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Influence of ultrasonic and peracetic acid incorporation on microbiological and physicochemical properties of sweet potato (*Ipomoea batatas* L.)

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Sweet potato (*Ipomoea batatas* L.) has a low glycemic index by low digestibility of the starch Therefore it is very appropriate for diabetic or obesity people. During harvesting, sweet potato tuber is normally contaminated by dust, soil and microorganism. It also has high respiration rate and perishability. Keeping the original tuber without water cleaning in dry cool place can store it for a nearly one month. In case of washing sweet potato tuber to prevent cross-contamination, it can lead to decay or rotten. With the purpose of preservation for the clean tuber in a long period of time, it can be washed in water under bubble blowing with ultrasonic and peracetic acid. Sweet potato tuber was primarily infected *E. Coli, Salmonella, Staphylococcus, Listeria* strains at 0.1 % to obtain 8.5 log CFU/g. Experiments examined the impact of ultrasonic cavitation at 37 kHz and 50 W at 12 ^{o}C in different period intervals (2.0÷4.0 minutes), various concentration of peracetic acid (0÷30 ppm) on the survival of these inoculated microbial strains as well as physicochemical properties such as firmness, carotenoid, total phenolic content, total flavonoid content on the control and treated sweet potato. Results showed that ultrasonic at 37 kHz, 50 W at 12 ^{o}C in 3.5 minutes combined peracetic acid at 15 ppm successfully retarded the pathogen density, effectively maintained physicochemical attributes of sweet potato. Ultrasound and peracetic acid incorporation greatly improved spoilage and pathogenic microorganisms sterilization while maintaining the physicochemical quality attributes in sweet potato with respect to individual treatments.

Keywords: Microbial, peracetic acid, physicochemical, sweet potato, ultrasound

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is one of the most important crop in the world by providing nutrients for millions of people in a short period time of planting (about 4 months) (Satheesh et al. 2019). It's a rich source of dietary fibers, minerals, vitamins, antioxidants beneficial for health benefits (Ramesh et al. 2011). Its pulp has different specific colours such as white, yellow, orange and purple (Yoshimoto et al. 2005; Teow et al. 2007; Shao and Huang, 2008; Wu et al. 2008; Liu et al. 2009; Ahmed et al. 2010; Enicole et al. 2010; Katayama et al. 2011; Aoran Li et al. 2019). Phytochemical elements inside its pulp had different pharmacological activities such as antioxidant, anticancer, antiinflammatory, antimutagenic, anticarcinogenic, chemopreventive, antihyperglycemic, antidiabetic, memory and cardiovascular enhancement, free radical scavenging, lower insulin resistance (Kusano and Abe, 2000; Yoshimoto et al. 2001; Oki et al. 2002; Matsui et al. 2002; Konczak-Islam et al. 2003; Haskell et al. 2004; Kano et al. 2005; Saigusa et al. 2005; Suda et al. 2008; Wu et

al.2008; Zhang et al. 2009; Ahmed et al. 2010; Lim et al. 2013; Ellong et al. 2014; Sugata et al. 2015; Hu et al. 2016; Mohammad et al. 2016). Sweet potato tuber is commonly preserved in dry cool storage facilities without washing. During distribution into supermarket, sweet potato tuber with significant amounts of dust and soil adhered to the surface is not attractive for customers. Dust and soil usually contain decay-causing spores that are a ready source of contamination. To minimize decay, processors add antimicrobial agents like sodium hypochlorite, ozonation and copper ionization into the washing water. Antimicrobial agents must be replenished more frequently to ensure the effectiveness of sanitation. Moreover, fungicide is used in certain occasions to prevent decay-producing organisms such as *Rhizopusstolonifer*.

Peracetic acid is commonly available in liquid, clear, and colorless form with no foaming capability. It has an excellent oxidative ability over ozone and even chlorine (Davidson et al. 2018). Peracetic acid degrades quickly without harmful residue to human health. It is a mixture of acetic acid and hydrogen peroxide (Srey et al. 2013; Rosario et al. 2017). Peracetic acid reacts on the outer cell membrane of vegetative bacterial cells, endospores, yeast and mold spores. It can penetrate on the cell wall and cell membrane to oxidize the H-S and S-S linkages in the cell's enzyme. Hence, microbials alters their functional properties (Gawande et al. 2013). Therefore it's utilized to sanitize the recirculating water in washing raw materials. Ultrasound can effectively eliminate a great amount of spoilage and pathogenic microorganisms adhering on surface of fruits and vegetables (Ajlouni et al. 2006; Cao et al. 2010; Wang et al. 2006; Alexandre et al. 2012; Li et al. 2001). Microbial are directly disinfected by cavitation under mechanical, physical and chemical effects (Joyce et al. 2003). Objective of our study examined another alternative by incorporation of ultrasonic and peracetic acid in the washing step to remove clinging soil and surface sanitation.

MATERIALS AND METHODS

Material

Orange-fleshed sweet potato tubers were cultivated in HauGiangprovince, Vietnam. They harvested at 120th day after planting. After collecting, they should be immediately moved to laboratory for experimental demonstrations. They were subjected to ultrasonic washing under bubble blowing combined peracetic acid. *E. Coli, Salmonella, Staphylococcus, Listeria* strains were supplied from Nam Dong Scientific supplier. Testing chemical reagents were all analytical grade.

Researching method

Stock cultures of both strains were maintained in tryptic soy broth. Stock cultures of .*E. Coli, Salmonella, Staphylococcus, Listeria*strains were preserved at 8^{o}C in trypton broth. They were activated at 37^{o}C for 12 hours before inoculation. Each culture infected to the sweet potato samples at 0.1% to achieve 8.5 log CFU/g. One ultrasonic washing machine incorporated with bubble blowing and chilling was used to conduct the cleaning. The samples were sonicated at 37kHz and 50 W at 12 ^{o}C in different time intervals (2.0÷4.0 minutes). Peracetic acid was also added at various concentrations (0÷30 ppm). The treated samples were examined survival of the inoculated microbial strains as well as physicochemical properties such as firmness, carotenoid, total phenolic content, total flavonoid content.

Physicochemical and microbiological determination

E. Coli, Salmonella, Staphylococcus, Listeria enumeration (log CFU/g) were performed by Petrifilm plates. Firmness (N) was estimated by penetrometer. Carotenoid content (mg/100g) was estimated by acetone-petroleum ether extraction followed by spectrophotometric measurement (Mohammad et al., 2016). Total phenolic (mg GAE/100 g) was estimated by the Folin-Ciocalteu colorimetric method (Blainski et al., 2013). Total flavonoid (mg QE/100 g) was evaluated by method described by Zhishen*et al.* (1999). Decay rate (%) was estimated by comparing the weight of the rotten tuber with the weight of the initial lot. Overall acceptance (sensory score) was evaluated by a group of panelist using 9-point Hedonic scale.

Statistical analysis

The experiments were run in triplicate with different groups of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS

Table 1 showsthe survival (log CFU/g) of pathogen microorganism (*E. Coli, Salmonella, Staphylococus* and *Listeria)* on sweet potato tuber

after ultrasonic and peracetic acid treatments. It could be clearly noticed that a combination of ultrasonic and peracetic acid creates better effect in microbial inactivation compared to individual treatments. Incorporation of ultrasonic treatment at 37 kHz, power 50 W in 3.5 minutes together with 15 ppm peracetic acid is appropriate to kill these pathogenic microorganisms.Our findings are similar to others in different reports. Zhen *et al.* (1997) examined the impact of ultrasound frequency in improving theinactivation of *P. Aeruginosa*biofilms. Bettner*et al.* (1998) verified the influence of ultrasoundwashing on disinfection of microbials. Joyce *et al.* (2003) demonstrated the effectiveness of ultrasonic treatment onmicrobial suspensions. Kelli *et al.* (2004) investigated the sanitation of bacterial spores by high efficiency non-contact ultrasonic transducers. Zoran*et al.* (2013)examined the influence of high intensity ultrasonic on the disinfection of food spoilage bacteria. Mamadou*et al.* (2020) evaluated the influence of ultrasonic and ozone incorporation on microbiological survial and bioactive retention on cabbage. Ultrasoundcaneliminate the microorganisms in laboratory, it may be inadequate in industrial scale because of its low sterilization effect (Sagong et al., 2011). To obtain a satisfying disinfection effect, long treatment duration and high acoustic energy are required, but this can seriously damage the texture of raw material leading to sensitive infestation by spoilage and pathogen microbials (Seymour et al., 2002; Ajlouni S et al., 2006; Cao et al., 2010). Moreover, microbials adheringon peel of fruits and vegetables will be released into the washing water with a greatchance of cross-contamination (Seymour et al., 2002). Ultrasoundenhancesdisinfection by losing the microbial cell wall, facilitating the penetration of sanitizer agents (Minh 2019). Ultrasound supportsa removing effect on fruits and vegetables because cavitation bubble collapse near the solid is non-symmetric and produces a powerful jet which will dislodge microorganism cells. The ultrasonic cleaning can enter crevices that are not easily accessible using conventional cleaning methods (Mason, 2002). Cherrytomatoe was treated with ultrasound (45 kHz) for 10 min in the presence of40 mg/L peracetic acid. The highest reduction of adherent *Salmonella* Typhimurium by 3.9 $\log_{10}$ cfu/g was reported (Jackline and Maria, 2012). Combination of peracetic acid and ultrasound reduced *Salmonella* Typhimurium on fresh lettuceto undetectable levels (< 1 log cfu/g) (Luiza et al., 2018).

Table 1: Survival (log CFU/g) of pathogen microorganism (*E. Coli, Salmonella, Staphylococus* and *Listeria)* on sweet potato tuber after ultrasonic and peracetic acid treatments

Microorganisms	Treatment time (min)	Peracetic acid concentration (ppm)			Ultrasonic + peracetic acid (ppm)		
		0	15	30	0	15	30
E. Coli	2.0	8.11±0.01^{a}	7.63±0.00^{ab}	6.95±0.02^{b}	5.10±0.04^{bc}	3.72±0.00^{c}	3.53±0.04^{ac}
	2.5	7.98±0.03^{a}	6.74±0.01^{ab}	5.82±0.00^{b}	4.07±0.02^{bc}	2.03±0.03^{c}	1.96±0.01^{c}
	3.0	7.45±0.04^{a}	6.12±0.00^{ab}	5.03±0.02^{b}	3.41±0.01^{bc}	1.70±0.00^{c}	1.58±0.03^{c}
	3.5	7.32±0.00^{a}	5.24±0.03^{b}	4.62±0.01^{bc}	2.94±0.03^{c}	1.14±0.04^{cd}	0.45±0.02^{d}
	4.0	7.19±0.03^{a}	5.16±0.04^{b}	4.13±0.00^{bc}	2.33±0.02^{c}	0.95±0.01^{d}	0.16±0.03^{e}
Salmonella	2.0	7.54±0.02^{a}	6.31±0.01^{ab}	5.12±0.03^{b}	4.17±0.00^{bc}	3.19±0.04^{c}	3.02±0.01^{c}
	2.5	7.22±0.01^{a}	6.07±0.00^{ab}	4.83±0.02^{b}	3.44±0.01^{bc}	2.06±0.03^{c}	1.93±0.02^{c}
	3.0	6.89±0.00^{a}	4.12±0.02^{b}	3.04±0.01^{bc}	2.36±0.02^{c}	1.03±0.00^{cd}	0.77±0.03^{d}
	3.5	6.53±0.02^{a}	2.09±0.04^{b}	1.13±0.00^{c}	0.32±0.03^{cd}	0.07±0.04^{d}	0.03±0.01^{d}
	4.0	6.19±0.03^{a}	2.03±0.01^{b}	1.01±0.02^{c}	0.19±0.01^{cd}	0.04±0.02^{d}	0.02±0.00^{d}
Staphylococus	2.0	7.67±0.04^{a}	6.14±0.01^{ab}	5.64±0.02^{b}	4.77±0.01^{bc}	3.06±0.03^{c}	2.89±0.00^{c}
	2.5	7.42±0.02^{a}	5.72±0.02^{b}	4.23±0.01^{bc}	3.41±0.03^{c}	2.01±0.00^{cd}	1.63±0.04^{d}
	3.0	7.05±0.00^{a}	4.89±0.03^{b}	3.72±0.03^{bc}	2.24±0.01^{c}	1.63±0.04^{cd}	1.08±0.02^{d}
	3.5	6.84±0.01^{a}	3.21±0.02^{b}	2.04±0.00^{bc}	1.13±0.02^{c}	0.31±0.03^{cd}	0.14±0.04^{d}
	4.0	6.75±0.02^{a}	3.02±0.01^{b}	1.95±0.04^{bc}	1.01±0.03^{c}	0.24±0.01^{cd}	0.11±0.00^{d}
Listeria	2.0	8.04±0.00^{a}	6.89±0.02^{ab}	5.01±0.01^{b}	4.32±0.04^{bc}	1.64±0.00^{c}	1.53±0.03^{c}
	2.5	7.64±0.03^{a}	5.07±0.00^{ab}	4.24±0.02^{b}	2.16±0.01^{bc}	1.03±0.02^{c}	0.99±0.04^{c}
	3.0	7.21±0.04^{a}	4.31±0.01^{b}	3.07±0.03^{bc}	2.34±0.00^{c}	0.55±0.04^{d}	0.34±0.02^{d}
	3.5	6.83±0.02^{a}	3.24±0.04^{b}	1.95±0.01^{c}	0.43±0.03^{cd}	0.12±0.01^{d}	0.07±0.00^{d}
	4.0	6.55±0.01^{a}	3.05±0.03^{b}	1.64±0.00^{c}	0.27±0.01^{d}	0.05±0.02^{d}	0.01±0.00^{d}

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2. Firmness (N), carotenoid (mg/100 g), total phenolic content (mg GAE/100 g), total flavonoid

(mg QE/100 g) of sweet potato tuber after ultrasonic and peracetic acid treatment

Parameters	Treatment time (min)	Peracetic acid concentration (ppm)			Ultrasonic + peracetic acid (ppm)		
		0	15	30	0	15	30
Firmness (N)	2.0	29.75±0.04^a	29.74±0.01^a	29.76±0.00^a	29.71±0.02^a	29.73±0.03^a	27.70±0.00^a
	2.5	29.72±0.01^a	29.68±0.03^a	29.63±0.02^a	29.59±0.04^a	29.60±0.01^a	29.62±0.00^a
	3.0	29.67±0.00^a	29.63±0.02^a	29.65±0.03^a	29.54±0.01^a	29.50±0.02^a	29.47±0.01^a
	3.5	29.60±0.03^a	29.54±0.04^a	29.50±0.01^a	29.47±0.02^a	29.43±0.00^a	29.42±0.02^a
	4.0	29.54±0.04^a	29.53±0.01^a	29.50±0.02^a	29.45±0.03^a	29.42±0.00^a	29.41±0.00^a
Carotenoid (mg/100 g)	2.0	377.80±0.00^a	377.64±0.03^a	377.59±0.04^a	377.53±0.02^a	377.40±0.01^a	377.37±0.03^a
	2.5	377.44±0.01^a	377.42±0.00^a	377.38±0.03^a	377.30±0.04^a	377.24±0.02^a	377.19±0.01^a
	3.0	377.35±0.03^a	377.33±0.02^a	377.29±0.01^a	377.25±0.00^a	377.23±0.04^a	377.15±0.00^a
	3.5	377.29±0.00^a	377.14±0.01^a	377.07±0.04^a	377.03±0.03^a	377.02±0.02^a	377.00±0.01^a
	4.0	377.25±0.04^a	377.11±0.00^a	377.04±0.03^a	377.01±0.01^a	369.98±0.03^a	369.95±0.00^a
Total phenolic content (mg GAE/ 100 g)	2.0	124.53±0.02^a	124.51±0.03^a	124.49±0.00^a	124.47±0.03^a	124.45±0.02^a	124.43±0.04^a
	2.5	124.50±0.01^a	124.49±0.00^a	124.47±0.02^a	124.43±0.01^a	124.39±0.04^a	124.36±0.02^a
	3.0	124.47±0.03^a	124.45±0.01^a	124.41±0.04^a	124.37±0.02^a	124.35±0.00^a	124.30±0.01^a
	3.5	124.45±0.04^a	124.42±0.03^a	124.38±0.01^a	124.36±0.00^a	124.33±0.02^a	124.29±0.00^a
	4.0	124.41±0.02^a	124.36±0.00^a	124.32±0.03^a	124.28±0.01^a	124.23±0.04^a	124.21±0.03^a
Total flavonoid (mg QE/100 g)	2.0	79.95±0.01^a	79.94±0.04^a	79.92±0.00^a	79.91±0.03^a	79.87±0.02^a	79.86±0.01^a
	2.5	79.91±0.00^a	79.88±0.01^a	79.86±0.02^a	79.85±0.04^a	79.81±0.03^a	78.79±0.00^a
	3.0	79.87±0.03^a	79.83±0.00^a	79.80±0.01^a	79.78±0.02^a	79.77±0.04^a	79.75±0.02^a
	3.5	79.85±0.00^a	79.81±0.04^a	79.78±0.03^a	79.75±0.01^a	79.71±0.02^a	79.68±0.01^a
	4.0	79.83±0.02^a	79.80±0.03^a	79.76±0.01^a	79.72±0.04^a	79.68±0.00^a	79.65±0.03^a

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3: Weight loss (%), decay rate (%) and overall acceptance of the treated samples in storage

	Storage time (week)	Non-washing	Washing with water in 3.5 minutes	Ultrasonic (37 kHz, 50W, 12 ^oC) + peracetic acid 15 ppm, washing in 3.5 minutes
Weight loss (%)	1	1.63±0.02^b	2.34±0.00^a	0.27±0.03^c
	2	2.54±0.01^b	3.85±0.03^a	0.44±0.00^c
	3	3.85±0.03^b	4.59±0.01^a	0.61±0.02^c
	4	5.66±0.04^b	6.98±0.02^a	0.94±0.01^c
	5	7.41±0.00^b	8.34±0.03^a	1.03±0.02^c
Decay rate (%)	1	0.21±0.03^b	0.85±0.01^a	0.00±0.00^c
	2	0.69±0.01^b	1.34±0.04^a	0.06±0.03^c
	3	0.98±0.00^b	2.65±0.02^a	0.14±0.01^c
	4	1.45±0.03^b	3.27±0.00^a	0.23±0.01^c
	5	1.96±0.00^b	4.88±0.03^a	0.31±0.03^c
Overall acceptance (sensory score)	1	8.82±0.01^a	8.75±0.04^a	8.94±0.02^a
	2	8.21±0.02^{ab}	7.23±0.00^b	8.91±0.01^a
	3	7.86±0.03^{ab}	6.21±0.01^b	8.85±0.03^a
	4	7.31±0.00^b	4.68±0.02^c	8.82±0.02^a
	5	7.04±0.02^b	3.23±0.00^c	8.79±0.03^a

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Firmness, carotenoid, total phenolic and flavonoid constitute the critical quality attributes of orange-fleshed sweet potato. An incorporation of ultrasonic and peracetic acid reveals synergistic effect to maintain firmness, carotenoid, total phenolic content, total flavonoid of sweet potato tuber.

There is not significant difference in treatment time. In case of using peracetic acid alone, or combination of ultrasonic and peracetic acid, there is not significant difference (see table 2). Many literatures proved that ultrasound maintained the texture of fruits and vegetables during storage (Chen and Zhu, 2011; Cao et al., 2010; , Wang et al. 2006; Alexandre et al., 2012; Wei 2010; Zhao et al., 2007).

It can be explained that ultrasound had ability to retard enzyme activity of pectin methylesterase and polygalacturonase which are responsible for

texture softening (Cao et al., 2010). Enzymatic breakdown of cell wall components depends on the energy produced through respiration (Hertog et al., 2004). Pretreatment with ultrasound could effectively maintain pigments (Wei, 2010; Alexandre et al., 2012). Anthocyanin degradation in strawberry was retarded by ultrasonic treatment (Alexandre et al., 2012). Chlorophyll in asparagus could be successfully maintained by ultrasound (Wei, 2010). Ultrasound reduced the decomposition of litchi anthocyanin at power 120 W for 10 min (Chen et al., 2012).

Total flavonoid, total phenolic content were highly preserved in ultrasound treated fresh products (Chen et al., 2011; Cao et al., 2010; Wang et al., 2006; Alexandre et al., 2012; Wei, 2010; Zhao et al., 2007). A combination of ultrasonic (37 kHz, 50W, 12 ^{o}C) and peracetic acid 15 ppm, washing in 3.5 minutes shows a great influence to retardation of weight loss and decay percentage while improvement of overall acceptance over the non-washing as well as washing with clean water in 3.5 minutes (see table 3). Sweet potato has thin, delicate skin that is sensitively damaged by cuts and abrasions resulting to shrinkage and rotten. Surface pitting greatly speed up respiration rate and decay caused by *Penicillium* spp. Tuber may not exude latex in cutting. Weight loss is significantly correlated to respiration. By limitation of respiration by ultrasound, weight loss also decreases respectively. Senescence in fruit and vegetable is significantly correlated to reactive oxygen species and incidental oxidative damage of mitochondrial protein (Tian et al., 2013).

There is a scavenging system of to reactive oxygen species including superoxide dismutase, catalase, peroxidase, ascorbate peroxidase and glutathione peroxidase. Activities of these enzymes were elevated after ultrasonic treatment (Zhao et al., 2007; Li et al., 2007). The combined treatment was more effective in lowering decay and preserving better quality parameters of loquat fruit than ultrasonic or peracetic acid treatment alone (Chen et al. 2018).

CONCLUSION

Spoilage and pathogen microorganisms, dirt and soil are the major foreign matters adhering the outer layer of sweet potato tuber. These matters easily cause the decay of raw sweet potato tuber and risk to human health. Power ultrasound has diversified function in disinfecting spoilage and pathogenic microbials as well as separating other harmful matters. Peracetic acid is one of the most environmentally friendly antimicrobial agents. Owing to the synergetic effect of ultrasound and peracetic acid; a shorter treatment duration, lower acoustic energy consumption, lower dosage of peracetic acid, and much more friendly environment were easily noticed.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

REFERENCES

Ahmed M., Akter S., Eun J.B. (2010). Peeling, drying temperatures, and sulphite-treatment affect physicochemical properties and nutritional quality of sweet potato flour. *Food Chem* 121: 112–118.

Ajlouni S., Sibrani H., Premier R., Tomkins B (2006). Ultrasonication and fresh produce (Cos lettuce) preservation. *Journal of Food Science* 71: 62-68.

Alexandre E.M.C., Brandao T.R.S., Silva C.L.M. (2012). Efficacy of non-thermal technologies and sanitizer solutions on microbial load reduction and quality retention of strawberries.*Journal of Food Engineering* 108: 417-426.

Amr A. and Al-Tamimi E. (2007). Stability of the crude extracts of Ranunculus asiaticusanthocyanins and their use as food colourants. *International Journal of Food*

Science and Technology 42: 985-991.

Aoran L., Ruoshi X., Sijia H., Xiaoyu A., Yi H., Chengtao W., Sheng Y., Bin W., Xuewei S., Jingren H. (2019). Research advances of purple sweet potato anthocyanins: Extraction, identification, stability, bioactivity, application, and biotransformation. *Molecules* 24: 3816.

Bettner M.D., Beiswanger M.A., Miller C.H., Palenik C.J. (1998). Effect of ultrasonic cleaning on microorganisms.*American Journal of Dentistry* 11: 185-188.

Blainski A., Lopes G.C., de Mello J.C.P. (2013). Application and analysis of the folinciocalteu method for the determination of the total phenolic content from *Limoniumbrasiliense* L. *Molecules* 18: 6852–6865.

Cao S.F., Hu Z.C., Pang B., Wang H.O., Xie H.X., Wu F. (2010). Effect of ultrasound treatment on fruit decay and quality maintenance in strawberry after harvest.*Food Control* 21: 529-532.

Chen L., Jia X., Shuang S., Li W., Peng J., Yonghua Z. (2018). Effect of ultrasonic treatment combined with peracetic acid treatment reduces decay and maintains quality in loquat fruit. *Journal of Food Quality* 2018: 7564056.

Chen Y.L., Jiang Y.M., Yang S.Y., Yang E., Yang B., Prasad K.N. (2012). Effects of ultrasonic treatment on pericarp browning of postharvest litchi fruit.*Journal of Food Biochemistry* 36: 613-620.

Chen Z. and Zhu C.H. (2011).Combined effects of aqueous chlorine dioxide and ultrasonic treatments on postharvest storage quality of plum fruit (*Prunussalicina*L.).*Postharvest Biology and Technology* 61: 117-123.

Davidson J., Steven S., David L.S., Kevin K.S., Christopher G. (2018). Evaluating the effects of prolonged peracetic acid dosing on water quality and rainbow trout *Oncorhynchusmykiss* performance in recirculation aquaculture systems.*Aquac. Eng.* 84: 117-127.

Ellong E.N., Billard C., Adenet S. (2014). Comparison of physicochemical, organoleptic and nutritional abilities of eight sweet potato (*Ipomoea batatas*) varieties.*Food Nutr. Sci.* 5: 196.

Enicole B., Maris C., Vanden T. (2010). Extraction of anthocyanins from industrial purple-fleshed sweet potatoes and enzymatic hydrolysis of residues for fermentable sugars.*Ind. Crops Prod.* 32: 613–620.

Gawande H.M., Dhotre A.V., Shendurse A.M., Khodwe N.M. (2013).Peroxyacetic acid: A potent food industry sanitizer. *Indian Food Industry Mag* 32: 26-30.

Haskell M.J., Jamil K.M., Hassan F., Peerson J.M., Hossain M.I., Fuchs G.J., Brown K.H. (2004). Daily consumption of Indian spinach (*Basellaalba*) or sweet potatoes has a positive effect on total body vitamin A stores in Bangladeshi men. *Am. J. Clin. Nutr.* 80: 705-714.

Hertog M., Nicholson S.E., Jeffery P.B. (2004). The effect of modified atmospheres on the rate of firmness change of 'Hayward' kiwifruit.*Postharvest Biology and Technology* 31: 251-261.

Hu Y., Deng L., Chen J., Zhou S., Liu S., Fu Y., Chen M. (2016). An analytical pipeline to compare and characterise the anthocyanin antioxidant activities of purple sweet potato cultivars.*Food Chemistry* 194: 46-54.

Jackline F.B.S.J. andMaria C.D.V. (2012). Effect of ultrasound and commercial sanitizers in removing natural contaminants and *Salmonella enterica* Typhimurium on cherry tomatoes.*Food Control* 24: 95-99.

Joyce E., Mason T.J., Phull S.S., Lorimer J.P. (2002). The development and evaluation of ultrasound for the treatment of bacterial suspension.*UltrasonSonochem* 10: 315-318.

Kano M., Takayanagi T., Harada K., Makino K., Ishikawa F. (2005).Antioxidative activity of anthocyanins from purple sweet potato, *Ipomoerabatatas* cultivar Ayamurasaki. *Biosci.Biotechnol.Biochem.* 69: 979–988.

Katayama K., Kitahara K., Sakai T., Kai Y., Yoshinaga M. (2011). Resistant and digestible starch contents in sweet potato cultivars and lines*. J. Appl. Glycosci.* 58: 53–59.

Kelli H., Mahesh B., Nancy O., Owen T.(2002). Destruction of bacterial spores by phenomenally high efficiency non-contact ultrasonic transducers.*Materials Research Innovations*6: 291-295.

Konczak-Islam I., Yoshimoto M., Hou D.X., Terahara N., Yamakawa O. (2003). Potential chemopreventive properties of anthocyanin-rich aqueous extracts from in vitro produced tissue of sweetpotato (*Ipomoea batatas* L.). *Journal of Agricultural and Food Chemistry* 51: 5916-5922.

Kusano S. and Abe H. (2000). Antidiabetic activity of white skinned sweet potato (*Ipomoea*

batatas L.) in obese Zuckers fatty rats. *Biological and Pharmaceutical Bulletin* 23: 23–26.

Li C.L., Duan S.H., Liao P. (2001). Application of ultrasound and coating in the preservation of bean (in Chinese).*Food Science and Technology* 4: 61-62.

Li P., Han T., Li L.P., Wang Z.M. (2007). Effect of ultrasound wave combined with calcium on reactive oxygen metabolism of postharvest peach. *ScientiaSilvaeSinicae* 43: 36-40.

Lim S., Xu J., Kim J., Chen T.Y., Su X., Standard J., Carey E., Griffin J., Herndon B., Katz B. (2013). Role of anthocyanin-enriched purple-fleshed sweet potato P40 in colorectal cancer prevention. *Mol. Nutr. Food Res.* 57: 1908–1917.

Liu S.C., Lin J.T., Yang D.J. (2009).Determination of cis- and trans-α and β-carotenoids in Taiwanese sweet potatoes (*Ipomoea batatas* (L.) Lam.) harvested at various times. *Food Chem* 116: 605–610.

Luiza O.S., Denes K.A.R., Ana C.G.G., Syllas B.S.O., Yhan S.M., Clara S. M., Jussara M.C., Patrícia C.B. (2018). Combination of peracetic acid and ultrasound reduces *Salmonella* Typhimurium on fresh lettuce (*Lactuca sativa* L. var. crispa). *J Food Sci Technol.* 55: 1535–1540.

Mamadou B.T., Aidong S., Zhilin G., Wei Y.L., Hamidou S., Yue Z., Jacques T., Kankou H.F., Aboubacar M.S. (2020). Assessing the impact of the combined application of ultrasound and ozone on microbial quality and bioactive compounds with antioxidant attributes of cabbage (Brassica Oleracea L. Var. Capitata). *Journal of Food Processing and Preservation* 44: 14779.

Mason T.J. and Lorimer J.P. (2002).*Introduction to applied ultrasonics*. In: Applied sonochemistry: uses of power ultrasound in chemistry and processing, Wiley-VCH Verlag, Weinheim, 1-24.

Matsui T., Ebuchi S., Kobayashi M., Fukui K., Sugita K., Terahara N., Matsumoto K. (2002). Anti-hyperglycemic effect of diacylated anthocyanin derived from *Ipomoea batatas* cultivar Ayamurasaki can be achieved through the aglucosidase inhibitory action. *Journal of Agricultural and Food Chemistry* 50: 7244-7248.

Minh N.P. (2019). Ultrasound degradation effect on residual pesticides and microorganisms in commercially available fruits and vegetables.*Journal of Engineering and Applied Sciences 14*:120-129

Mohammad K.A., Ziaul H.R., Sheikh N.I. (2016). Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange-fleshed sweet potato varieties grown in Bangladesh.*Foods* 5: 64.

Oki T., Masuda M., Furuta S., Nishiba Y., Terahara N., Suda I. (2002). Involvement of anthocyanins and other phenolic compounds in radical-scavenging activity of purple-fleshed sweet potato cultivars. *J. Food Sci.* 67: 1752–1756.

Ramesh R.C., Sandeep P.K., Manas S.R., Sethuraman S.P. (2011). Proximate composition and sensory evaluation of anthocyanin-rich purple sweet potato (*Ipomoea batatas* L.) wine. *International Journal of Food Science and Technology* 2011: 02861.

Rosario D.K.A., da Silva M.Y., Peixoto J.M.C. (2017). Ultrasound improves chemical reduction of natural contaminant microbiota and *Salmonella enterica* subsp. *enterica* on strawberries. *Int J Food Microbiol.* 241: 23–29.

Sagong H.G., Lee S.Y., Chang P.S., Heu S., Ryu S., Choi Y.J. (2011). Combined effect of ultrasound and organic acids to reduce *Escherichia coli*O157:H7, *Salmonella Typhimurium*, and *Listeria monocytogenes*on organic fresh lettuce. *International Journal of Food Microbiology* 145: 287-292.

Saigusa N., Terahara N., Ohba R. (2005). Evaluation of DPPH radical scavenging activity and antimutagenicity and analysis of anthocyanins in an alcoholic fermented beverage produced from cooked or raw purple-fleshed sweet potato (*Ipomoea batatas*cv*Ayamurasaki*) roots. *Food Science and Technology Research* 11: 390–394.

Satheesh N. andSolomon F.W. (2019). Review on nutritional composition of orange-fleshed sweet potato and its role in management of vitamin A deficiency. *Food Science and Nutrition* 7: 1920-1945.

Seymour I.J., Burfoot D., Smith R.L., Cox L.A., Lockwood A. (2002).Ultrasound decontamination of minimally processed fruits and vegetables.*International Journal of Food Science and Technology* 37: 547-557.

Shao Y.Y. and Huang Y.C. (2008).Effect of steaming and kneading with presteaming treatments on the physicochemical properties of various genotypes of sweet potato (*Ipomoea batatas* L.).*J Food Process*

Eng 31: 739–753.

Srey S., Jahid I.K., Ha S.D. (2013). Biofilm formation in food industries: a food safety concern. *Food Control* 31: 572–585.

Sugata M., Lin C.Y., Shih Y.C. (2015). Anti-inflammatory and anticancer activities of Taiwanese purple-fleshed sweet potatoes (*Ipomoea batatas* L. Lam) extracts.*BioMed Research International* 768093: 768093.

Teow C.C., Truong V., McFeeters R.F., Thompson R.L., Pecota K.V., Yencho G.C. (2007). Antioxidant activities, phenolic and bcarotene contents of sweet potato genotypes with varying flesh colours.*Food Chemistry* 103: 829–838.

Tian S., Qin G., Li B. (2013). Reactive oxygen species involved in regulating fruit senescence and fungal pathogenicity. *Plant molecular biology* 82: 593–602.

Wang J., Han T., Li L.P., Wang K.S., Sun S.W. (2006). Effect of ultrasonic treatment on the peaches quality during storage.*Journal of Shihezi University (Natural Science)* 24: 732-735.

Wu D.M., Lu J., Zheng Y.L., Zhou Z., Shan Q., Ma D.F. (2008). Purple sweet potato color repairs D-galactose-induced spatial learning and memory impairment by regulating the expression of synaptic proteins. *Neurobiol. Learn. Mem.* 90: 19–27.

Yoshimoto M., Okuno S., Yamaguchi M., Yamakawa O. (2001). Antimutagenicity of deacylatedanthocyanins in purple-fleshed sweetpotato. *J. Agric. Chem. Soc. Jpn.* 65: 1652–1655.

Zhang Z.F., Fan S.H., Zheng Y.L., Lu J., Wu D.M., Shan Q., Hu B. (2009). Purple sweet potato color attenuates oxidative stress and inflammatory response induced by D-galactose in mouse liver. *Food Chem. Toxicol.* 47: 496–501

Zhao Y.X., Feng Z.S., Li X.W. (2007). Effect of ultrasonic and MA packaging method on quality and some physiological changes of fragrant pear.*Journal of Xinjiang University* 30: 61-63.

Zhen Q., Richard D.S., William G.P. (1997). Theeffect of ultrasonic frequency upon enhanced killing of *P. Aeruginosa*biofilms. *Annals of Biomedical Engineering* 25: 69-76.

Zoran H., Ksenija M., Brankica S.S., Anet R.J., Tomislava V., Janko K. (2013). Effect of high intensity ultrasound treatment on the growth of food spoilage bacteria.*Food Technology Biotechnology* 51:352–359.