in L coordinate under different conditions of HWB and MWB*

Method	Temperature (°C)/Power (W)	k (s^{-1})	L^*_e	R^2	SE
HWB	70	0.0151±0.0085^{a}	53.71±1.90^{a}	85.29±4.68	1.82±0.39
	80	0.1561±0.0525^{d}	57.72±0.40^{b}	98.87±1.54	0.65±0.53
	90	0.1300±0.0577^{cd}	57.12±0.43^{b}	98.37±1.18	0.84±0.30
MWB	300	0.0334±0.0021^{ab}	57.43±0.38^{b}	98.64±1.07	0.76±0.31
	400	0.0600±0.0249^{ab}	56.62±0.19^{b}	97.00±0.60	1.14±0.12
	500	0.0872±0.0066^{bc}	57.32±0.53^{b}	98.43±0.89	0.84±0.24

Different superscripts in each column show a significant difference ($p < 0.05$)

3.2.2 Effect of blanching methods on a* coordinate of *Ehretia asperula* leaves

Figure 2b depicted that the change in a* of *E. asperula* leaves during HWB at 70 °C was not pronouced, leading to the failure of projection of the model (38.48 R^2 and 0.45 SE). However, the selected model successfully fitted to experimental data of a* of *E. asperula* leaves during blanching under other conditions (Table 3).

Table 3: Kinetic parameters of changes in a coordinate under different conditions of HWB and MWB*

Method	Temperature (°C)/Power (W)	k (s^{-1})	a^*_e	R^2	SE
HWB	70	0.0061±0.0050^{a}	4.73±0.62^{d}	38.48±13.36	0.45±0.09
	80	0.0364±0.0042^{ab}	-2.97±0.05^{c}	97.17±1.71	0.38±0.06
	90	0.1034±0.0404^{c}	-4.19±0.27^{ab}	97.62±2.29	0.41±0.15
MWB	300	0.0171±0.0010^{a}	-3.88±0.27^{b}	88.66±2.55	0.96±0.13
	400	0.0612±0.0170^{b}	-3.91±0.02^{ab}	91.34±3.70	0.83±0.10
	500	0.0506±0.0033^{b}	-4.44±0.07^{a}	94.54±2.23	0.70±0.10

Different superscripts in each column show a significant difference ($p < 0.05$)

The results showed that HWB and MWB improved greeness of *E. asperula* leaves by lowering the a* coordinate (Figure 2b). The greeness shift was also observed in green bean pods (Ruiz-Ojeda and Penas, 2013), water dropwort (Tang et al., 2019) and India gooseberry (Mandliya et al., 2023). This shift could be a side effect of trapped air removal, altering reflecting properties of blanched samples (Mandliya et al., 2023). The change rate constants enhanced as a result of temperature/microwave power abuse, with the highest value was observed in *E. asperula* leaves blanched at 90 °C using hot water (0.1034 s^{-1}). However, the equilibrium values of a* coordinate were insignificantly different beween *E. asperula* leaves blanched at 90 °C using hot water or 400-500 W using microwave heating (Table 3).

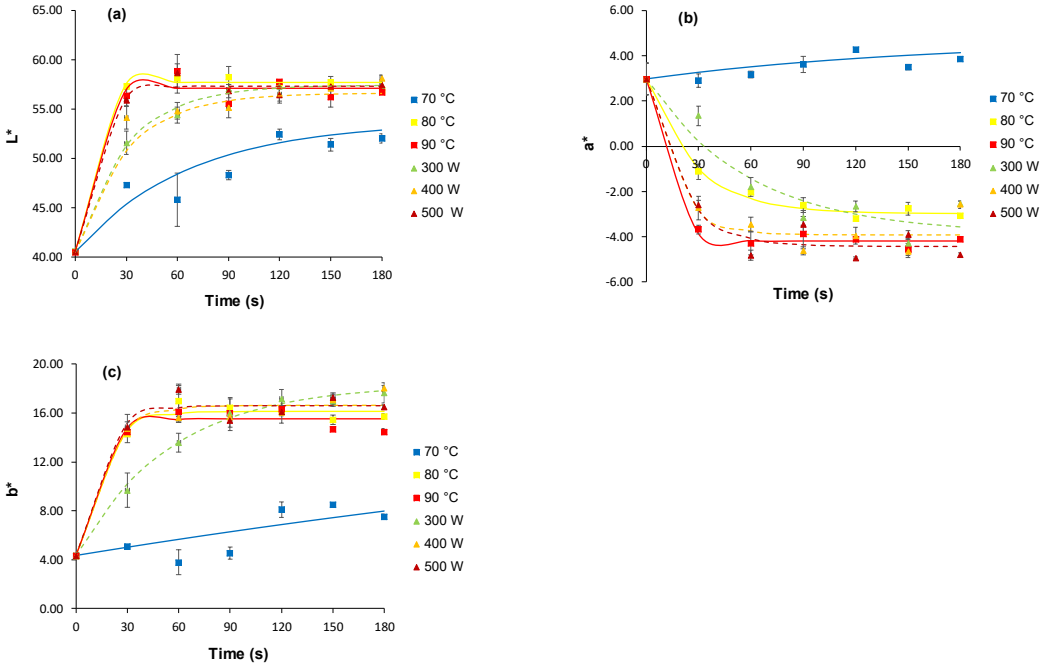

Figure 2: Changes in (a) L, (b) a*, and (c) b* of Ehretia asperula leaves under different conditions of HWB and MWB*

3.2.3 Effect of blanching methods on b* coordinate of *Ehretia asperula* leaves

The results from Table 4 illustrated that the chosen model also failed to describe the changes in blueness/yellowness of *E. asperula* leaves during HWB at 70 °C.

Table 4: Kinetic parameters of changes in b coordinate under different conditions of HWB and MWB*

Method	Temperature (°C)/Power (W)	k (s^{-1})	b^*_e	R^2	SE
HWB	70	0.0015 ± 0.0005^{a}	20.10 ± 3.90^{b}	56.73±1.21	1.46±0.04
	80	0.0674 ± 0.0012^{b}	16.15 ± 0.45^{a}	97.67±1.77	0.71±0.33
	90	0.0897 ± 0.0258^{c}	15.51 ± 0.32^{a}	96.04±0.92	0.93±0.14
MWB	300	0.0179 ± 0.0028^{a}	18.41 ± 0.62^{ab}	96.04±1.21	0.70±0.31
	400	0.0603 ± 0.0149^{b}	16.64 ± 0.02^{a}	96.63±0.84	0.93±0.13
	500	0.0715 ± 0.0055^{bc}	16.62 ± 0.30^{a}	95.81±2.98	0.99±0.41

Different superscripts in each column show a significant difference ($p < 0.05$)

Figure 2c demonstrated that *E. asperula* leaves tended to have a more yellowness during blanching, with a higher change rate at higher temperatures/microwave powers. The higher heat intensity could facilitate the thermal degradation of chlorophyll to phenophytin (Mandliya et al., 2023). Indeed, HWB at 90 °C and MWB at 500 W induced the highest increase rate constant (0.0715-0.0897 s^{-1}). However, the change in b* was unapparently recorded in visual observation of *E. asperula* leaves, which was consistent with some research on green beans (Ruiz-Ojeda & Penas, 2013) and water dropwort (Tang et al., 2019). The equillibrium b* value was the same for most blanching conditions, with the exception of HWB at 70 °C due to the lack of prediction.

In general, the suggested model was statisfactorily to fit expermental data of L*a*b*, with the exception of HWB at 70 °C. Many research also used the fractional equation to model experimental data of blanched sample's color (Goncalves et al., 2007). If *E. asperula* leaves were expected to be blanched at 90 °C for 101 s using hot

water to achieve the safety level of POD acitivity, color factors might exhibit the following difference in relation to unblanched leaves: L* differed 41 %, a* differed 240 %, and b* differed 258 %. These figures were slightly higher in case of HWB at 500 W for 89 s (42 % for L*, 246 % for a*, and 283 % for b*). Blanched *E. asperula* leaves had a brighter and greener color, so these differences could be considered as desirable changes in this material. However, negative effects of blanching were observed at some different materials, such as pumpkins (Tran et al., 2024), red beets (Latorre et al., 2013) and green beans (Ruiz-Ojeda & Penas, 2013).

4. Conclusions

Higher water temperatures/microwave powers show stronger influences on POD inactivation and color changes of *E. asperula* leaves, which is confirmed by kinetic parameters. However, the selected model struggles to predict the changes in color of *E. asperula* leaves during HWB at 70 °C owing to the irrevesible changes in color as a consequence of POD activation at a low temperature and short time. HWB at 90 °C for 101 s effectively inactivates POD activity and significantly improves appreance of *E. asperula* leaves. This condition can be applied as a pretreatment in the industrial drying. MWB at 500 W for 89 s shows an ease in the laboratory scale with slightly higher positive effects. The changes in bioactive compounds should be monitored during drying of *E. asperula* leaves and storage of *E. asperula* leaf powder in further research.

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References

Furumo N.C., Furutani S., 2008, A simple method for assaying total protein, polyphenol oxidase and peroxidase activity from 'Kaimana' *Litchi chinensis* Sonn, Journal of Hawaiian and Pacific Agriculture, 15, 1-7.

Goncalves E.M., Pinheiro J., Abreu M., Brandao T.R.S., Silva C.L. M., 2007, Modelling the kinetics of peroxidase inactivation, colour, and texture changes of pumpkin (*Cucurbita maxima* L.) during blanching, Journal of Food Engineering, 81(4), 693-701.

Hoang T.L.H., Jang D.C., Nguyen Q.T., Na W.H., Kim I.S., Vu N.T., 2021, Biochar-improved growth and physiology of *Ehretia asperula* under water-deficit condition, Applied Sciences, 11(22), 10685.

Kachhadiya S., Kumar N., Seth N., 2018, Process kinetics on physico-chemical and peroxidase activity for different blanching methods of sweet corn, Journal of Food Science and Technology, 55, 4823-4832.

Koohi S., Nasernejad B., Zare M.H., Elahifard M., Shirazian S., Ghadiri M., 2020, Extraction of oxidative enzymes from green tea leaves and optimization of extraction conditions, Chemical Engineering & Technology, 43(12), 2548-2556.

Latorre M.E., de Escalada Plá M.F., Rojas A.M., Gerschenson L. N., 2013, Blanching of red beet (*Beta vulgaris* L. var. conditiva) root. Effect of hot water or microwave radiation on cell wall characteristics, LWT - Food Science and Technology, 50(1), 193-203.

Lin L., Lei F., Sun D.W., Dong Y., Yang B., Zhao M., 2012, Thermal inactivation kinetics of *Rabdosia serra* (Maxim.) Hara leaf peroxidase and polyphenol oxidase and comparative evaluation of drying methods on leaf phenolic profile and bioactivities, Food Chemistry, 134(4), 2021-2029.

Mandliya S., Majumdar J., Misra S., Pattnaik M., Mishra H.N., 2023, Evaluation of dry microwave and hot water blanching on physicochemical, textural, functional, and organoleptic properties of Indian gooseberry (*Phyllanthus emblica*), Journal of Food Measurement and Characterization, 17(3), 2881-2891.

Rudra S.G., Shivhare U.S., Basu S., Sarkar B.C., 2008, Thermal inactivation kinetics of peroxidase in coriander leaves, Food and Bioprocess Technology, 1(2), 187-195.

Ruiz-Ojeda L.M., Penas F.J., 2013, Comparison study of conventional hot-water and microwave blanching on quality of green beans, Innovative Food Science and Emerging Technologies, 20, 191-197.

Singh B., Suri K., Shevkani K., Kaur A., Kaur A., Singh N., 2018, Enzymatic browning of fruit and vegetables: A review, In: Kuddus M. (Ed.), Enzymes in Food Technology, 63-98.

Tang M., Sun H., Zhang Z., Zhao J., Cao J., Thakur K., He S., 2019, Evaluation of hot water and microwave blanching on qualities and sensory characteristics of water dropwort (*Oenanthe javanica* DC.), Journal of Food Processing and Preservation, 43(10), e14104.

Tran C.N., Kieu M.V., Luu T.D., Nguyen N.M.P., Tong T.A.N., 2024, Effects of blanching on browning enzyme inactivation and color of pumpkins (*Cucurbita moschata* D.), Chemical Engineering Transactions, 113, 457-462.

Xiao H.W., Pan Z., Deng L.Z., El-Mashad H.M., Yang X.H., Mujumdar A.S., Gao Z.J., Zhang Q., 2017, Recent developments and trends in thermal blanching – A comprehensive review, Information Processing in Agriculture, 4(2), 101-127.