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# Effect of Tertiary Butylhydroquinone on the Shelf Life of Salted-in-the-Shell Roasted Peanuts[1]

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## ABSTRACT

Roasted salted-in-the-shell peanuts (*Arachis hypogaea* L.) normally have a shelf life of four to six weeks. Three levels of tertiary butylhydroquinone (0.02%, 0.04% and 0.06%) were added to a 12.5% NaCl brine solution which was used to vacuum impregnate Virginia type peanuts prior to roasting. A control was also run. After drying and roasting, the peanuts were placed in a 63°C oven, and an accelerated shelf life study was conducted. Flavor evaluations and total carbonyl contents were determined weekly. The antioxidant treatment extended the shelf life of salted-in-the-shell roasted peanuts, reducing the total carbonyls produced during storage and giving higher flavor scores. Applications of 0.04% and 0.06% TBHQ approximately doubled the shelf life of the salted-in-the-shell peanuts. A correlation coefficient of 0.96 was found between the total carbonyl values and flavor scores.


Key Words: Peanuts, Antioxidant, Shelf life, Sensory evaluation, Carbonyls.

The shelf life of peanuts (*Arachis hypogaea* L.) salted-in-the-shell for roasting is reported to be four to six weeks or approximately half that of unsalted nuts (5). Applications of antioxidant systems have been successful in extending the shelf life of many peanut products (1, 9, 12), however, no attempts to treat salted-in-the-shell nuts have been reported. The objective of this study was to impregnate unshelled nuts prior to roasting, with a brine solution containing an antioxidant and to determine the effects of the treatment on the keeping qualities of the roasted peanuts. Flavor panel evaluations and total carbonyl contents of the peanuts were used as indices of rancidity. Earlier work with an intermediate product, powdered peanut butter (9), showed that an interrelation existed between total carbonyl content and sensory evaluations, however, no formal taste panels were conducted. A second objective therefore, was to study the correlation between panelist flavor ratings and total carbonyl contents of the roasted peanuts.

The antioxidant chosen was tertiary butylhydroquinone (TBHQ). TBHQ is reported to be superior to butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and propylgallate (PG) as an antioxidant in highly unsaturated fat systems (11, 13, 14). Three levels of TBHQ, 0.02%, 0.04% and 0.06%, based on the weight of the brine solution, were used to impregnate the peanuts. A control without antioxidant was also prepared. The FDA presently allows the addition of 0.02% TBHQ based on the fat content of the food products (7).

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## Materials and Methods

### Sample Preparation

Good quality Virginia type peanuts were used for the experiment. Twenty percent active TBHQ and 10% citric acid (used for chelation purposes) were dissolved in 70% propylene glycol. Carter and Pike (4) found combinations of TBHQ and citric acid more effective than TBHQ alone which in turn was more effective than citric acid alone. This stock solution was used to disperse the antioxidant in the brine solutions prepared for each replicate. The peanuts were impregnated with a 12.5% NaCl solution containing 0.02%, 0.04% and 0.06% TBHQ, based on the weight of the solution. A control without antioxidant was also prepared. Four replicates of each TBHQ level were prepared.

Vacuum impregnation was carried out by placing 2,270 g of peanuts in a covered perforated basket which was submerged in 6,810 g of brine solution in a vacuum chamber. A 41 cm (16 in) vacuum was drawn and held for 4 min. The vacuum was released, and the peanuts remained in the solution an additional 4 min. The nuts were then drained and held at room temperature for about 16 hr. Drying was accomplished by placing the nuts in a tunnel drier with moving air (90 meters/min) at 40°C. The dried peanuts were then roasted at 177°C for approximately 15 min until a medium dark roast was obtained.

The roasted peanuts were spread in pans 5 cm deep and placed in a 63°C incubation oven. The oven test (10) was used to accelerate the storage time, with 24 hr oven storage approximating one week's storage at room temperature. Total carbonyl and flavor evaluations were made on all samples on the day of roasting, and then at one week intervals thereafter, during the accelerated storage period.

### Total Carbonyl Determination

Total carbonyls were determined weekly using the procedure suggested by Henick et al, (8). Certain modifications were made in the method to facilitate its usage with peanuts. Samples were duplicated, and two aliquots of both duplicates were analyzed giving four values per sample. Samples were removed from the oven on the day of analysis, shelled and the skins removed. The nuts were then ground into peanut butter in a laboratory-size peanut butter mill. The peanut butter was mixed thoroughly, and 2 g were weighed into 50 ml centrifuge tubes. Reagent grade benzene (40 ml) was added to each tube. Samples were stirred thoroughly with a stirring rod until the peanut butter was suspended in the benzene. The tubes were stoppered and stored in the dark for 1 hr before centrifuging. Samples were then centrifuged for 20 min at 1400 x g and the benzene layer removed for analysis.

Fat contents were obtained by pipetting 5 ml of each sample's benzene layer into tared 50 ml beakers. The benzene was evaporated "over a steam bath under a hood". Samples were then placed in a 56°C oven for 1 hr to dry. The dried samples were cooled to room temperature and weighed on an analytical balance to obtain the amount of fat present in 5 ml of each sample.

The sample's benzene layer was also used to determine the

amount of carbonyls present. Trichloroacetic acid and 2, 4-dinitrophenylhydrazine solutions were prepared monthly by dissolving the chemicals in carbonyl free benzene and were stored in the dark. Five ml of each sample's benzene layer were pipetted into 50 ml volumetric flasks containing 3 ml of 4.3% trichloroacetic acid and 5 ml of 0.05% 2,4-dinitrophenylhydrazine. A reagent blank was also prepared. The flasks were stoppered and placed in a 60°C water bath for 30 min after which they were removed and allowed to come to room temperature. A 4% ethanolic KOH solution was prepared daily and 10 ml of this solution was added to each of the cooled flasks. The flasks were brought to volume with ethanol, inverted ten times to mix the contents, and allowed to stand for 15 min. Absorbance readings were taken at 430 nm and 460 nm using a 1 cm cuvette in a Bausch and Lomb Spectronic 70. Calculations were made as proposed by Chipault et al. (6).

$$\text{Unsaturated carbonyls} = \frac{4.204\ A_{460} - 3.266\ A_{430}}{W}$$

$$\text{Saturated carbonyls} = \frac{5.971\ A_{430} - 4.533\ A_{460}}{W}$$

W represents the amount of fat contained in a 5 ml aliquot. Unsaturated and saturated carbonyls were combined to give a total carbonyl value.

**Taste Panel Evaluations**

Six trained and experienced panelists were selected. The samples were removed from the oven and evaluated by the panelists weekly on the same day as the carbonyl analysis. A five point hedonic scale was used. A rating of 5 was considered excellent, 4 - good, 3 - fair, 2 - poor but edible, and 1 - unacceptable.

## Results and Discussion

The total carbonyl contents of all samples increased during the storage period. The correlation between each sample's total carbonyl content and storage time was significant at the p = 0.01 level (Fig. 1). Flavor scores for all samples dropped during the storage period, and their correlation with time was also significant (p = 0.01). Flavor ratings ranged from a perfect score of five (excellent) for freshly roasted nuts, to one (unacceptable) for the control after two weeks of accelerated storage at 63°C. Thus, total carbonyl content proved to be a good index of flavor scores.

The addition of TBHQ to the brine solution inhibited the production of carbonyl compounds during storage. The effect of the percent TBHQ applied was proportional with time. Carbonyl formation, which is related to oxidation, occurred rapidly in the untreated nuts, whereas, TBHQ treatment of the nuts retarded this process, resulting in lower carbonyl values and higher flavor scores. There was a significant difference between each level's total carbonyl mean at the end of the two week storage period. Figure 2 illustrates the effect of the level of antioxidant applied on total carbonyl content, at each time interval.

Statistical analysis (2) of both carbonyl content and flavor scores indicated that the percent TBHQ applied had a significant interaction (p = 0.01) with the amount of time stored. Due to this interaction, a Waller Duncan K-ratio t-test (2) was necessary for each level of TBHQ for both total carbonyl contents and flavor scores (Table 1). The interaction may be explained by the fact that the majority of the carbonyl formation occurred during the storage period, however, peanuts do undergo some oxidation during the roasting process (3). The total carbonyl contents determined on the day of roasting gave evidence that the antioxidant was also effective in reducing the amount of oxidation that occurred during roasting (Table 1).

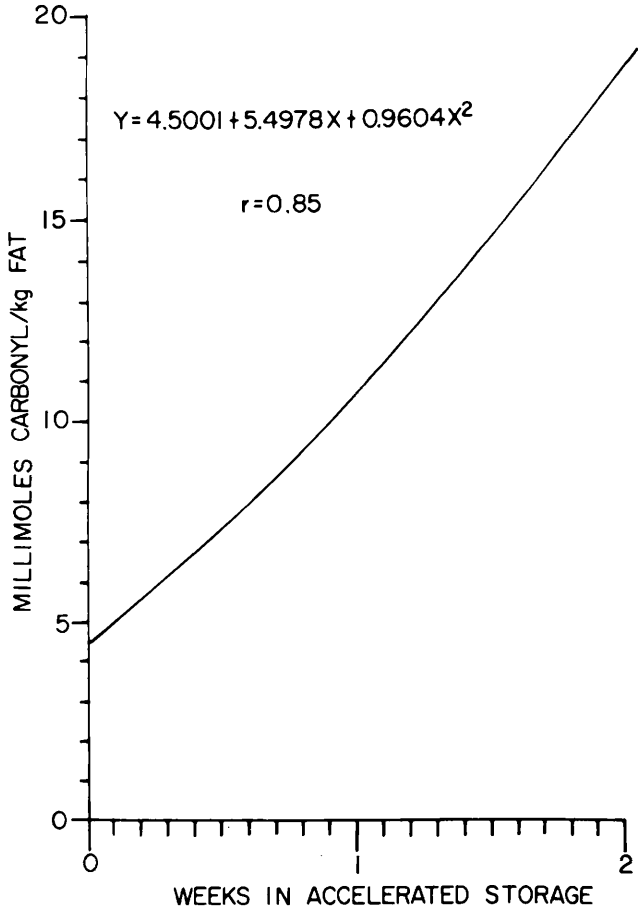


**Fig. 1. Total carbonyl contents of salted-in-the-shell roasted peanuts during the two week accelerated storage period. One day of storage at 63°C aproximates seven days of storage at room temperature.**

A major objective of this experiment was to evaluate the relationship between the total carbonyl content and the flavor score determined for each sample. Figure 3 illustrates the relationship between total carbonyl contents and flavor scores for all samples analyzed during the storage period. The correlation coefficient of 0.96 is highly significant (p = 0.01) and suggests that total carbonyl content is certainly a good indicator of the flavor of the peanuts. The curvilinear relationship between total carbonyl content and flavor score ratings supports the findings in Table I. When the nuts were freshly roasted panelists did not detect any significant differences in their flavors. During the storage period the total carbonyl contents of the con-

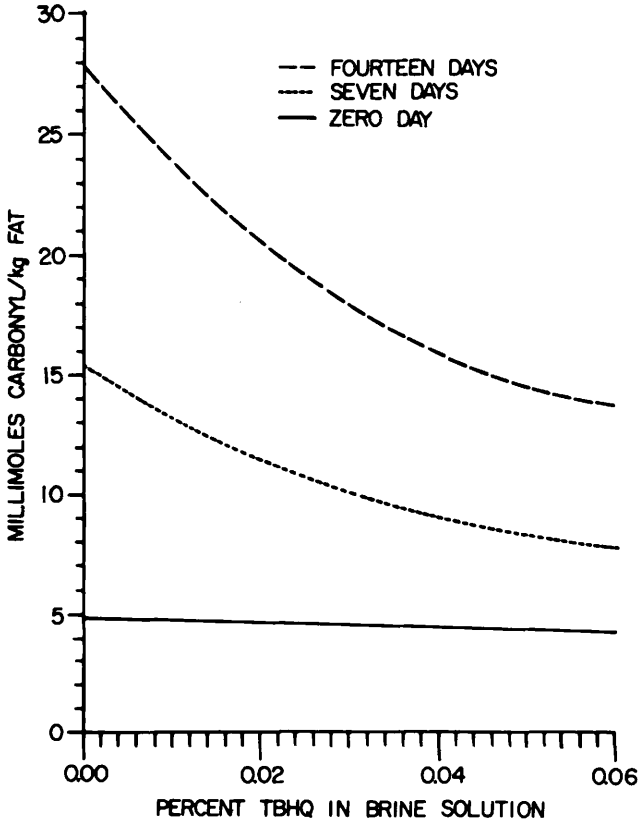


Fig. 2. Effects of TBHQ levels on the carbonyl content of roasted salted-in-the-shell peanuts during accelerated storage at 63°C.

Table 1. Total carbonyl and flavor score means as determined by the Waller Duncan k-ratio t-test.

| Weeks in 63°C Storage | Percent TBHQ | MEANS* Total Carbonyls | MEANS* Flavor Scores |
|---|---|---|---|
| 0 | 0.00 | 4.7726 a | 4.5370 a |
| | 0.02 | 4.6860 ab | 4.5522 a |
| | 0.04 | 4.2831 b | 4.6444 a |
| | 0.06 | 4.2586 b | 4.6717 a |
| 1 | 0.00 | 15.2955 a | 2.7341 b |
| | 0.02 | 11.9819 b | 2.9068 b |
| | 0.04 | 8.6617 c | 3.3886 a |
| | 0.06 | 8.0319 c | 3.6614 a |
| 2 | 0.00 | 27.9992 a | 1.5978 b |
| | 0.02 | 20.1054 b | 1.9239 b |
| | 0.04 | 16.2145 c | 2.3717 a |
| | 0.06 | 13.5831 d | 2.7087 a |

*Means within the same column for a given storage period having the same letter are not significantly different (p = .05).

trol began to rise sharply. Samples treated with TBHQ showed a less rapid increase, and panelists began to detect differences in the flavor of the treated and control nuts.

The amount of antioxidant actually present in the peanuts was not determined analytically. Direct applications of 0.01%, 0.015% and 0.02% TBHQ in an earlier experiment (9) caused much greater

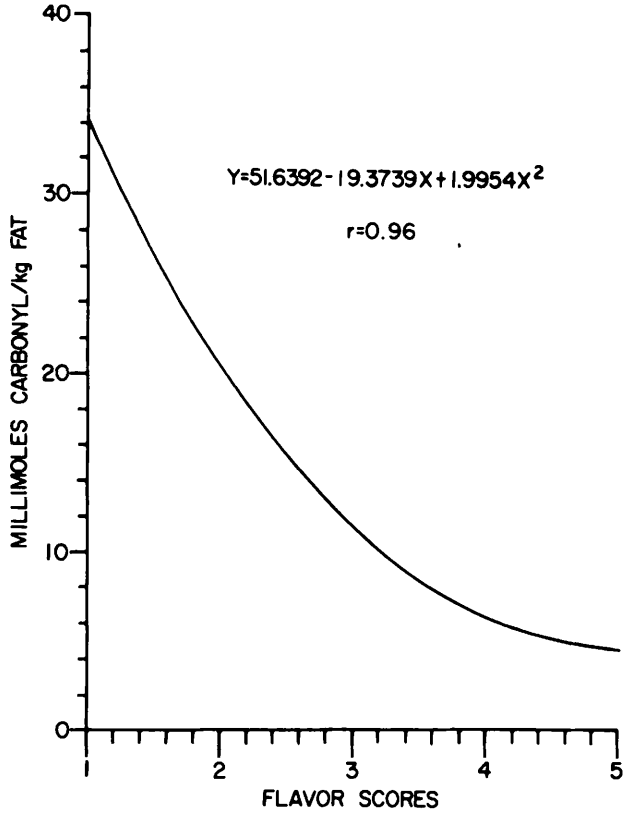


Fig. 3. Curvilinear relationship between total carbonyl content and flavor scores for all samples over the entire storage period (1 - unacceptable, 2 - poor but edible, 3 - fair, 4 - good, 5 - excellent).

reductions in total carbonyls than those found in this experiment. This result might suggest that the antioxidant did not reach these levels in salted peanuts during impregnation in this study. On the other hand, the method of preparation and salt contents of the salted-in-the-shell peanuts very likely played a role in the rate with which the nuts became rancid.

Optimum effects were achieved by impregnating peanuts with a brine solution containing 0.04% to 0.06% TBHQ. The shelf life of these peanuts was approximately twice that of the control. The total carbonyl content of the same peanuts was 100% lower than the carbonyl content of the control. There were no significant differences (p = 0.05) in the flavor scores of the two levels, however, carbonyl values for the 0.06% level were significantly lower than the 0.04% level after two weeks of accelerated storage.

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