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Research Article

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Inhibition of the Oxidation of Acetophenone by Aqueous Extracts of Edible Fruits and Vegetables

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Abstract

A body of research has identified some fruits and vegetables to have anti-oxidant potential in biological systems. However limited literature reports exist for the inhibition of chemical oxidation reactions by fruits and vegetables. The research reported here examined the effect of plants, fruits, and vegetables on the oxidation reaction of acetophenone by bleach and if the bleach oxidation reaction of acetophenone is chlorine-induced. To examine the ability of plants to inhibit the oxidation of acetophenone, the reactions were carried out in the presence and absence (control) of plant materials and Vitamin E. Results suggest that the reactions without the plant materials or Vitamin E produce 1.53 g of benzoic acid, an oxidative product, while reactions in the presence of plant materials or Vitamin E were inhibited and produced a varying amount of oxidative product ranging from 0-0.9 g. Similar reactions of acetophenone with chlorine free bleach in the absence of plant materials did not produce any oxidative product. The order of inhibition of oxidation by fruit and vegetable extracts which is inversely related to the amount of oxidative product formed is carrot~ tomatoes~ spinach~ bitter leaf (0.0 g) > yellow bell pepper (0.008 g) > mustard green (0.01 g) > turnip green (0.03 g) > broccoli (0.27 g) > red bell pepper (0.17 g) > green bell pepper (0.31 g) > cucumber (0.59 g) > red lettuce (0.68 g) > rosemary (0.76 g) > green onions (0.82 g) > green lettuce (0.84 g) > romaine lettuce (0.91 g). These results suggest that (i) fruits and vegetables have varying degrees of antioxidant ability and (ii) the bleach oxidation of acetophenone to benzoic acid is chlorine induced.

Keywords: Antioxidant; Vegetables; Bitter leaf; *Vernonia amygalalina*; Oxidation reaction; Bleach; Acetophenone

Introduction

Several recent research has focused on fruits and vegetables as potential sources of natural antioxidants [1-8]. The phytochemicals in fruits and vegetables have been reported to have beneficial health effects against coronary disease [9,10], cancer [11], and degenerative diseases [12]. Normal metabolic processes in the body produce radicals as by-products. These radicals cause lipid and protein oxidation. Vitamins C, E, and carotene are known antioxidants that scavenge or destroy these free radicals and inhibit lipid and protein oxidation. Thus, the research reported here evaluates the ability of various plants, fruits and vegetables to inhibit the oxidation of acetophenone by oxidizing agents such as sodium hypochlorite a major component of commercial bleach.

Materials and Methods

Regular chlorinated bleach and chlorine free-bleach (Chlorox 2) were bought from a local market. Acetophenone and dl-alpha tocopherol (Vitamin E) were bought from Aldrich Chemicals. All reactions were stirred for 45 min at room temperature. The level of inhibition of oxidation by each plant material is inversely related to the amount of oxidative product formed.

Preparation of plant materials (extracts)

Fresh plants (100 g of the following plants: Fruity Vegetables: *Capsicum annum* (red, green, and yellow bell pepper), *Daucus carota* (carrot), *Lycopersicon esculentum* (tomatoes).

Leafy Vegetables: *Spinacia oleracea* (spinach), *Brassica juncea* (Mustard Green), *Brassica oleracea*, *Brassica rapa var rapifera* (turnip Green), *Vernonia amygalalina* (bitter leaf), *Letuca sativa* (red, green, and Romaine lettuce), *Cucumis sativus* (Cucumber), *Allium fistulosum*, and *Rosemarinus officinalis* (Rose Mary herb); Fruits: *Vitis vinifera* (red and green grapes), *Malus domestica* (red and green apple), *Citrus sinensis* (orange), *Ananas comosus* (pineapple) and *Citrus latifolia* (lime) bought from a local market were washed with deionized water and patted dry with kimwipes. Each vegetable or fruit was pureed in a regular kitchen blender using 200 ml of de-ionized water. The puree was filtered using a white handkerchief bought from a local Wal-Mart store. The filtrate was put in 4-50 ml centrifuge tubes. The tubes and their continents were centrifuged for 10 minutes at 3000 rpm. The supernatants were collected and placed in a clean beaker.

Reactions of acetophenone

Reaction of acetophenone and chlorinated bleach in water: Acetophenone (5 ml) was added to a mixture of 70 ml of regular bleach (purchased from local market) and 70 ml of water (in triplicates). The resulting mixture was stirred for 45 minutes at room temperature. Ether (70 ml) was added to the mixture and stirred for 5 minutes. The resulting mixture was poured into a 250 ml separatory funnel. The layers were separated and the aqueous layer was extracted with another 70 ml of ether. The resulting two layers were separated and to the aqueous layer, was added concentrated Hydrochloric acid (drop wise) until the pH of the solution was 1. The solid product that formed was filtered, dried, and weighed.

Reaction of acetophenone and non-chlorinated bleach in water: Acetophenone (5 ml) was added to a mixture of 70 ml of non chlorinated bleach (purchased from local market) and 70 ml of water (in triplicates). The resulting mixture was stirred for 45 minutes at room temperature. Ether (70 ml) was added to the mixture and stirred for 5 minutes. The resulting mixture was poured into a 250 ml separatory funnel. The layers were separated and the aqueous layer was extracted with another 70 ml of ether. The resulting layers were separated and

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to the aqueous layer, was added concentrated Hydrochloric acid (drop wise). No precipitate was observed even after excess acid was added to make the solution very acidic at pH 1.

Reaction of acetophenone and chlorinated bleach in the presence of each fruit or vegetable material: Acetophenone (5 ml) was added to a mixture of 70 ml of regular bleach and 70 ml of a vegetable or fruit extract (in triplicates), respectively. The resulting mixture was stirred for 45 minutes at room temperature. Ether (70 ml) was added to the mixture and stirred for 5 minutes. The resulting mixture was poured into a 250 ml separatory funnel. The layers were separated and the aqueous layer was extracted with another 70 ml of ether. The resulting layers were separated and to the aqueous layer was added concentrated Hydrochloric acid (drop wise) until the solution has a pH of 1. If any solid product is formed, the mixture was filtered and the solid that formed is dried and weighed on an analytical balance.

Reaction of acetophenone and chlorinated bleach in the presence of vitamin E (dl alpha tocopherol): Acetophenone (2 ml) was mixed with 1 ml of dl alpha-tocopherol purchased from Aldrich chemicals and 70 ml of regular chlorinated bleach (purchased from local market) was added. The resulting mixture was stirred for 45 minutes at room temperature. Ether (30 ml) was added to the mixture and stirred for 5 minutes. The resulting mixture was poured into a 250 ml separatory funnel. The layers were separated and the aqueous layer was extracted with another 30 ml of ether. The layers were separated and to the resulting aqueous layer, was added concentrated Hydrochloric acid (drop wise). No precipitate was observed even after excess acid was added to make the solution very acidic at pH 1.

Effect of heating the fruit and vegetable extracts on their ability to inhibit the oxidation of acetophenone

Reaction of Acetophenone and Chlorinated Bleach in the presence of heated green and yellow bell pepper, broccoli, carrot, and lime extracts: The extracts of green bell pepper, yellow bell pepper, broccoli, carrot and lime prepared above were heated to a boil for five minutes and then allowed to cool. Acetophenone (5 ml) was added to a mixture of 70 ml of the chlorinated bleach and 70 ml of the heated vegetable or fruit extract (in triplicates), respectively. Each mixture was stirred at room temperature for 45 minutes. Ether (70 ml) was added to each mixture and stirred for 5 minutes. Each of the resulting mixture was poured into a 250 ml separatory funnel. The layers were separated and the aqueous layer was extracted with another 70 ml of ether. The resulting layers were separated and to the aqueous layer was added concentrated Hydrochloric acid (drop wise) until the solution has a pH of 1. The mixture was filtered and the solid that formed (when applicable) was obtained, dried, and weighed.

Results

The control reaction of benzophenone with chlorinated bleach in water produced on average 1.53 g of oxidative product while similar reaction with chlorine free bleach failed to produce any oxidative product. Reaction of acetophenone with chlorinated bleach in the presence of vitamin E did not produce any oxidative product. The order of inhibition of oxidation by fruity vegetables is carrot = tomatoes (0.0 g) > yellow bell pepper (0.008 g) > red bell pepper (0.17 g) > green bell pepper (0.31 g) > cucumber (0.59 g). With the leafy vegetables, the order of inhibition of oxidation is spinach = bitter leaf (0.0 g) > mustard green (0.01 g) > turnip green (0.03 g) > broccoli (0.27 g) > red lettuce (0.68 g) > rosemary (0.76 g) > green onions (0.82 g) >green lettuce (0.84 g) > romaine lettuce (0.91 g). All the fruits (red and green grapes, red and green apples, pineapple and lime) completely inhibited the oxidation reaction except for the reaction in the presence of orange which gave 0.9 g of oxidative product.

Figures 1-3 below show the variation in the inhibition of the oxidation reaction of acetophenone with regular bleach in the presence of various fruit and vegetable extracts. Furthermore, it compares the inhibition potential of leafy vegetables, fruity vegetables, and fruits.

Figure 4 compared unheated and heated vegetable and fruit extracts in inhibiting the oxidation reaction of acetophenone with bleach.

The results demonstrate that heating the vegetable extracts greatly reduced their ability to inhibit the oxidation reaction.

In related but different reactions, the oxidation of benzyl alcohol with potassium permanganate to produce benzoic acid was inhibited in the presence of plant materials while the reaction in the absence of plant material gave oxidative product (benzoic acid). Similarly, cyclohexene reacted with $KMnO_4$ in water to give adipic acid. However, similar reaction in the presence of vitamin E or plant materials did not produce any adipic acid (Figures 1-4).

Discussion

On whether fruit and vegetable extracts can inhibit the oxidation of acetophenone by bleach, the results showed that plants inhibited the

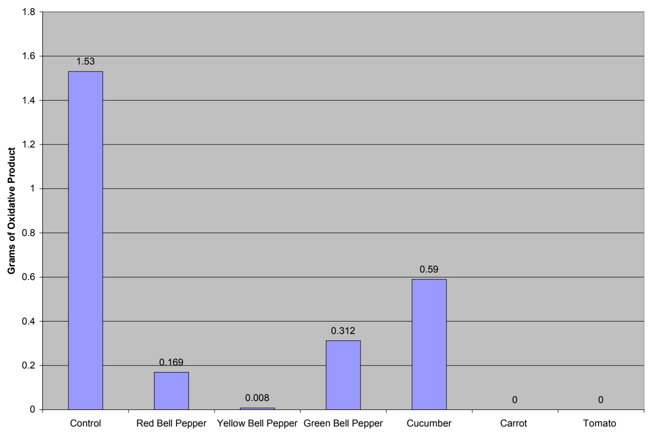

Figure 1: Oxidative product formed in the oxidation reaction of acetophenone and bleach in the presence of fruity vegetables.

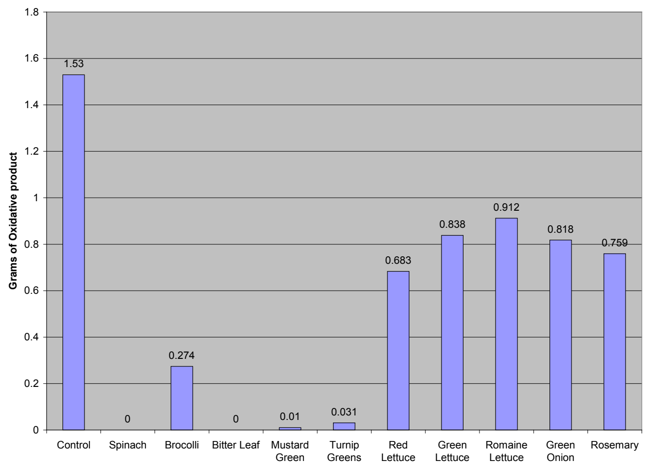

Figure 2: Oxidative product formed in the oxidation reaction of acetophenone and bleach in the presence of leafy vegetables.

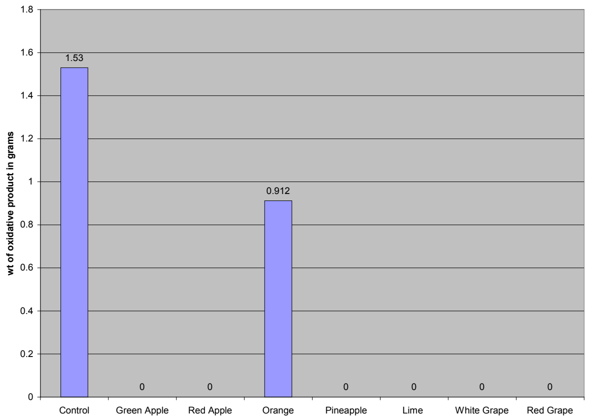

Figure 3: Oxidative product formed in the oxidation reaction of acetophenone and bleach in the presence of edible fruits.

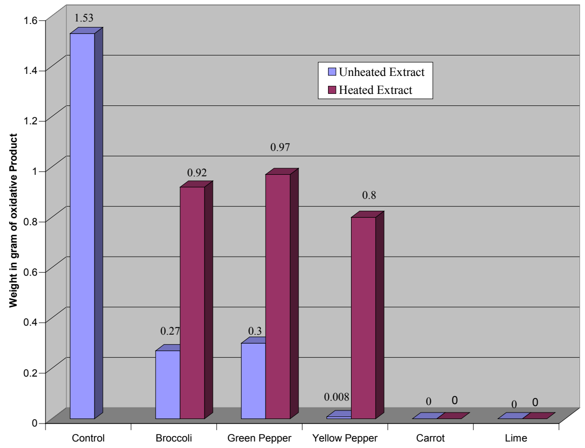

Figure 4: Comparison of the inhibition of oxidation by unheated and heated plant extracts.

oxidation reaction when compared with the control experiment which gave oxidative product. It is interesting to note that the amount of vitamin C in a given vegetable or fruit did not directly correlate with the oxidation inhibition ability of that vegetable or fruit. Although orange contains 130% of vitamin C, it did not inhibit the oxidation reaction as affectively as some fruits and vegetables that contain far less vitamin C such as spinach (25%), tomatoes (40%), lime (35%), pineapple (25%), and grapes (25%). However, it appears that their oxidation inhibition ability correlates with the level of vitamin A present in a given vegetable or fruit as suggested by carrot 270%, Spinach, 70%, Mustard green 90%, Romaine lettuce 20%.

On whether the bleach oxidation of acetophenone is chlorine induced, the oxidation reaction using chlorine free bleach did not produce any oxidative product while similar reaction with chlorinated bleach gave a good amount of oxidative product.

On comparing heated and unheated extracts in inhibiting oxidation, the data showed that heating the extracts reduced the oxidation inhibition ability drastically in the case of green and yellow bell pepper and broccoli. However, heating did not affect oxidation inhibition ability of carrot and lime.

Conclusion

Despite the levels of vitamins A and C present, the poly phenol content of each plant material to a greater extent influences the anti-oxidant potential. There is a varying degree of inhibition of oxidation antioxidant potential between various fruits and vegetables used in this study. The inhibition of the oxidation reaction does not correlate with the vitamin C content of the fruit or vegetable. This is in agreement with the finding by Wang who found that the high antioxidant activities of some common fruits could not be accounted by their vitamin C content [13]. However, the order of inhibition of oxidation reported in this project is closely in line with the antioxidant activities of these fruits and vegetables reported by Cao [14]. Thus, the order of inhibition of acetophenone oxidation reported here could be related to the phenolic or other phytochemical content of the fruits or vegetables. Furthermore, our data suggest that fruits inhibited the oxidation of acetophenone better than the vegetables. The fact that heating vegetable extracts (bell pepper, yellow bell pepper, and broccoli) drastically reduced their oxidation inhibitory effect when compared to the heated carrot and Lime that did not show any effect suggests that probably some of the phytochemicals in the vegetable extracts could have evaporated, decomposed, or denatured as the temperature of the extracts is increased from 25°C to 90°C or higher. Agwaramgbo [15] reported similar observation in the phytoremediation of lead contaminated water using heated and unheated plant extracts.

References

1. Ozen T (2010) Antioxidant activity of wild edible plants in the Black Sea region of Turkey. Grasas Y Aceites 61: 86-94.
2. Murcia MA, Jimenez AM, Martínez-Tome M (2001) Evaluation of the antioxidant properties of Mediterranean and tropical fruits compared with common food additives. J Food Prot 64: 2037-2046.
3. Karadeniz F, Burdurlu HS, Koca N, Soyer Y (2005) Antioxidant activity of selected fruits and vegetables grown in Turkey. Turk J Agric For 29: 297-303.
4. Miller HE, Rigelhof F, Marquart L, Prakash A, Kanter M (2000) Antioxidant content of whole grain breakfast cereals, fruits and vegetables. J Am Coll Nutr 19: 312S-319S.
5. Abdou HM (2011) Comparative antioxidant activity of some edible plants used as spices in Egypt. Journal of American Science 7: 1118-1122.
6. Cervellati R, Renzulli C, Guerra MC, Speroni E (2002) Evaluation of antioxidant activity of some natural polyphenolic compounds using the Briggs-Rauscher reaction method. J Agric Food Chem 50: 7504-7509.
7. Block G, Norkus E, Hudes M, Mandel S, Helzlsouer K (2001) Which plasma antioxidants are most related to fruit and vegetable consumption? Am J Epidemiol 154: 1113-1117.
8. Huda-Faujan N, Noriham A, Norrakiah AS, Babji AS (2009) Antioxidant activity of plants methanolic extracts containing phenolic compounds. African Journal of Biotechnology 8: 484-489.
9. Hertog MG, Feskens EJ, Hollman PC, Katan MB, Kromhout D (1993) Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study. Lancet 342: 1007-1011.
10. Knekt P, Jarvinen R, Reunanen A, Maatela J (1996) Flavonoid intake and coronary mortality in Finland: a cohort study. BMJ 312: 478-481.
11. Shamberger RJ, Baughman FF, Kalchert SL, Willis CS, Hoffman GC (1973) Carcinogen-induced chromosomal breakage decreased by antioxidants. Proc Natl Acad Sci U S A 70: 1461-1463.
12. Ames BN, Shigenaga MK, Hagen TM (1993) Oxidants, antioxidants, and the degenerative diseases of aging. Proc Natl Acad Sci U S A 90: 7915-7922.
13. Wang H, Cao G, Prior RL (1996) Total antioxidant capacity of fruits. J Agric Food Chem 44: 701-705.
14. Cao G, Sofic E, Prior RL (1996) Antioxidant capacity of tea and common vegetables. J Agric Food Chem 44: 3426-3431.
15. Lathan N, Thomas C, Edwards S, Agwaramgbo L (2013) Comparative study of lead removal by extracts of spinach, coffee, and tea. Journal of Environmental Protection 4: 250-257.