EVALUATION OF THE QUALITY OF PORK CHOPS SPRAY COATING WITH CHINESE MAHOGANY (*TOONA SINENSIS*) EXTRACT DURING STORAGE AT 10℃

D .C. Liu [1], Z. H. Lin[1] , Rommanee Thammasena[1], F. R. Tang[1], J. H. Liu[2] , C. F. Wu [3]and P. K. Hsu[3]

[1] Dept. of Animal Sci. National Chung Hsing Univ. Taichung, Taiwan ROC

[2] Dept. of Animal Sci. North Dakota State Univ. Fargo, ND, USA

[3] Greenyn Biotechnology Co., LTD Taiwan ROC

Abstract –The pH value, TBA and VBN value of pork chops in all lots increased with storage time; control and positive control were significantly higher than all lots sprayed with *T. sinensis* extract after 10 days during storage at 10℃. However, the TBA and VBN of pork chops sprayed with 250 and 500 ppm *T. sinensis* extract were kept stable and lower value during whole storage. The total plate count of control and positive control increased significantly with time, and reached 10^7 CFU/g at the 7^{th} day of storage but all lots sprayed with *T. sinensis* extract were prolonged to the end of storage (14 days). The a* value of pork chops sprayed with *T. sinensis* extract maintained stable during storage but control and positive control were significantly decreased with storage time. The profiles of sensory panel in all lots of pork chops showed no significant differences at the beginning. However, odor and overall acceptance in pork chops of control and positive control can not be accepted over 3 days of storage but treated by 250 and 500 µg/mL *T. sinensis* were prolonged to 7 days of storage at 10℃ in this study.

Key Words –Positive Control, anaerobic count, odor.

I. INTRODUCTION

A lot of food products are easily perishable by nature and required safety from spoilage during their preparation, storage and delivery for extended shelf-life. Nowadays, many perishable food products are often sold at low temperature to extend their shelf-life. Food grade chemicals have been used in the food industry to extend the shelf-life of products by changes chemical or reducing microbial growth. However, the greater notice and concern regarding synthetic chemical additives of consumer and make natural foods preservative become popular. Antimicrobial compounds found in plants can enhance shelf-life of unprocessed or processed foods by inhibiting microbial growth and also improve the taste and flavor of foods (Holley and Patel, 2005). *The* leaves of *T. sinensis* have been reported to possess strong antimicrobial activity. It was against *Aeromonas hydrophila*, which is a pathogenic bacteria in tilapia (*Oreochromis mossanbicus*). *T. sinensis* could increase the immune response, respiratory burst, phagocytic efficiency and lysozyme activity in plasma of tilapia after injected with this bacterial pathogen (Wu *et al*., 2010). Moreover, the tender leaves of *T. sinensis* could inhibit SARS coronavirus replication (Chen *et al*., 2008). Additionally, rutin is a flavonoid of *T. sinensis* could increase resistance against *Vibrio alginolyticus* bacteria pathogen on Pacific white shrimp (*Litopenaeus vannamei*) by increasing phenoloxidase activity, survival rate and retained lower haemolymph glucose, lactate, and lipid levels after injecting with a pathogen (Hsieh *et al*., 2008).

Therefore, the objective of this study was to evaluate antibacterial activity of *T. sinensis* extracts spraying on the surface of pork chops during storage at 10°C for 14days.

II. MATERIALS AND METHODS

3% of ground dried leaves of *T. sinensis* was mixed in 50% ethanol with 120 rpm shaking at room temperature for 24 h. After shaking, the ethanolic extract was filtrated through a filter paper, evaporated under reduced pressure in a rotary evaporator at 60°C until change to viscous concentrates. Preparation of spray coating solutions were as the following: control-RO water, Positive control (PC)-70% alcohol, 125, 250 and 500ppm- *T. sinensis* extract diluted with

70% alcohol to 125¸ 250 and 500ppm, individually. Pork loins with 0.3 cm thickness of back fat were cut by 1.5cm thickness. 5 mL of blank(C), PC and *T. sinensis* extracts were sprayed coating on the surface of pork loin chops and kept at 4℃ for 5min then packed by aerobic package. A total of 30 packs which contained 3 piece (about 180 g)of pork loin chop was prepared for each treatment and stored at 10 ºC for 14days. At day0, 1, 3, 5, 7, 10 and 14, three bags of each treatment was taken to analysis total plate count, color (L*, a*, b*), volatile basic nitrogen (VBN), pH value, TBA value and one bag for sensory evaluation. Color, odor and total acceptance will be evaluated by 10 trained panelists. A 7 point hedonic scale test was performed in this study. 7 is very like, 1 is very dislike.

III. RESULTS AND DISCUSSION

pH, VBN and TBA

The pH value of all lots increased with storage time (table 1); control and positive control were significantly higher than all *T. sinensis* extract treatments after 7 days during storage. The VBN value of control and positive control increased quickly with storage time (table2) and the value was 27.04and 25.90 mg% at the 10th day. However, the VBN of fresh pork chop spray coated with 250 and 500 ppm *T. sinensis* extract were kept stable and lower value during whole storage. The change of TBA value was similar to VBN in this study. The TBA of control was increased rapidly to 4.74 mg MDA/kg at the 3rd day and reached the peak point (6.36 mg MDA/kg) at the 5th day then swiftly decreased and down to 0.79 at the end of storage(table3). Nevertheless, all *T. sinensis* extract treatments kept stable TBA value until the end of storage.

Total plate count

The profiles of microbial(table 4), the total plate count of control and positive control increased significantly with storage time, and reached over 10^7 CFU/g at the 7th days of storage. However, the equal number (10^7 CFU/g) of total plate count of fresh pork chops spray coating with different levels of *T. sinensis* extract were obtained at the end of storage (14 days). The results demonstrated that use of *T. sinensis* extract can significantly inhibit the growth of bacteria in pork chops during storage at 10℃.

Color (L, a and b value)

The L* value of all lots significantly increased with storage time but had no significant difference among treatments. The a* value of fresh pork chop treated by spray coating with different levels of *T. sinensis* extract maintained a stable and fixed number during whole storage but control and positive control were significantly decreased after 3days during storage(figure 1). Moreover, the b* value of all lots kept stable until the end of storage. These results indicated that *T. sinensis* extract has efficient decelerate discoloration of pork chops during storage at 10 ℃.

Sensory panel test

The profiles of sensory panel test (color, odor and overall acceptance), the sensory score of fresh pork chop in all lots decreased significantly with storage time but no significant differences were found at the beginning (table5-7). According of color score, the fresh pork chops in control and positive control were unacceptable at the 7th day but spray coating with 250 and 500 ppm *T. sinensis* extract were still acceptable by sensory people. Furthermore, combination with odor and overall acceptance, pork chops of control and positive control can not be acceptable after 3 days of storage and the acceptable time of fresh pork chops treated by 250 and 500 ppm *T. sinensis* extract were prolonged to 7 days of storage.

IV. CONCLUSION

Based on the analysis of total plate count, all level of *T. sinensis* solution exhibited effective antibacterial ability when spray coated on the surface of pork chops and can prolong the shell-life to 14 day at 10℃. However, the shell-life of pork chops for control and positive control was 3days , treated with 125ppm *T. sinensis* was 5 days *and with 250* and 500ppm was 7days individually when combined with all sensory panel items in this study.

Table 1. The changes in pH value of pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃

	pH value				
day	Control	PC	125 ppm	250 ppm	500 ppm
0	6.1^{B}	6.1^{B}	6.1^{AB}	6.0^{BC}	6.0^{C}
1	6.1^{B}	6.1^{B}	6.2^{AB}	6.1^{B}	6.3^{B}
3	6.4^{a,B}	6.3^{ab,B}	6.2^{ab,AB}	6.4^{BC}	6.1^{BC}
5	6.1^{B}	6.1^{B}	6.3^{A}	6.2^{BC}	6.1^{BC}
7	6.2^{B}	6.1^{B}	6.3^{B}	6.2^{BC}	6.1^{BC}
10	7.0^{a,A}	7.0^{a,A}	6.4^{b,A}	6.3^{b,B}	6.3^{b,B}
14	7.1^{a,A}	7.1^{a,A}	6.4^{b,A}	6.5^{b,A}	6.6^{b,A}

$^{a\text{-}b}$: Means within the same row without the same superscript are significantly different ($p<0.05$).

$^{A\text{-}C}$: Means within the same column without the same superscript are significantly different ($p<0.05$).

Table 2. The changes in VBN value of pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃

	VBN value (mg %)				
day	Control	PC	125 ppm	250 ppm	500 ppm
0	10.8^{E}	10.1^{E}	11.2^{C}	10.8^{D}	10.2^{D}
1	10.8^{E}	10.9^{DE}	11.7^{C}	10.0^{D}	10.8^{CD}
3	13.4^{a,DE}	13.3^{ab,DE}	12.3^{b,C}	11.6^{b,D}	11.1^{b,CD}
5	14.9^{CD}	14.1^{CD}	13.0^{C}	12.6^{CD}	11.4^{CD}
7	17.1^{aC}	17.4^{a,C}	17.0^{a,B}	14.4^{ab,BC}	13.4^{b,BC}
10	27.0^{a,B}	25.9^{a,B}	17.8^{b,B}	15.8^{b,B}	15.2^{b,B}
14	36.2^{a,A}	33.6^{a,A}	30.8^{a,A}	23.2^{b,A}	23.9^{A}

Footnotes are the same as Table 1

Table 3. The changes in TBA value of pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃

	TBA value (mg MDA/kg)				
day	Control	PC	125 ppm	250 ppm	500 ppm
0	0.45^{F}	0.30^{E}	0.40^{C}	0.36^{C}	0.32^{D}
1	0.54^{a,EF}	0.59^{a,D}	0.48^{ab,C}	0.50^{ab,C}	0.42^{b,CD}
3	4.74^{a,C}	0.66^{b,D}	0.63^{b,C}	0.61^{b,BC}	0.53^{b,BC}
5	6.36^{a,A}	1.20^{b,C}	0.53^{c,C}	0.46^{c,C}	0.57^{c,BC}
7	5.08^{a,D}	1.43^{b,C}	0.54^{c,C}	0.67^{c,BC}	0.49^{c,BCD}
10	1.22^{b,E}	3.56^{a,A}	1.39^{b,B}	0.86^{c,B}	0.66^{c,B}
14	0.79^{d,E}	2.29^{a,B}	1.64^{b,A}	1.63^{b,A}	1.08^{c,A}

Footnotes are the same as Table 1

Table 4. The changes in total plate count of pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃

	Count (log CFU/g)				
days	Control	PC	125 ppm	250 ppm	500 ppm
0	4.80^{a,DE}	4.78^{a,DE}	4.63^{a,D}	3.79^{b,F}	3.43^{b,F}
1	5.09^{a,D}	4.66^{b,E}	4.42^{c,D}	4.66^{bc,DE}	4.09^{d,E}
3	4.50^{E}	4.40^{E}	4.38^{D}	4.43^{E}	4.19^{E}
5	5.76^{ab,C}	5.38^{bc,D}	5.84^{a,C}	4.75^{c,}D	5.26^{d,D}
7	7.28^{a,B}	6.66^{b,E}	6.65^{b,B}	5.80^{c,C}	5.79^{c,C}
10	7.76^{a,B}	7.53^{a,B}	6.66^{b,B}	6.62^{b,B}	6.41^{b,B}
14	8.74^{a,A}	8.65^{a,A}	7.77^{b,A}	7.63^{b,A}	7.10^{c,A}

Footnotes are the same as Table 1.

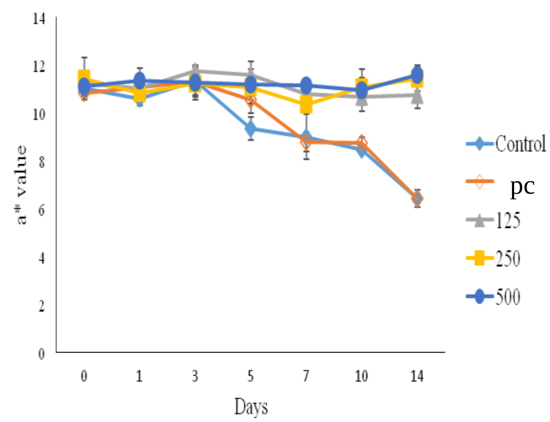

Figure 1. The changes in a* value of pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃.

Table 5. The changes in color score of raw pork chops spray coating with different levels of *T. sinensis* extract during storage at 10℃

	Score				
day	Control	PC	125 μg/mL	250 μg/mL	500 μg/mL
0	5.8^{A}	6.3^{A}	6.4^{A}	5.8^{A}	6.4^{A}
1	6.1^{A}	5.7^{B}	5.4^{B}	5.8^{A}	6.2^{AB}
3	5.1^{B}	5.4^{B}	5.4^{B}	5.8^{AB}	5.5^{BC}
5	4.3^{b,C}	4.2^{b,C}	5.1^{a,B}	4.9^{a,BC}	5.1^{a,C}
7	2.1^{c,D}	3.3^{b,D}	3.1^{b,C}	4.2^{a,C}	4.3^{a,D}
10	1.2^{b,E}	1.6^{b,E}	2.3^{a,D}	2.4^{a,D}	2.4^{a,E}
14	1.0^{E}	1.0^{E}	1.0^{E}	1.2^{E}	1.2^{F}

Footnotes are the same as Table 1

Table 6. The changes in odor score of raw pork chops spray coated by different levels of *T. sinensis* extract during storage at 10℃

day	Score				
	Control	PC	125 μg/mL	250 μg/mL	500 μg/mL
0	5.5^{AB}	5.8^{A}	5.9^{A}	5.7^{A}	5.7^{A}
1	5.91^{A}	5.6^{A}	5.4^{AB}	5.4^{A}	5.5^{A}
3	5.4^{ab,B}	5.3^{b,A}	5.3^{b,A}	5.8^{a,A}	5.4^{ab,A}
5	3.6^{b,C}	3.5^{b,B}	4.7^{a,B}	4.8^{a,B}	4.8^{a,B}
7	1.9^{c,D}	1.9^{c,C}	2.9^{b,C}	3.8^{a,C}	3.9^{a,B}
10	1.0^{c,E}	1.2^{bc,D}	1.5^{bc,D}	2.5^{a,D}	2.2^{ab,C}
14	1.0^{E}	1.0^{D}	1.1^{D}	1.2^{E}	1.2^{D}

Footnotes are the same as Table 1

Table 7. The changes in overall acceptance score of raw pork chops spray coated by different levels of *T. sinensis* extract during storage at 10℃

day	Score				
	Control	PC	125 μg/mL	250 μg/mL	500 μg/mL
0	5.5^{A}	5.7^{A}	5.6^{A}	5.6^{A}	5.3^{AB}
1	5.7^{A}	5.6^{A}	5.6^{A}	5.5^{A}	5.7^{A}
3	5.7^{a,A}	5.3^{b,A}	5.4^{ab,A}	5.6^{ab,A}	5.4^{ab,A}
5	3.61^{b,B}	3.6^{b,B}	5.0^{a,A}	4.6^{a,B}	4.8^{a,B}
7	1.9^{b,C}	2.4^{b,C}	3.6^{a,B}	4.0^{a,C}	4.2^{a,C}
10	1.0^{b,D}	1.0^{b,D}	1.6^{a,C}	1.7^{a,D}	1.8^{a,D}
14	1.0^{D}	1.0^{D}	1.0^{C}	1.1^{E}	1.1^{E}

Footnotes are the same as Table 1

ACKNOWLEDGEMENTS

All members of National Chung Hsing University's team would like to thank the financial support from Greenyn Biotechnology Co., LTD Taiwan and Ministry of Science and Technology, Taiwan , ROC.

REFERENCES

1. Cheng, K. W., Yang, R. Y., Tsou, S. C., LO, S. C., Ho, C. T., Lee, T. C. and Wang, M. (2009). Analysis of antioxidant activity and antioxidant constituents of Chinese toon. Journal of Functional Food 1: 253 - 259.

2. Helander, I. K., Alakomi, H. L., Latva-Kala ,K., Mattila-Sandholm, T., Pol, I. and Smid, E. J. (1998). Characterization of the action of selected essential oil compounds on gram negative bacteria. Journal of Agricultural and Food Chemistry 46: 3590 - 3595.

3. Liu, D. C., Tsau, R. T., Lin, Y. C., Jan, S. S. and Tan, F. J. (2009). Effect of various levels of rosemary or Chinese mahogany on the quality of fresh chicken sausage during refigerated storage. Food Chemistry 117: 106 - 113.

4. Qi, S. and Zhou, D. (2013). Lotus seed epicarp extract as potential antioxidant and anti-obesity additive in Chinese Cantonese Sausage. Meat Science 93: 257-262.

5. Vallverdi-Queralt, A., Regueiro, J.,Martinez-Huelamo, M., Alvarenga, J. F. R., Leal, L. N. and Lamuela-Raventos, R. M. (2014). A comprehensive study on the phenolic profile of widely used culinary herbs and spices: rosemary, thyme, oregano, cinnamon, cumin and bay. Food Chemistry 154: 299 – 307

6. Wang, K. J., Yang, C. R. and Zhang, Y. J. (2007). Phenolic antioxidants from Chinese toon (fresh young leaves and shoots of *Toona sinensis*). Food Chemistry 101: 365 - 371.

7. Wu, J. G., Peng, W., Yi, J., Wu, Y.B., Chen, T. Q., Wong, K. H. and Wu, J. Z. (2014). Chemical composition, antimicrobial activity against *Staphylococcus aureus* and apro-apoptotic effect in SGC-7901 of the essential oil from *Toona sinensis* (A.Juss.) Roem. leaves. Journal of Ethnopharmacology 154: 198-205.