Improving Shelf Life of Roasted and Salted Inshell Peanuts Using High Oleic Fatty Acid Chemistry

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ABSTRACT

Major markets for the large-seeded virginia-type peanut (*Arachis hypogaea* L.) include roasted inshell and salted inshell products with short shelf life being a common consumer complaint. Unlike many other peanut products, it is not economically possible to package these inshell peanuts in nitrogen flushed, oxygen barrier bags. A number of studies have shown that roasted runner-type peanuts with high contents of oleic fatty acid have improved oxidative stability and longer shelf life. A large-seeded, virginia-type peanut cultivar (AgraTech VC-2) with the high oleic trait has been released but no information is available on its shelf life stability. Therefore, this high oleic cultivar and the normal oleic cultivar VA 98R from the 2000 and 2001 crop were used for shelf life evaluations. Peanuts were sized into the fancy inshell grade for roasted inshell and salted inshell products. Peroxide value (PV) results for the roasted inshell peanuts indicated that normal oleic fatty acid (50% range) peanuts reached a PV of 20 meq/kg by the end of 4 wk of storage. On the other hand, the high oleic fatty acid (80% range) peanuts did not reach a value of 20 meq/kg until approximately 32 wk. When salted inshell the normal oleic peanuts exceed a PV of 20 meq/kg before the 2nd wk, whereas the high oleic peanuts still had not reached a PV of 20 meq/kg after 40 wk of storage. These results show a significant advantage of high oleic peanuts for extending shelf life of large-seeded, virginia-type peanuts for either roasted or salted inshell processing.

Key Words: Peroxide value, cultivar, fatty acids.

Approximately 35 to 40% of the large-seeded virginia-type peanut production is used for inshell processing. Therefore, delivery of high quality inshell peanuts that are appealing to consumers is vital to the inshell industry. The most frequent complaint from consumers of inshell products is the rancid taste that develops over time. Due to shipping and handling, often it is 6 to 8 wk after roasting or salting of the inshell peanuts before the consumer makes a purchase. Thus, it is important that inshell peanuts be of the highest quality and have long shelf life.

The major fatty acids in peanuts include about 50% oleic (C18:1), 28% linoleic (C18:2), 12% palmitic (C16:0), 3% stearic (C18:0) and minor amounts of arachidic (C20:0), eicosenoic (C20:1), behenic (C22:0), and lignoceric (C24:0). Norden *et al.* (1987) first reported an experimental peanut line from the Florida breeding program that had a high oleic trait (80% oleic fatty acid) and low linoleic (2%).

A number of studies have examined the effect of the high oleic trait on stability of runner-type peanut and peanut oil (O'Keefe *et al.*, 1993; Braddock *et al.*, 1995; Pattee and Knauft, 1995; Mugendi *et al.*, 1997; Baker *et al.*, 2002; Pattee *et al.*, 2002). The results of these studies show that the rates of oxidation, as assessed by peroxide value (PV) measurements, are about 10 times lower in high oleic peanut compared to normal oleic peanut. Sensory panel evaluations have shown that high oleic peanut have at least double the shelf life of normal peanut (Braddock *et al.*, 1995). High oleic peanut develop less painty flavor in storage compared to normal peanut and this leads to higher acceptability of high oleic peanut and a longer shelf life. Peanut seed having a mid-oleic level

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(between 65 and 70%) have also been shown to extend shelf life based on peroxide value endpoints (Saha, 2001).

No literature is available on the use of high oleic oil chemistry with large-seeded virginia-type peanut. However, with the release of the private commercial peanut cultivar AgraTech VC-2 in 1999, a large-seeded virginia-type cultivar became available which possesses high oleic fatty acid chemistry. This high oleic cultivar provides a unique opportunity to produce a high quality inshell product with long shelf life. This study was conducted to determine if the use of this cultivar could increase the shelf life of roasted and salted inshell products over a cultivar with normal oleic fatty acid chemistry. Extended shelf life would lend impetus to the use of the high oleic characteristic in future large-seeded virginia-type cultivars used by the inshell industry. Such use could help to increase sales of inshell products since shelf life could be increased significantly and consumer concerns about rancid taste would be minimized.

Materials and Methods

Roasted Inshell. Farmer stock peanut seed of large-seeded, virginia-type high oleic cultivar AgraTech VC-2 and normal oleic cultivar VA 98R from the 2000 crop were obtained from Golden Peanut Company, Suffolk, VA. Plots were grown using production practices outlined by the Virginia Agric. Exp. Sta. for producing high yields and quality. Peanuts pods were sized into fancy inshell grade (pods that rode a 13.5 mm roller spacing on the presizer and did not exceed a count of 496/kg) at the Tidewater Agric. Res. and Extension Center (TAREC) in Suffolk, VA. The pods were subsequently stored at 4.5 C and 65 to 70% RH in a commercial storage facility (Birdsong Peanuts, Franklin, VA) on 9 April 2001. Peanut pods used from the 2001 crop were grown at TAREC in Suffolk, VA using similar recommended cultural practices as in 2000. Pods were also sized into fancy inshell grade and prepared for processing immediately after sizing. The 2000 crop peanut pods in cold storage were removed 2 d before roasting. Peanut pods from both the 2000 and 2001 crop year were roasted at the same time in a commercial roasting facility (Jimbo Jumbo's, Edenton, NC) on 12 Feb. 2002 using standard commercial roast parameters. The roasted peanut pods were packaged in 2-mil cellophane bags, sealed and stored at ambient temperature. Three replicate samples were taken the day of roasting and then every 2 wk for 12 wk after which samples were taken at 4-wk intervals through 36 wk. After each sampling date, all samples were frozen (-15 C) until PV were determined.

Salted Inshell. Salted inshell processing involves creating a vacuum to pull a saturated salt solution into the peanut pod, drying the peanuts and then roasting. For this part of the study, the same two cultivars with normal and high oleic traits were used for the salted inshell studies as were used for the roasted inshell studies. Handling of treatments was the same for both crop years except the 2001 crop samples were put in cold storage on 22 March 2002 and held with the 2000 samples until 2 d prior to the salting process. Commercial salting was not an option because 2270 kg lots were required. Therefore, a large stainless steel pressure cooker was modified for salting the samples in a saturated salt solution obtained from a commercial processor (Northampton Peanut Co., Severn, NC). A vacuum (26 cm of mercury) was pulled to inject the salt solution into small lots of peanut pods (5.4 kg). The peanut pods were removed from the salt solution, drained, dried to ca. 9% moisture in a forced air drier and put in wire mesh bags for identity-preserved roasting. All samples were roasted on 4 Sept. 2002 at a commercial roasting facility (Northampton Peanut Co., Severn, NC) using standard commercial roast parameters, packaged in 3-mil cellophane bags, sealed, and stored at ambient temperature. Three replicate samples were taken the day of roasting and then every 2 wk for 12 wk, then every 4 wk through 32 wk with a final sample at 40 wk. All samples were frozen (-15 C) until PV were determined.

Peroxide Value Determination. The Amer. Oil Chemists' Soc. Official Method Cd 8-53 (Firestone, 1998) was used to quantify peroxides in the extracted oils. Results are expressed as meq peroxide per kg oil.

Statistical Analysis. Data were subjected to analysis of variance using the general linear model procedure (PROC GLM) of SAS (SAS Inst., 1990). The model included cultivar, year, storage time, and appropriate interactions as possible sources of variation. If significant interactions were detected then means were compared using the PDIFF option of the GLM procedure of SAS.

Results and Discussion

Peroxide values have long been used as a measure of shelf life potential in peanuts. In sensory panel studies, Braddock *et al.* (1995) reported that a PV of ca. 10 meq/kg indicated noticeable oxidation, and by 20 meq/kg, peanuts had reached unacceptable levels of oil oxidation. In the present study, PV was determined to estimate the change in oxidation over storage time of peanut pods from a cultivar with the high oleic fatty acid content vs. a cultivar with normal oleic fatty acid content after roasting inshell and salting inshell. Based on the work of Braddock *et al.* (1995) peroxide values of 20 meq/kg were used as the arbitrary point to indicate unacceptable oxidation during storage.

Roasted Inshell. Data analysis revealed no significant differences between crop years ($P > 0.05$). Highly significant differences ($P \leq 0.0001$) were obtained between cultivars as was expected with the normal oleic cultivar VA 98R having a 36 wk average PV of 43.0 compared to the high oleic cultivar AgraTech VC-2 average of 7.9. The effect of storage time was highly

significant ($P \leq 0.0001$) over the 36 wk of sampling. Significant interactions were found for cultivar by year ($P \leq 0.0001$), storage time by year ($P \leq 0.0002$), and cultivar by storage time ($P \leq 0.0001$). The cultivar by storage time interaction was the main emphasis of this study, and these data will be discussed in detail and illustrated graphically in Figure 1.

Analyses of samples obtained immediately after roasting revealed that the normal oleic cultivar had a PV of 10.4 meq/kg, whereas the high oleic cultivar was 1.0 meq/kg. This indicates that the normal oleic cultivar has some degree of oxidation immediately after roasting and that the high oleic acid cultivar had very little measurable oxidation. By 4 wk of storage, samples of the normal oleic cultivar had an average PV of 20.9 meq/kg, indicating that it already had an unacceptable oxidation level. However, the high oleic cultivar did not reach a PV of 20 meq/kg until after 32 wk of storage. Peroxide values of the normal oleic cultivar samples continued to increase with storage time reaching a high of 95.2 meq/kg after 36 wk, whereas samples of the high oleic cultivar also continued to increase but reached only a PV of 25.3 meq/kg after 36 wk. Reed *et al.* (2002) reported that normal oleic dry roasted runner-type peanut reached a PV of 20 meq/kg after 5 to 6 wk of storage, depending on the water activity of storage. Peanut seed in their study were only stored for 7 wk, but at that time the high oleic peanut had only reached PV of 3-5 meq/kg, and is in good agreement with the PV obtained for peanut seed stored for the same time period in this inshell study.

These data demonstrate the positive effect of high oleic fatty acid chemistry on the shelf life of roasted inshell large-seeded, virginia-type peanuts. The normal oleic cultivar had a shelf life of only 4 wk compared to approximately 32 wk for the high oleic acid cultivar. With 4 wk established as the maximum storage life of the normal oleic cultivar based on PV, statistical comparisons show that the PV of the normal oleic cultivar at 4 wk were significantly higher than the PV for 0 through 28 wk for the high oleic acid cultivar. Only after 32 wk was the PV of the high oleic cultivar significantly higher than that of the normal oleic cultivar at 4 wk. Therefore, based on the PV of this study and statistical comparisons, the use of high oleic fatty acid chemistry should significantly increase shelf life of roasted inshell virginia-type peanut cultivars.

Salted Inshell. Analysis of data from the salted inshell portion of this study gave results that were similar to those of the roasted inshell study. Significant differences were not obtained between years ($P \geq 0.05$), but as expected highly significant differences were observed between cultivars ($P \leq 0.0001$) and time in storage ($P \leq 0.0001$). Cultivar differences indicated an average PV of 105.3 meq/kg for the normal oleic cultivar vs. a PV of 5.0 meq/kg for the high oleic cultivar over the 40 wk sampling period. This difference is similar to data from other high oleic storage studies (O'Keefe *et al.*, 1993; Braddock *et al.*, 1995; Mugendi *et al.*, 1997) and shows the real benefit of using peanut cultivars with high oleic fatty acid chemistry for salted inshell processing.

The only significant interaction was cultivar by storage time ($P \leq 0.0001$), which similar to the roasted inshell processing was the interaction of interest for this study. An analysis of samples taken the day of processing showed that the normal oleic cultivar had a PV of 8.5 meq/kg compared to 0.5 meq/kg for the high oleic cultivar (Fig. 2). After 2 wk of storage, the salted inshell normal oleic cultivar had a PV of 84.1 meq/kg and increased to a high of 150.3 meq/kg by the end of 8 wk. The PV actually decreased after this date as shown in Figure 2 but was still above acceptable levels at each sampling date.

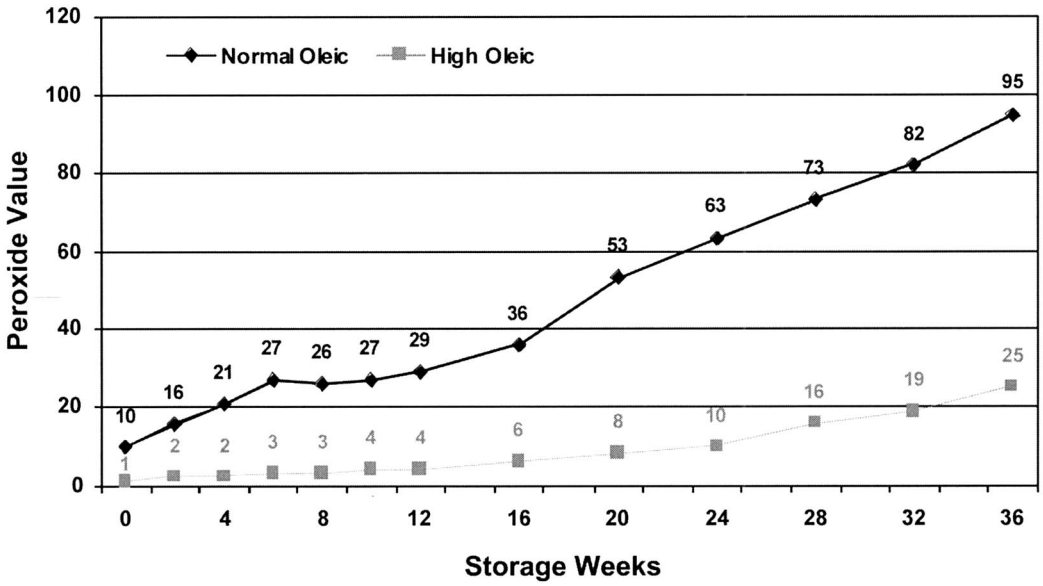

Fig. 1. Shelf life of roasted inshell normal vs. high oleic peanut.

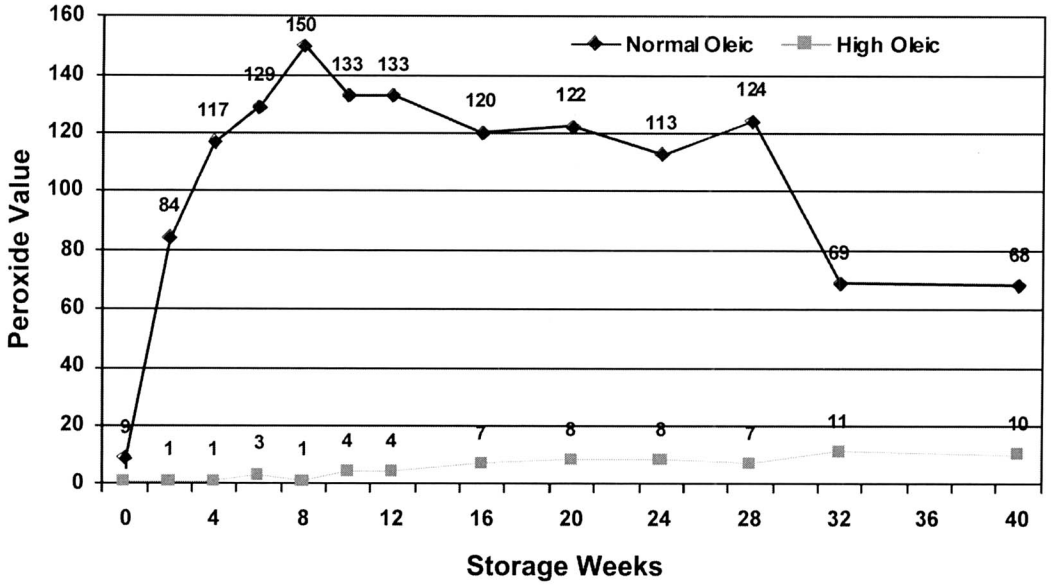

Fig. 2. Shelf life of salted inshell normal vs. high oleic peanut.

Peroxide Value is a measure of the concentration of the primary products of lipid oxidation. Hydroperoxides produced during oxidation are subject to a variety of further destructive reactions leading to their breakdown (Gray, 1978). In long-term studies, it is common to see destructive influences on hydroperoxide concentrations outweighing generative factors, leading to reductions in PV. The decrease in PV with extended oxidation is a well known feature of this analysis and is explained by the degradation of peroxides and formation of secondary oxidation products such as hexanal and other carbonyls (Braddock *et al.*, 1995).

The PV of 84.1 meq/kg for the normal oleic cultivar at 2 wk of storage is well above the level of 20 meq/kg considered as unacceptable, compared to a PV of only 0.8 meq/kg for the high oleic cultivar. The normal oleic cultivar had a shelf life of less than 2 wk when salted inshell, whereas the high oleic product had not reached a PV of 20 meq/kg by the end of 40 wk of storage. A shelf life of 2 wk is not long enough for the product to be distributed, stocked and purchased without significant quality deterioration. These data may help explain the many complaints regarding flavor from customers who purchase peanut pods that are salted and then roasted inshell. In fact, analysis of peroxide values of salted inshell peanut pods from many markets has shown that these are often sold having PV well above 20 meq/kg (S.F. O'Keefe, unpubl. data, 2001). Unfortunately, the perishable nature of normal oleic peanut pods that are salted inshell makes it highly unlikely that the product could reach the consumer at a stage of high quality. The use of high oleic cultivars obviously has tremendous potential for extending the shelf life of this inshell product, providing consumers with a high quality product, and likely leading to the potential for greater sales.

Roasted Inshell and Salted Inshell Comparisons. Differences in storage time were observed between the roasted inshell and salted inshell process for the normal oleic acid cultivar. As seen in Figure 3 the salted inshell product oxidized at a much more rapid rate than did the roasted inshell peanuts. The salted inshell peanut pods had a PV of 84 meq/kg after 2 wk of storage indicating that it probably reached a PV of 20 meq/kg within 1 wk of storage. The roasted inshell peanut pods did not reach a PV of 20 meq/kg until 4 wk. The roasted inshell peanut pods continued to oxidize at a steady rate with time throughout the 36 wk of storage, whereas the salted inshell rapidly oxidized reaching a peak PV of 150 meq/kg after 8 wk and then declined as discussed above.

Peanut pods with high oleic fatty acid content oxidized at about the same rate whether roasted inshell or salted inshell until about 24 wk as shown in Figure 4. After 24 wk the roasted inshell continued to deteriorate at a steady rate, whereas the rate of oxidation for salted inshell appeared to plateau. These data demonstrate the shelf life benefit of the peanut cultivars with the high oleic fatty acid chemistry. The 28 wk shelf life increase for roasted inshell is significant but extension of shelf life for the salted inshell peanut pods is particularly impressive considering the rapid rate of oxidation for the normal oleic fatty acid chemistry.

Summary and Conclusions

The results of this study illustrate the advantage of high oleic fatty acid chemistry for extending shelf life of inshell large-seeded, virginia-type peanut products. Estimated shelf life of the roasted inshell product was 4 wk for the normal oleic peanut cultivar VA 98R and 32 wk for the high oleic peanut cultivar AgraTech VC-2. Similar results

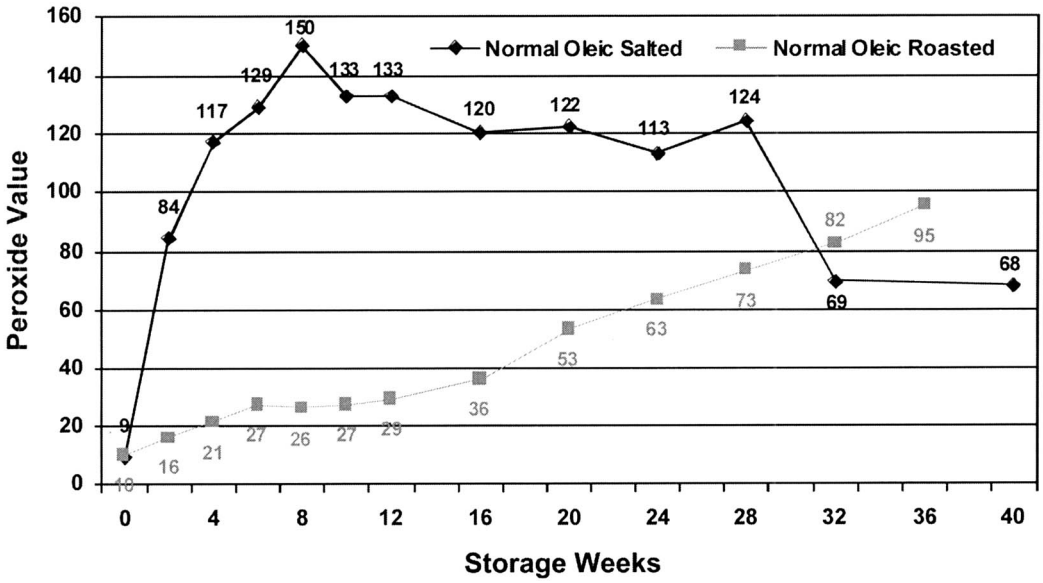

Fig. 3. Shelf life of normal oleic peanuts when roasted or salted inshell.

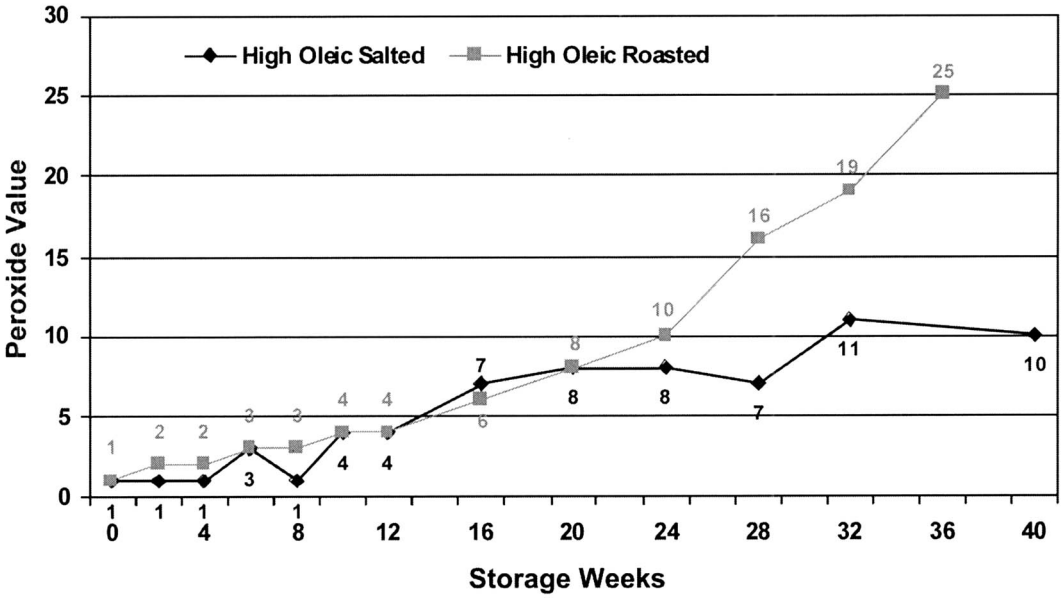

Fig. 4. Shelf life of high oleic peanuts when roasted or salted inshell.

were found for the salted inshell product with a shelf life of less than 2 wk for the normal oleic and more than 40 wk for the high oleic. These data are also interesting in that the salted inshell normal oleic acid peanut pods become rancid much more rapidly than the roasted inshell, whereas the high oleic acid peanut pods seem to oxidize at about the same rate whether roasted inshell or salted inshell through 24 wk of storage. These data suggest that the use of high oleic fatty acid chemistry in the future breeding of large-seeded virginia-type peanut cultivars will be very beneficial to the inshell peanut industry based on the extended shelf life demonstrated in this research. By extending shelf life of inshell products consumer complaints should be diminished and product sales increased thereby benefiting the total peanut industry.

Acknowledgments

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