EFFECT OF GINGER LEAF EXTRACT ON THE OXIDATIVE STABILITY OF CHICKEN OILS

Y. J. Wu, M. C. Chen, D. C. Liu and F. J. Tan*

Department of Animal Science, National Chung-Hsing University, Taichung, Taiwan

*Corresponding author email: tanfj@daragon.nchu.edu.tw

Abstract – The effect of adding ginger leaf extract on the oxidation stability of chicken oil was evaluated. The microwave-rendered chicken oil was prepared from broiler skin, and added with 0, 250, 500, and 1000 ppm of the ginger leaf extract (GLE) or 200 ppm BHT. All the samples were kept at 65°C for 14 days. Changes in the peroxide values (PV), acid values (AV) and 2-thiobarbituric acid (TBA) values of the samples were monitored during storage. The samples contained GLEs had significantly lower oxidation, as performing the lower PV, AV, and TBA value. As the concentration of GLEs was increased, the inhibitory effects were also increased. Particularly, the sample with addition of 1000 ppm GLE performed the best efficacy and there was no difference on the PV and TBA values between the samples with addition of 1000 ppm of GLE and 200 ppm of BHT. The results demonstrated that ginger leaf to be a potent antioxidant for stabilization of oil oxidation.

Key Words – 2-thiobarbituric acid value, acid value, chicken oil, ginger, lipid oxidation, peroxide value

I. INTRODUCTION

Oxidation of fats and oils leads to the development of rancid or off flavors, consequently decreases in nutritional quality and safety [1]. Oils that contain relatively high amounts of polyunsaturated fatty acid may be oxidized easily. When unsaturated fatty acids are exposed to the air, they react with the molecular oxygen by a free radical chain mechanism, and produce some hydroperoxides, which further break down to certain products, such as alcohols, aldehydes, ketones, and hydrocarbons. These volatile compounds are the major causes of offensive off-flavors [2] and [3]. Application of synthetic antioxidants, such as butylated hydroxytoluene (BHT), can delay oxidation in oils, yet might have possible toxic and carcinogenic effects on humans [4]. Because of the safety concerns, many efforts have been conducted to replace these synthetic antioxidants with natural sources. Ginger (*Zingiber officinale*, Zingiberaceae) has been widely grown in many tropical regions. In Taiwan, ginger rhizomes are commonly used as a cooking spice; a great amount of leaves are produced during planting. It has been reported that agricultural byproducts or wastes are interesting and cheap sources of health-promoting antioxidant polyphenols [5]. It also has been showed that leaves of ginger had higher inhibition of β-carotene oxidation and radical-scavenging activity than rhizomes [6]. Therefore, the objective of this study was to evaluate the antioxidant effect of adding ginger leaves extract to chicken oil by measuring the changes in peroxide value, acid value and 2-thiobarbituric acid value during accelerated storage.

II. MATERIALS AND METHODS

The ginger leaf extract (GLE) was prepared by the method of Annegowda *et al* [7] with some modification. Ginger leaf powder was mixed with ethanol (1:10 w/w) in 500 mL bottle, then sonicated (ES-600N, TST, Taiwan) under 30 kHz at 60°C for 60 min and filtered to obtain the GLE. The chicken oil was prepared according to the procedures described by Zhang *et al* [8]. One kg ground broiler skin was heated in a microwave oven at 900 W for 10 min and filtered. The chicken oils were added with 0 ppm (C), 250 ppm (G1), 500 ppm (G2), and 1000 ppm (G3) of GLE, or 200 ppm of BHT as a positive control. After stirring for about 10 min, GLEs and BHT were dissolved completely in the oil. All the samples were filled in a 500 mL bottle and kept in an oven at 65°C for 14 days. Analyses were carried out at regular intervals of 7 days. PV (meq peroxide/kg of sample) was determined by using the AOCS method [9]. Five gram of oil was weighed into a 250 mL flask. Fifty mL of acetic acid-isooctane

solution (3:2, v/v) and 0.5 mL of saturated potassium iodide solution were added with vigorous stirring for 1 min. After adding 30 mL of distilled water, the mixture was titrated with 0.1 N $Na_2S_2O_3$ until the yellow color was almost disappeared. Then, 0.5 mL of the starch indicator was added and continually the titration until the blue color was just disappeared.

$$\text{PV} = (\text{S} - \text{B}) \times \text{N} \times 1000 / g\ sample$$

where S was the volume of sample consumed (mL); B was the volume of blank consumed (mL) and N was the normality of $Na_2S_2O_3$.

AV (mg KOH/g of sample) was determined by using the AOCS method [10]. Five gram of oil was weighed into a 250 mL flask. Fifty mL of 60°C ethyl alcohol and 1% phenolphthalein were added. The mixture was titrated with 0.1 N KOH with occasional stirring until the permanent pink color was appeared and persisted at least for 30 s.

$$\text{AV} = (S - B) \times N \times 56.1 / g\ \ sample$$

where S was the volume of sample consumed (mL), B was the volume of blank consumed (mL), N is the normality of KOH and 56.1 is the molecular weight of KOH.

The TBA value (µmol/g of sample) was determined by using the AOCS method [11]. First, 100 mg of oil was accurately weighed into a 25 mL volumetric flask and added with 1-butanol to make up to the volume. Five mL of the mixture was transferred to a dry test tube. After adding 5 mL of TBA solution, the samples were placed in a water bath at 95°C for 2 h. Then the samples were removed and cooled for about 10 min until reached room temperature. The absorbance of samples was measured at 530 nm.

$$\text{TBA value} = (\text{S} - \text{B}) \times 50 \times 1000 / mg\ sample$$

where S was the absorbance of the test solution and B was the absorbance of the reagent blank.

All analytical determinations were performed in triplicate. The values were expressed as mean ± standard deviation. Significant differences between the means ($P < 0.05$) were assessed by Duncan's test using SAS 9.4 software.

III. RESULTS AND DISCUSSION

Development of the peroxide value during storage

PV is a measurement of the primary lipid oxidation, indicating the amount of peroxides such as peroxides, free radicals, malondialdehyde and cholesterol formed during oil oxidation [12]. The changes in the PV of the chicken oils during the accelerated storage (65°C) are shown in Fig. 1. The PV of all samples was increased along with storage time. Initially, the difference between the control and treated oils were not noticeable. After 7 and 14-day storage, the highest PV was observed in the control sample, followed by the G1, G2, BHT and G3 treatments. These results were confirmed with the findings of Iqbal and Bhanger [13], who monitored the stabilization of garlic extract in sunflower oil at 65°C. At all the concentrations, the ginger leaf extracts significantly lowered the PV of the samples, illustrating good antioxidant efficacy. The effect of addition of 1000 ppm extract was comparable to that of adding of 200 ppm BHT.

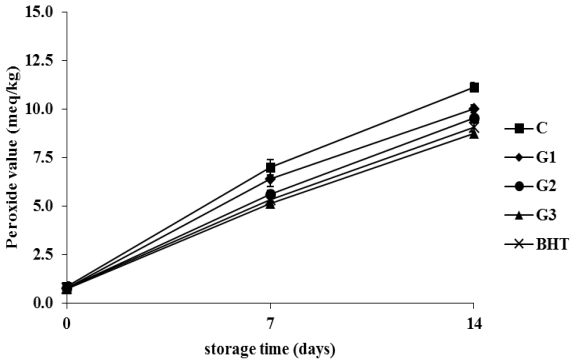

Figure 1. Peroxide values (meq/kg) of the treated chicken oil with addition of 0 ppm (C), 250 ppm (G1), 500 ppm (G2), and 1000 ppm (G3) ginger leaf extract, and 200 ppm BHT during accelerated storage.

Development of the acid value during storage

During storage, moisture, temperature, and enzyme may affect hydrolysis, in which some free fatty acids are then produced in oils. It has been reported that the carboxylic molecular group of the free fatty acid may accelerate the rate of decomposition of hydroperoxides [14]. To monitor the quality of oil, the results of the acid values under 65°C were shown in Fig 2. The significant difference between the control and treated samples after 14 days of storage was observed. Adding ginger leaf extract as an antioxidant at all concentrations could inhibit the oxidation of the oil. The highest efficacy was observed in G3 sample which had addition of 1000 ppm GLE, followed by G2 (500 ppm) and G1 (250 ppm) treatments.

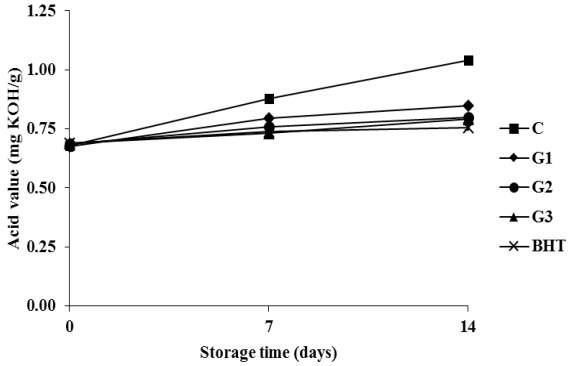

Figure 2. Acid value (mg KOH/g) of the treated chicken oil with addition of 0 ppm (C), 250 ppm (G1), 500 ppm (G2), and 1000 ppm (G3) ginger leaf extract, and 200 ppm BHT during accelerated storage.

Development of the TBA value during storage

TBA value is the measurement of the formation of secondary oxidation products, such as malondialdehyde or carbonyls. In this study, the TBA values of the samples were monitored under the accelerated storage, and results were shown in Fig. 3. During storage, the TBA value showed a decrease in the samples with addition of ginger leaf extract, while the control sample showed an increasing trend. This could be attributed to the further break down of malondialdehyde to alcohols or organic acid, thus decreasing the malondialdehyde level [15].

In the current study, the TBA values had the same order with the case of the peroxide value. Ginger leaf extract significantly inhibited the formation of the secondary oxidation products, while the sample with addition of 1000 ppm extract showed the best efficacy and was comparable to that of the BHT treatment. Base on the results obtained in the current study, the ginger leaf extract exhibited some inhibition of chicken oil deterioration. Previous studies have been demonstrated that some phenols might contribute to the antioxidant abilities of the plant extracts [16]. However, further studies are requested to confirm.

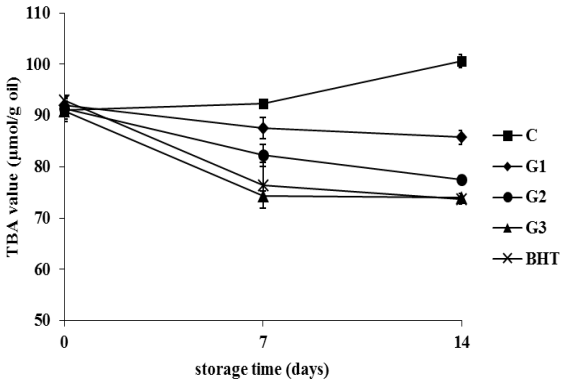

Figure 3. The 2-thiobarbituric acid value (µmol/g) of the treated chicken oil with addition of 0 ppm (C), 250 ppm (G1), 500 ppm (G2), and 1000 ppm (G3) ginger leaf extract, and 200 ppm BHT during accelerated storage.

IV. CONCLUSION

In conclusion, the extract of ginger leaves stabilized the chicken oil and was comparable to the synthetic antioxidant, particularly at high adding level. Therefore, ginger leaf can be considered as a potential natural antioxidant and may have economic benefit in reusing the agricultural waste.

REFERENCES

1. Moure, A., Cruz, J. M., Franco, D., Domínguez, J. M., Sineiro, J., Domínguez, H., Núñez, M. J. & Parajó, J. C. (2001). Natural antioxidants from residual sources. Food Chemistry 72: 145-171.
2. Roy, L. G., Arabshahi-Delouee, S., & Urooj, A. (2010). Antioxidant efficacy of mulberry (Morus

indica L.) leaves extract and powder in edible oil. International Journal of Food Properties 13: 1-9.
3. Gómez-Alonso, S., Salvador, M. D., & Fregapane, G. (2004). Evolution of the oxidation process in olive oil triacylglycerol under accelerated storage conditions (40–60°C). Journal of the American Oil Chemists' Society 81: 177-184.
4. Ito, N., Hirose, M., Fukushima, S., Tsuda, H., Shirai, T., & Tatematsu, M. (1986). Studies on antioxidants: their carcinogenic and modifying effects on chemical carcinogenesis. Food and Chemical Toxicology 24: 1071-1082.
5. Llorach, R., Tomás-Barberán, F. A., & Ferreres, F. (2004). Lettuce and chicory byproducts as a source of antioxidant phenolic extracts. Journal of Agricultural and Food Chemistry 52: 5109-5116.
6. Elzaawely, A. A., Xuan, T. D., & Tawata, S. (2007). Essential oils, kava pyrones and phenolic compounds from leaves and rhizomes of *Alpinia zerumbet* (Pers.) BL Burtt. & RM Sm. and their antioxidant activity. Food Chemistry 103: 486-494.
7. Annegowda, H. V., Bhat, R., Min-Tze, L., Karim, A. A., & Mansor, S. M. (2012). Influence of sonication treatments and extraction solvents on the phenolics and antioxidants in star fruits. Journal of Food Science and Technology 49: 510-514.
8. Zhang, L., Yin, B., & Rui, H. (2011). Effect of microwave rendering on the yield and characteristics of chicken fat from broiler abdominal fat tissue. Journal of Food Science and Technology-Mysore 48: 1-7.
9. AOCS. (1997). Official methods and recommended practices of the American oil chemists' society, Official method Cd 8b-90. American Oil Chemists' Society, USA.
10. AOCS. (1997). Official methods and recommended practices of the American oil chemists' society, Official method Cd 3d-63. American Oil Chemists' Society, USA.
11. AOCS. (2009). Official methods and recommended practices of the American oil chemists' society, Official method Cd 19-90. American Oil Chemists' Society, USA.
12. Subramanian, R., Nandini, K. E., Sheila, P. M., Gopalakrishna, A. G., Raghavarao, K. S. M. S., Nakajima, M., Kimura, T. & Maekawa, T. (2000). Membrane processing of used frying oils. Journal of the American Oil Chemists' Society 77: 323-328.
13. Iqbal, S. & Bhanger, M. I. (2007). Stabilization of sunflower oil by garlic extract during accelerated storage. Food Chemistry 100: 246-254.
14. Frega, N., Mozzon, M., & Lercker, G. (1999). Effects of free fatty acids on oxidative stability of vegetable oil. Journal of the American Oil Chemists' Society 76: 325-329.
15. Dugan, L. R. (1961). Development and inhibition of oxidative rancidity in foods. Food Technology 15: 10.
16. Williams, C. A., & Harborne, J. B. (1977). The leaf flavonoids of the Zingiberales. Biochemical Systematics and Ecology 5: 221-229.