Journal of Food Biosciences and Technology,
Islamic Azad University, Science and Research Branch, 2, 9-12, 2012

The Stabilising and Chelating Effects of Green and Roasted Coffee Extracts

S. Khorsandmanesh [a], ***M. Gharachorloo*** [b*], ***B. Bazyar*** [c]

[a] *M. Sc. Student of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[b] *Assistant Professor of the College of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[c] *Assistant Professor of the College of Agriculture and Natural Resources, Science and Research Branch, Islamic Azad University, Tehran, Iran.*

Received 15 September 2011; Accepted 22 November 2011

ABSTRACT: Oxidation might be regarded as one of the most important reaction in oils and fats. Prooxidants namely iron and copper intensify and catalyze the oxidation while the chelating agents might retard or delay this process. Citric acid, phosphoric acid, some of phenolic compounds and phospholipids are considered as the compounds that chelate the prooxidant metals and through this mechanism stabilize the oil. Coffee extract, due to the nonenzymatic browning reactions during roasting of coffee and the resultant products might play an important role in the chelation of metals. The object of this research work is to study the chelation power of the coffee extracts on the stability of oils and fats. Two types of coffee; Arabica and Robousta, both green and roasted were selected for this study. Isopropanol was employed as a solvent to obtain the extract. Peroxide value determinations and induction period measurements using Rancimat apparatus, measuring the secondary oxidation products were employed as means to evaluate the chelating power of coffee extracts at 0.15% concentration and compared to citric acid a well known chelating agent at 0.01% concentration. It was concluded that both roasted and green coffee extracts due to the presence of phenolic compounds in the green beans exhibited antioxidant activity but the extracts were deficient in chelation of metals particularly copper.

Keywords: *Chelating Agents, Citric Acid, Coffee Arabica, Coffee Robousta, Prooxidants*.

Introduction

Metals are strong catalyst for oil and fat oxidation. They cause formation of hydroperoxide and consequently accelerate autooxidation chain reactions (Lawki, 1994). Chelating agents form a complex with the metal ions specially copper and iron and are enable to delay or retard oxidation reactions. Some compounds namely citric acid and phenolic substances might be regarded as the major members of this group (Pokorny, 2001; Shahidi, 2004). Coffee has much polyphenolic compounds (Gordon & Kohen, 2004). Coffee also contains other substances such as sugar, koffalic acid and citric acid (Ky *et al*., 2001). Coffee polyphenols form a non-soluble complex with copper and iron and this ligament causes the absorbance lack of iron and copper in the stomach. The effect of phenolic compound on the absorbance of these metals has been studied and indicated that phenolic monomers and polyphenols form complex with metals. Fernandez *et al* (2002) found that flavanoids might be regarded as good scavengers for free radicals apart from the antioxidant and chelating abilities.

The object of the following study is to evaluate the possible chelating activity of coffee extract.

*Corresponding Author: m_gharachorlo@srbiau.ac.ir

Materials and Methods

Arabica (Brazil) and Robousta (Indonesia) coffee in two forms of green and roasted were purchased from special coffee centre in Tehran.

Sheep tail fat was purchased from Palaiien Slaughter-House, Tehran. 4-Cyclohexyl butyric acid copper salt was obtained from Sigma-Aldrich Chemical Company. All the other chemicals used were purchased from Merck Chemical Company.

Green and roasted coffee extracts were isolated by the application of soxhlet apparatus using isopropanol as the solvent (Madhava *et al*., 2008). Tallow was obtained by dry rendering of the sheep tail fat using rotary evaporator under vacuum (Gharachorloo *et al*., 2007). Fatty acid composition of tallow was determined by the preparation of methyl esters according to Christie (1973) followed by the application of the methyl esters to a Acme Gas Chromatograph. model 6000 equipped with CPSill 88 capillary column and Flame Ionization Detector according to the standard AOCS method; CE 1e-91 (Firestone, 1994). Peroxide value determinations, namely hydroperoxide as an index to the oxidation chain reaction, was carried out by heating the oil in a predetermined temperature oven environment (100°C) for 48 hours followed by titration with sodium thiosulphate according to AOCS standard method, number Cd 8b-90 (Firestone, 1994). The oxidative stability of the oil was determined by the induction period measurements using Rancimat apparatus. The equipment measures the secondary oxidation products namely volatile acids which are released from the oxidizing oil at 110°C in an air flow of 18-20 l/h according to ISIRI 3734 (Izadyar *et al*., 2011).

All the experiments were carried out in triplicate order and reported as means. Extracted data with statistical software (SPSS 18) and means by duncans multiple range tests were considered. Statistical analysis mean values were considered significantly different when $p<0.05$.

Results and Discussion

The stabilizing effect of coffee extracts on tallow is presented in Table 1.

Coffee contains quite considerable quantities of phenolic substances that act as primary antioxidants. In the model system designed tallow a natural fat deficient in natural antioxidant if any was chosen to evaluate the antioxidant activities of the compounds. The fatty acid composition of tallow consisted of 43% saturated and 57% unsaturated fatty acids. Palmitic (24%) and oleic (42%) were the predominant saturated and unsaturated fatty acids present respectively. Therefore tallow a low melting fat might be regarded as a suitable media for this study. Two types of coffee in two forms; green and roasted were examined. The natural antioxidants present in the beans as well as the compounds formed as the results of non enzymatic browning reactions due to roasting were expected to retard the oxidation; the former due to the activity of phenolic compounds and the latter apart from the presence of phenolic compounds, due to the complexation with the metals as it has been claimed by various researchers that consumption of coffee or tea might make the metals present in the diet and biological system unavailable. In order to investigate the matter further, known concentrations of copper, citric acid, individually and in incombination were added to tallow (Mahasti *et al*., 2005) and the induction periods were measured at 110°C (Table 1). The induction period of tallow with added citric acid was unaffected while the addition of copper in the form of 4-cyclohexyl butyric acid copper salt drastically reduced the induction period. The addition of citric acid to a sample containing copper regained the original induction period to some extend. These findings were confirmed by peroxide

Table 1. Peroxide values and induction periods of tallow with added coffee extracts, citric acid and copper

Treatment	Peroxide value at 100°C (meq/kg)		Induction period at 110°C (hour)
	0 hour	48 hour	
Tallow (blank)	0	19.33	6.7
Tallow + (0.1 ppm) copper	0	30.66	0.6
Tallow + (0.01 %) citric acid	0	22.66	6.5
Tallow + (0.1 ppm) copper + (0.01 %) citric acid	0	20.66	4.2
Tallow + 0.15% green Arabica coffee	0	10.66	9.9
Tallow + 0.15% roasted Arabica coffee	0	4.00	11.7
Tallow + 0.15% green Robousta coffee	0	6.00	9.8
Tallow + 0.15% roasted Robousta coffee	0	3.66	11.6
Tallow + (0.1 ppm) copper + 0.15% green Arabica coffee	0	20.00	6.6
Tallow + (0.1 ppm) copper + 0.15% roasted Arabica coffee	0	22.66	1.3
Tallow + (0.1 ppm) copper + 0.15% green Robousta coffee	0	20.00	1.7
Tallow + (0.1 ppm) copper + 0.15% roasted Robousta coffee	0	26.00	0.8
Tallow + (0.1 ppm) copper + (0.01 %) citric acid + 0.15% green Arabica coffee	0	24.00	Not determined
Tallow + (0.1 ppm) copper + (0.01 %) citric acid + 0.15% roasted Arabica coffee	0	24.00	Not determined
Tallow + (0.1 ppm) copper + (0.01 %) citric acid + 0.15% green Robousta coffee	0	20.66	Not determined
Tallow + (0.1 ppm) copper + (0.01 %) citric acid + 0.15% roasted Robousta coffee	0	24.66	Not determined

value determinations after 48 hours of heating the samples in a predetermined temperature oven environment (100°C). The model systems designed was based on two determinations, peroxides value; the primary oxidation product which are decomposed relatively at elevated temperatures and induction period by Rancimat, based on secondary oxidation products; the volatile acids. The addition of coffee extracts alone containing phenolic compounds to tallow increased and decreased the induction periods and peroxide values of the substrates respectively and interestingly roasted extracts isolated by isopropanol from both types of coffee acted superior to the green bean extracts. This is possibly due to the formation of compounds formed as the result of roasting or nonenzymatic browning reactions.

The peroxide value determinations were carried out after 48 hour of heating. Due to the decomposition of hydroperoxides at 100°C after a prolong period, the chosen period might be justified.

The addition of the extracts in combination with the organic copper salt did not exhibit any chelating activities and both induction periods and peroxide values of the model substrates deteriorated. Only for some unknown reasons, the addition of green Arabica coffee extract acted differently in term of the induction period which is the subject of further investigation. In the case of citric acid addition in combination with coffee extracts and organic copper salt, peroxide values of the substrate after heating at 100°C for 48 hour did not improve, therefore it might be suggested that coffee extracts could only act as primary antioxidants but not as chelating agents.

Conclusion

The antioxidant and chelating abilities of green and roasted coffee extracts indicated that the phenolic compounds present in the

extracts are responsible for stabilizing the model substrate based on tallow and roasted coffee due to formation of compounds as the results of non enzymatic browning reactions exhibited superior to the unroasted samples. It was also concluded that the extracts were deficient of chelating power.

References

Firestone, D. (1994). Official Methods and Recommended Practices of the American Oil Chemists Society, 4 th edn, AOCS Press, Champaign, IL.

Gharachorloo, M., Ghavami, M. & Aberomand, P. (2007). Qualitative evaluation of mutton tallow fractions. Journal of food technology & nutrition, 4, 3, 2-15(In Farsi).

Granot, E. & Kohen, R. (2004). Oxidative stress in childhood in health and disease states. Clinical Nutrition, 23, 3-11.

Isiri standard. (2005). Methods of measuring edible oils and fats stability against oxidation. Standard number 3734.

Izadyar, D., Gharachorloo, M., Ghiassi Tarzi, B. & Azizinejad, R. (2011). Chemical evaluation of oil extracted from the pulp of two varieties of avocado fruit cultivated in north of iran. Journal of food technology & nutrition, 8, 4, 37-50(In Farsi).

Ky, C-L., Louarn, J., Dussert, S., Guyot, B., Hamon, S. & Noirot, M. (2001). Caffeine, trigonelline, chlorogenic acids and sucrose diversity in wild Coffea Arabica L. and C. canephora P. accessions. Journal of Food Chemistry, 75: 223-230.

Lawkia, S. (1994) . A review on the use of citric acid in the processing of oils and fats. Oleagineux, 39: 84-104.

Madhava Naidu, M., Sulochanamma, G., Sampathu, S. R. & Srinivas, P. (2008). Studies on extraction and antioxidant potential of green coffee. Journal of Food Chemistry, 107: 377-384.

Mahasti, P., Ghavami, M. & Gharachorloo, M. (2005). Synergistic activities of tocopherols with citric acid, phospholipids and emulsifier YN. Journal of food technology & nutrition, 2, 1, 2-7.

Pokorny, J., Yanishlieva, N. & Gordon, M. (2001). Antioxidants in food. Practical Applications, CRC Press LLC, Boca Raton, FL. USA: PP.7-84.

Shahidi, F. (2000). Antioxidants in food and food antioxidant, Mol. Nutr. Food Res., 44: 158-163.

Tereza Fernandez, M., Lurdes Mira, M., Helena Florencio, M. & Jennings, K. R. (2002). Iron and copper chelation by flavonoids: an electrospray mass spectrometry study. Journal of Inorganic Biochemistry, 92: 105-111.