Effect of Blanching on Peanut Shelf-Life[1]

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ABSTRACT

Blanching, seed coat removal, is often a processing step in peanut manufacturing but the general peanut industry consensus is that shelf-life reduction occurs as a result of the process. In order to examine the effects of blanching on shelf-life, runner-type peanuts were blanched using total heating time and final temperature in a 3 × 3 factorial experiment. In each of nine treatments, heating began at 32 C and increased incrementally through six heating zones over a total time of 30, 45, or 60 min to a final temperature of either 76.7, 87.8, or 98.9 C. Blanched peanuts from each treatment and nonblanched control samples were stored at 26 ± 1 C and ambient RH and were sampled over a 28-wk period. Peroxide value (PV) and oxidative stability index (OSI) of blanched and nonblanched peanuts were similar indicating no meaningful shelf-life differences. Descriptive sensory analysis of peanuts roasted when taken from storage indicated no significant differences in intensity of painty and cardboardy descriptors between blanched and nonblanched peanuts. Mean separations of attributes, including roast peanutty, for which significant differences were noted revealed only a weak, inconsistent relationship between descriptor intensities and final blanching temperature.

Key Words: Descriptive sensory analysis, quality, storage.

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In peanut processing, the term 'blanching' refers to the total process of removing the seed coat, or testa from the seed. Blanched peanuts are still considered raw after the process. Several peanut manufacturing operations require the use of blanched peanuts and additionally, with the seed coats removed, peanuts can be inspected to remove damaged/discolored seed which may be associated with aflatoxin contamination. Although blanching is often a necessary processing step, the general peanut industry consensus is that significant shelf-life reduction occurs as a result of the process.

Blanching of peanuts has been accomplished through dry, spin, alkali, air impact, water and hydrogen peroxide methods (Woodroof, 1983). The most common method is dry blanching wherein peanuts are passed through a low temperature heat treatment. Although proprietary methods may vary, heating occurs as a 10-15 cm bed of peanuts moves on a conveyer through a multi-zone oven in which air flow is alternated from top to bottom in consecutive heating zones. The temperature in each zone increases incrementally from *ca.* 30 C in the first zone to *ca.* 90 C in the final zone. The total time for this heat treatment is about 45 min during which moisture is removed from the peanuts and the seed coat is loosened, apparently by differential expansion of the seed and seed coat (Paulson and Brusewitz, 1976). Peanuts are cooled with air in the final conveyer zones, held briefly in bins, and then the seed coats are mechanically removed in the blanching process. After bagging, blanched peanuts are held in cold storage until shipment for further processing. Storage times are generally held to the shortest time possible.

In the available scientific literature, there is no definitive consensus on the effect of blanching method, heating time, and heating temperature on the storage stability of raw blanched peanuts. Some off flavors found in stored raw peanuts are thought to partly result from the action of lipoxygenase on linoleic acid (Pattee and Singleton, 1971; St. Angelo *et al.*, 1977; Rackis *et al.*, 1979). However, previous work concerning the relationship between lipoxygenase activity and storage stability is contradictory. Lipoxygenase has been shown to be heat inactivated during blanching (Mitchell and Malphrus, 1977; St. Angelo *et al.*, 1977; Branch *et al.*, 1987); however, there is no general agreement on the effect of blanching on peanut shelf-life. This study was conducted to determine the effect of blanching on the shelf-life of stored blanched peanuts relative to nonblanched peanuts. The comparison was accomplished by examining initial lipoxygenase activity, peroxide value (PV), oxidative stability index (OSI), and descriptive sensory analysis on blanched peanuts from nine time/temperature treatments and nonblanched peanuts which were stored and sampled over 28 wk at 26 ± 1 C.

Materials and Methods

Peanuts (*Arachis hypogaea* L. cv. Florunner) were harvested at optimum harvest date, carefully cured, shelled, sized, and stored at 3 to 5 C. Medium commercial grade peanuts (< 8.3 mm to ≥ 7.1 mm width) from this single lot of approximately 365 kg were used for all tests. The large lot was initially divided in half to provide samples for replications of blanching treatments. In the blanching treatments, total heating time and maximum temperature were both tested at three levels in a 3 × 3 factorial experiment. In each of the nine treatments, heating began at 32 C and increased incrementally through six heating zones over a total time of 30, 45, or 60 min to a final temperature of either 76.7, 87.8, or 98.9 C (Table 1). A description of bed and seed temperatures, seed moisture, and blanchability in the nine treatments has been published (Adelsberg and Sanders, 1997).

Table 1. Dwell times and oven temperature settings for heating zones in blanching protocols.

Protocol	Time in each zone	Total heating time	Heating zone 1	2	3	4	5	6
	min	min	C					
1	5.0	30	32.2	41.1	50.0	58.9	67.8	76.7
2	7.5	45	32.2	41.1	50.0	58.9	67.8	76.7
3	10.0	60	32.2	41.1	50.0	58.9	67.8	76.7
4	5.0	30	32.2	43.3	54.4	65.6	76.7	87.8
5	7.5	45	32.2	43.3	54.4	65.6	76.7	87.8
6	10.0	60	32.2	43.3	54.4	65.6	76.7	87.8
7	5.0	30	32.2	45.5	58.9	72.2	85.6	98.9
8	7.5	45	32.2	45.5	58.9	72.2	85.6	98.9
9	10.0	60	32.2	45.5	58.9	72.2	85.6	98.9

To simulate a multi-zone industrial oven, a single chamber, flame-heated oven with direction controlled air flow was used to supply dry, heated air (Proctor & Schwartz, Inc., Horsham, PA). A 465-cm^2 steel wire mesh basket was filled with peanuts to a depth of 12.7 cm to simulate the bed of peanuts on a conveyer in an industrial scale oven. The basket was placed into an open basket with solid sides and rubber gaskets on the bottom edges to fit exactly in the flow system of the oven. The larger outer basket was filled to the same depth as the smaller basket (12.7 cm, approximately 15 kg) with additional medium peanuts. Although these additional peanuts were not from the same lot as those tested, they were the same size and moisture content. This procedure allowed use of the limited supply of uniform seed and ensured even air flow throughout the peanuts. Air flow (76.2 m/min) direction was alternated in consecutive heat zones. After heating, the peanuts were immediately cooled with forced room temperature air, about 23 C, for 4 to 5 min until the seed temperature was about 30 C. Samples of 300 g were taken for moisture determination and immediately placed in tightly sealed glass jars. A small scale blancher (Model EX, Ashton Food Machinery Co., Inc., Newark, NJ) with counter-rotating grit rollers was used to remove the seed coats loosened by the heating treatments. Peanuts were processed once through the blancher, bagged in burlap, and placed in refrigerated storage at approximately 5 C. The treatments were run in the order 1-9, as specified in Table 1, then replicated in the same order. All treatments were completed over a 3-d period. Except for transport time between Horsham, PA and Raleigh, NC, peanuts were held in cold storage.

Within 48 hr of completion of the treatments, peanuts were aspirated to remove loose seed coats and placed into

burlap bags for storage. For each treatment, a 500-g sample was obtained and frozen for a subsequent lipoxygenase assay. The peanuts were stored in two incubators at 26 C (± 1 C) and ambient winter relative humidity for 28 wk. Each incubator contained blanched peanuts from separate replications of treatments 1-9 and a nonblanched control. Samples were collected at weekly intervals through 20 wk of storage and the final sample was taken after 28 wk storage. Samples were frozen until utilized. Samples were not available for all times because of use in other studies. Sample times used for OSI, PV, and descriptive sensory analysis were approximately 3-wk intervals and are indicated on the graphed data.

Storage Stability. PV and OSI for peanuts were determined from a 60-g sample which was ground for 15 sec in a coffee grinder. Samples wrapped in cheesecloth were pressed for 6 min at 16,000 lb and yielded enough oil to perform duplicate PV and OSI tests. Filtered oil (4.0 g) was used to determine OSI at 110 C (AOCS, 1992) on an Oxidative Stability Instrument (Omnion, Inc., Rockland, MA). PV (AOAC, 1990) was determined on 5-g samples of oil.

Lipoxygenase Assay. Extracts of samples frozen only at the beginning of the storage study were prepared by first grinding 25 g seed in a coffee grinder for approximately 15 sec. Twelve mL of 0.1 M sodium phosphate buffer, pH 6.4, was added to 1 g ground peanuts in a 50-mL polycarbonate centrifuge tube and the mixture was homogenized for 1 min on a Tekmar TR-10 Tissuemizer. Hexane (20 mL) was added and the mixture was shaken in a cold room for 1 hr before centrifugation for 10 min at 6500 rpm. About 0.5 mL of the aqueous phase was drawn, stored in a vial, and subsequently assayed. Samples were kept cold throughout the extraction process except when centrifuged. Enzymatic activity of the extract was measured polarigraphically in a reaction vessel fitted with a Clark oxygen electrode (Sanders *et al.*, 1975). Lipoxygenase activity was determined by adding 200 µL of the aqueous enzyme extract to 1.5 mL of 82.50 µL linoleic acid and 0.8% Tween 20 in pH 6.4, 0.1 M phosphate buffer and aerated 0.2 mL phosphate buffer in a 1.7-µL reaction vessel.

Oxygen level in the reaction vessel was measured at 2-sec intervals with an oxygen probe. Data were converted to mV and enzyme activity was calculated from the slope of millivolts versus time assuming the initial oxygen concentration was 260 nmoles/mL.

Sensory Evaluation. Sensory evaluation of peanuts from treatments 2 (76.7 C, 45 min), 5 (87.8 C, 45 min), and 8 (98.9 C, 45 min) as representative of the nine treatments was conducted. Roasting of samples to a Hunter L value of 49 to 50 was accomplished in a Farberware Roaster, Model 355 modified with a Watlow digital temperature controller to increase temperature stability (Sanders *et al.*, 1989b). Initial temperature in the roaster was 27 ± 2 C and the final temperature was 205 ± 3 C for all roasts. After roasting, peanuts were removed from the roaster and cooled for 20 min at 2 C. Peanuts were hand blanched after roasting and color of all samples was determined with a HunterLab colorimeter (Model D25-PC2). Peanut paste was prepared with a Cuisinart food processor using a precise grind-cool protocol to maintain temperature < 32 C (Sanders *et al.*, 1989a). Peanut paste color was determined with the HunterLab colorimeter and pastes were frozen at -20 C until sensory analysis.

Pastes were presented to an eight-member panel trained in the Flavor Descriptive Spectrum Analysis Technique (Meilgaard *et al.*, 1987) to fully characterize the qualitative and quantitative aspects of peanut flavor. The panel had over 10 yr experience evaluating peanuts for scientific and industry applications and frequent panel maintenance sessions with known and unknown samples were utilized to document the adequacy of training and accuracy of the panel. Four samples per session were presented randomly in 1-oz white transparent cups labeled with 3-digit random numbers. Samples were assigned intensity ratings on a 1-15 point numerical category scale for the following descriptive terms: roast peanutty, woody, fruity, nutty aftertaste, over roast, under roast, painty, cardboardy, tongue/throat burn, sweet, sour, bitter, and bitter aftertaste. Terms were described by Oupadissakoon and Young (1984), Johnson *et al.* (1988), or Sanders *et al.* (1989b). Samples from each replication were presented twice to the panel as a repeated measure.

Data were analyzed using a Statistical Analysis System (SAS, 1985) program package. After an analysis of variance (GLM), significant differences among means were determined by the Waller Duncan Test. Significance of differences was defined at $P \leq 0.05$.

Results and Discussion

Storage Analysis. The GLM procedure of SAS indicated highly significant differences for PV among treatment and nonblanched sample means over the time of storage (Fig. 1). Differences between non-blanched peanuts and all blanched peanuts as a group (inset Fig. 1) was also highly significant ($P \leq 0.0001$). Standard deviations about the means (inset Fig.1) ranged from 0.019-0.134. Nonblanched peanuts had higher PV's. Despite these significant differences and the fact that mean PV's rose slightly over time as expected, there were no practically meaningful differences. The generally accepted industry specification for PV is 2 for unroasted peanuts. A numerical difference of less than one unit even after 28 wk indicated that the observed differences were meaningless in terms of

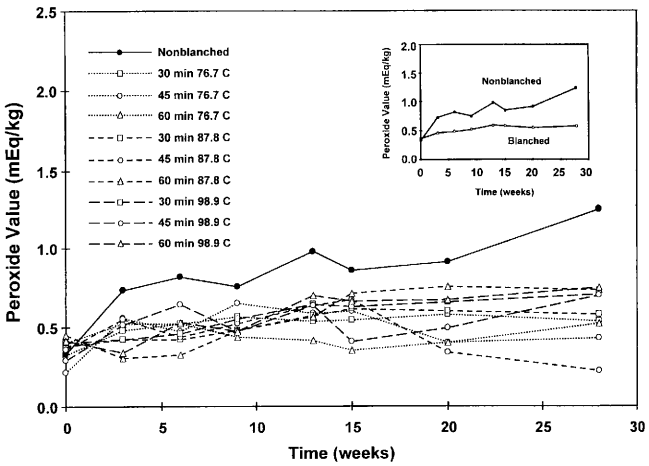

Fig. 1. Peroxide values (PV) of nonblanched peanuts and peanuts blanched with nine different time/temperature treatments over 28 wk at 26 ± 1 C. (Inset figure shows means for all blanching treatments vs. nonblanched control. Means were highly significantly different. SD about the means ranged from 0.019-0.134).

overall quality. Differences in PV among the blanching treatments were not significantly different.

Significant differences existed among the means for OSI of nonblanched and blanched peanuts over the 28 wk of storage (Fig. 2). However, differences between nonblanched and blanched peanuts as a group over the storage time were not significant (inset Fig. 2). Standard deviations about the means (inset Fig. 2) ranged from 0.03-0.26. OSI values numerically changed very little over the course of the study and significant differences noted are very unlikely to be meaningful in commercial processing.

Contrary to common industry perception, oil quality characteristics in this study did not indicate a reduction

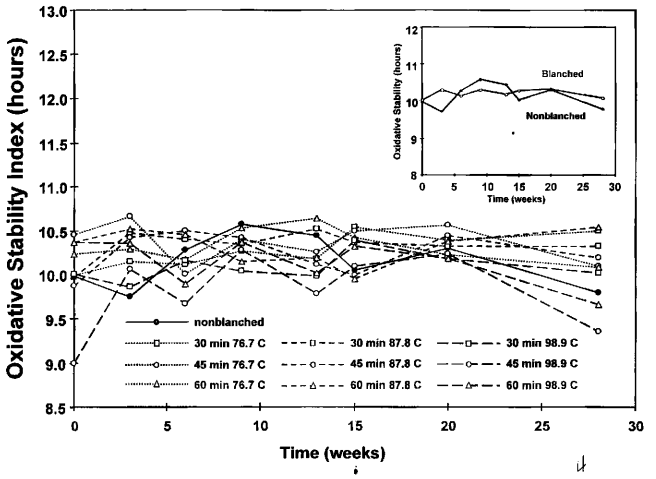

Fig. 2. Oxidative stability index (OSI) of nonblanched peanuts and peanuts blanched with nine different time/temperature treatments over 28 wk at 26 ± 1 C. (Inset figure shows means for all blanching treatments vs. nonblanched control. Means were NSD. SD about the means ranged from 0.03-0.26).

in quality potential due to blanching of peanuts. The peanuts used in this study were of initial high quality and had been carefully handled. In common practice, peanuts may be subjected to a wider range of environments and time delays before blanching. Additionally, many peanuts are blanched because of the need to reduce aflatoxin levels and these lots may contain more variable quality characteristics than the lot used in this study. This study does not support the contention that the blanching process reduces quality of peanuts; however, it does not rule out the potential that blanching of inferior quality peanuts may result in a more rapid deterioration of already low quality.

Sensory Evaluation. The relationship between oil deterioration characteristics such as high PV's and short OSI values with decreased roast peanutty flavor intensity and increases in the descriptive sensory terms card boardy and painty have been demonstrated (Sanders *et al.*, 1992; Bett *et al.*, 1994). The chemical and biochemical mechanisms leading from lipid degradation to off-flavor compounds have been described (Bett *et al.*, 1991; Vercellotti *et al.*, 1991; Sanders *et al.*, 1995). The lack of meaningful differences in oil quality characteristics thus suggests that meaningful differences in sensory characteristics may not occur; however, the final test of quality of a flavor based commodity lies in evaluation of the sensory characteristics.

Over the storage period, significant differences were observed among nonblanched and blanched peanut sample means for the descriptive terms roast peanutty, woody, fruity, tongue/throat burn, sweet, sour and bitter (Fig. 3). However, the mean separations for these attributes (Table 2) revealed only a very weak, inconsistent relationship between descriptor intensities and final blanching temperature. Intensity differences were very small and the maximum intensity range in any attribute over the course of storage was only 0.55 which occurred in roast peanutty between the two highest final blanching temperature treatments. Roast peanutty is the sensory characteristic most commonly used to describe the flavor of roasted peanuts. These data indicate that peanutty flavor developed upon roasting of peanuts that have been blanched and stored is not meaningfully

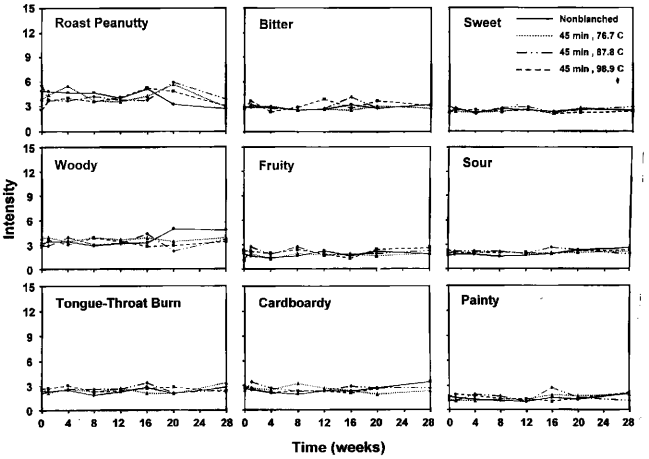

Fig. 3. Intensity of peanut flavor/taste descriptors of peanuts blanched with three different time/temperature treatments and nonblanched peanuts roasted after storage at 26 ± 1 C over 28 wk. All descriptors shown except cardboardy and painty had significant differences (P ≤ 0.05) among means over the storage time.

Table 2. Mean flavor/taste intensities of nonblanched and blanched peanuts stored at 26 ± 1 C for 28 wks.

Descriptive terms	Treatment[a] 0	2	5	8
	Intensity			
Roast peanutty	4.17 a	4.20 a	4.31 a	3.86 b
Bitter	2.88 cb	2.80 c	3.02 ab	3.12 a
Sweet	2.57 a	2.43 cb	2.54 ab	2.36 c
Woody	3.61 a	3.66 a	3.25 b	3.18 b
Fruity	1.77 b	1.63 b	1.95 a	2.06 a
Sour	1.92 b	2.01 ab	2.11 a	2.06 a
Tongue-throat burn	2.33 b	2.47 a	2.48 a	2.56 a
Carboardy	2.47 a	2.54 a	2.65 a	2.52 a
Painty	1.36 a	1.40 a	1.50 a	1.44 a

[a]Means in a row followed by the same letter are not significantly different (P ≤ 0.05). Treatment 0 = nonblanched, treatment 2 = 45 min., 76.7 C, treatment 5 = 45 min., 87.8 C, and treatment 8 = 45 min., 98.9 C.

different than that of nonblanched peanuts in storage up to 28 wk.

Peanut sensory descriptors related to lipid degradation are cardboardy and painty (Fig. 3). Given the fact that PV's were consistently low and OSI index for all samples was high, it is consistent that the intensity of these descriptors remained very low. No significant differences were observed among the blanched and nonblanched sample means over the storage period (Table 2).

Lipoxygenase. Lipoxygenase activity decreased significantly and almost consistently with increased heating time and temperature (Table 3). The inactivation of lipoxygenase due to dry heating is consistent with other data reported in the literature. St. Angelo *et al.* (1977) reported no decrease in lipoxygenase activity and no change in storage stability in virginia-type peanuts dry blanched at 71 C (no time was given). In protocols 1 and 3, maximum temperature was 76.7 C and lipoxygenase activity was only slightly reduced. Lipoxygenase activity was reduced by 93% in spanish-type peanuts heated at 100 C for 60 min (Mitchell and Malphrus, 1977). In the present study, maximum temperatures of 98.9 C resulted in decreases of 65-85% activity as time increased.

Lipoxygenase activity decreased with heating time and temperature but storage stability factor changes were not significant. The data suggest that storage stability, as measured by peroxide value and oxidative stability index, is not due to lipoxygenase inactivation.

Table 3. Lipoxygenase activity in peanuts blanched with different time/temperature treatments.

Treatment[a]	Activity[b]
	nmol O_2 consumed/mg seed/min
0	22.9 a
1	21.9 a
2	—
3	20.4 b
4	14.6 c
5	12.0 d
6	10.6 e
7	7.9 f
8	3.1 g
9	3.4 g

[a]0 = nonblanched.

[b]Means followed by the same letter are not significantly different ($P \leq 0.05$).

St. Angelo *et al.* (1977) water blanched peanuts at 86 C. Although lipoxygenase was completely inactivated, the shelf-life stability was less than that of the control peanuts. Mitchell and Malphrus (1977) found that steaming spanish peanuts at 100 C for 2 min completely inactivated lipoxygenase, yet extending the steaming time extended the shelf-life of the peanuts. Maximum shelf-life is apparently dependent upon other changes in addition to inactivation of this enzyme. These studies support the theory that lipoxygenase is not the only cause of lipid peroxidation in stored raw seed. Mitchell and Malphrus (1977) suggested that peroxidase, catalase, or hematin compounds may have an affect on oxidation of the unsaturated fatty acids.

Conclusions

In the blanching process, heating to higher temperatures (maximum of 98.9 C) for longer times (maximum of 60 min) had no meaningful effect on the storage stability factors of peroxide value and oxidative stability index, although lipoxygenase activity decreased with increased temperature and time of heating. During 28 wk of storage of blanched and nonblanched peanuts, descriptive sensory analysis of peanuts roasted upon removal from storage indicated only weak and inconsistent relationships to blanching treatment. Overall, blanching as conducted in this study did not reduce the 28 wk shelf-life of high quality peanuts.

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