Effect of Hot Water Immersion on Sensory Properties of Non-Refrigerated Peanuts[1]

A. L. Branch*, R. E. Worthington, M. S. Chinnan, E. K. Heaton and T. O. M. Nakayama[2]

ABSTRACT

Sensory properties of Fla Early Bunch and NC 7 peanuts immersed in hot water at 79 C for 90 sec and subjected to non-refrigerated storage were evaluated. Sensory scores were lower for immersed peanuts than the non-immersed peanuts, however the attributes for the immersed peanuts were not scored lower than borderline throughout storage. Flavor scores for both cultivars ranged between 6 for slightly good and 7 for moderately good. Significant cultivar differences were observed for color at the initial month and flavor at 2, 5, and 8 mo. NC 7 peanuts had significantly higher flavor sensory scores than the Fla Early Bunch nuts. Duo trio tests showed that panelists detected significant differences between non-immersed and immersed peanuts at the eighth month of storage.

Key Words: Peanuts, sensory, hot water immersion.

The peanut (*Arachis hypogaea* L.) contains a high amount of protein, 25-34% (2). Because of its high nutritional quality and inexpensive protein cost, much attention has been focused on the peanut as a food source that could alleviate world hunger. Peanuts are a widespread leguminous crop with more than half of the production occurring in developing countries where protein-calorie malnutrition is evident.

Production and processing techniques are not highly mechanized in the developing countries as the peanuts are handled manually and stored under unfavorable conditions. Since the peanut contains approximately 50% oil, non-refrigerated storage environments often lead to rancidity and adsorption of foreign odors and flavors in the peanut.

Heaton (5) found peanuts stored at room temperature for 2 yrs to be extremely resistant to oxidative rancidity and staling if water blanched by commercial means at 79 C for approximately 1 min. Woodroof (11) likewise reported hot water blanched peanuts to have a more stable shelf-life than those of the unblanched seed. The hot water blanching procedure, one of several methods designed for peanut skin removal, involves scalding the peanut kernels in hot water sprays for the minimum time possible to loosen the skins followed by rubbing the kernels between opposite surfaces for seed removal (3,4). Branch *et al.* (1) found peanuts that were immersed in hot water (79 C) for 90 sec to be more stable during storage than raw peanuts as shown by lower peroxide values, free fatty acids, and lipoxygenase activity. These researchers noted that water immersed seed which were low in linoleic acid were more resistant to deterioration than water immersed nuts of another cultivar which were high in linoleic acid.

As far as sensory qualities, hot water blanched peanuts were reported to be more attractive in appearance than dry or spin-blanched peanuts (11). Tough textures were observed in those water-blanched nuts which were dried too quickly after processing. Lawler (6) reported less shrinking and splitting in water blanched peanuts. According to Reeve (9), water-blanched nuts had a crispy texture in comparison to the soft texture of spin-blanched peanuts.

The purpose of this study was to compare sensory properties of non-immersed peanuts and peanuts immersed in hot water, 79 C, for 90 sec and stored at non-refrigerated conditions for eight months. Differences based on texture and flavor characteristics of the

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[2]Former Graduate Research Assistant, Associate Professor Emeritus, Associate Professor, Professor and, Professor, respectively, Department of Food Science and Technology, University of Georgia, Experiment, GA 30212.

peanuts at the eighth month of storage were also assessed using the duo trio test.

Materials and Methods

Cultivar Selection and Processing

Virginia type (*Arachis hypogaea* L. subsp. *hypogaea*) peanuts of the Fla Early Bunch and NC 7 cultivars were used in this study. The Fla Early Bunch peanuts were obtained from the Georgia Seed Foundation, Plains, GA, and the NC 7 seed were obtained from the VPI Tidewater Research Center, Suffolk, VA. Both cultivars were held at 2 C, 65% relative humidity (RH) until time of treatment.

The peanuts were immersed in hot water at 79 C for 90 sec according to the procedure outlined by Branch *et al.* (1). Throughout the paper, peanuts immersed in water and stored without skins, peanuts immersed in water and stored with skins, and peanuts not immersed in water and stored with skins will be referred to as INS, IWS and NI, respectively. The terminology INS, IWS and NI used here is in consistence with that employed by Branch *et al.* (1). The INS, IWS and NI samples were stored in open containers and kept in environmental rooms set at 23, 27 and 35 C with relative humidities of 55, 45, and 65%, respectively. Peanuts not immersed in water and stored with skins at 2C, 65% RH were referred to as control or CNI peanuts.

Organoleptic Evaluation

Peanuts were prepared for sensory quality analyses by first removing seed skins. Skins were removed from the immersed nuts by hand. The CNI and NI peanuts were heated for 5 min in a GE Rotisserie model R 20 (General Electric, Bridgeport, CT) at 204 C in order to loosen skins which were then removed by hand. A change in peanut color was not apparent. After skin removal, CNI, NI, IWS and INS nuts were oil roasted at 160 C for 10 min in a Wells Autofry Type F-48 (Wells Manufacturing Corp., San Francisco, CA) using coconut oil. This time was determined from trial runs using manufacturer's instructions. The endpoint of cooking was determined from subjective evaluation of seed brownness.

Samples were submitted to a fifteen-member laboratory panel experienced in judging peanut quality. Testing was performed in partitioned booths with incandescent lighting. In each session, a set of four samples, CNI, NI, IWS and INS peanuts of the same cultivar were subjected for evaluation. At a given session, the NI, IWS and INS peanuts had been stored at the same temperature and humidity. The peanuts were evaluated for appearance, color, aroma, texture, and flavor. At the initial month, two samples from each cultivar were presented in each session. These samples were NI and INS peanuts resulting in a total of four samples per session. A 9-point hedonic scale (9 = extremely good, 5 = borderline, 1 = extremely poor) was used for judging the sensory attributes of the samples presented in random order (7). Sensory evaluation of each set of samples was performed in duplication.

The duo trio test (8) was further used at the eighth month to determine texture and flavor differences of the samples. Testing was performed in booths with red lighting to disguise sample appearance. Panelists were selected using the duo trio test for screening, and all panelists scoring 60% or more for correct responses were chosen. All screened panelists were then trained through group sessions to recognize flavor and texture differences among the peanut samples. Nine trained panelists participated on the duo trio taste panel.

Statistical Analysis

Sensory data were analyzed on the IBM computer using the Analysis of Variance procedure and Duncan's Multiple Range Test of Statistical Analysis System (10).

Results and Discussion

Statistical analysis of sensory scores of CNI samples showed no statistical differences among the CNI samples tested in different sessions. Using the Analysis of Variance procedure and Duncan's Multiple Range test, sensory data collected from the initial testing period were analyzed, and data collected from 2, 5, and 8 mo. of storage were pooled and analyzed.

Mean sensory scores for appearance, color, aroma, texture, and flavor of peanuts at the initial month are presented in Table 1. Aroma, texture, and flavor characteristics were unaffected by water immersion. The non-immersed and immersed peanuts were found to be significantly different in appearance and color scores. These differences were believed to have been due to oil roasting and not water immersion since the immersed peanuts were described by panelists as "dark" and "over roasted" in appearance and color. The oil roasting time was decreased to 8 min for the immersed peanuts at the later months of testing.

Table 1. Mean Sensory Scores for Oil Roasted Peanuts at Initial Month of Storage.

		Sensory Scores[1]				
		Appearance	Color	Aroma	Texture	Flavor
Treatment	Non-immersed	7.75 a	7.55 a	7.73 a	7.70 a	7.53 a
	Immersed	7.18 b	7.00 b	7.63 a	7.45 a	7.40 a
Cultivar	NC 7	7.56 a	7.43 a	7.70 a	7.50 a	7.43 a
	FLA	7.35 a	7.13 b	7.65 a	7.65 a	7.55 a

[1]Scale of 9 to 1 where 9 = extremely good, 5 = borderline, and 1 = extremely poor. Means within each treatment or cultivar not followed by the same letter are significantly different ($P \leq 0.05$).

Cultivar was only significant for the color attribute. This difference was again probably due to the oil roasting procedure. The initial month of testing was the only time that the cultivars were evaluated simultaneously.

Table 2 contains the levels of significance for cultivar, treatment, and storage condition associated with the five sensory attributes at 2, 5, and 8 mo of storage. The levels of significance for the interactions were not presented in Table 2 as only three were less than or equal to 0.05. These interactions included cultivar and storage for appearance at the fifth month and treatment and storage for appearance and color at the eighth month.

From Table 2, it is apparent that treatment had the largest effect on the attributes. Storage condition had a significant effect on appearance and flavor at the eighth month, and on aroma and flavor at the fifth month. Rancidity was more pronounced by the fifth month in NI raw peanuts of the Fla Early Bunch cultivar according to Branch *et al.* (1), and was detected by some panelists in cooked nuts from various storage conditions. This would account for the significance of storage condition on flavor and aroma at the fifth month.

Although the two cultivars were not subjected to the sensory panel simultaneously, cultivar was significant for flavor at 2, 5, and 8 mo of storage and aroma at the fifth month. As shown in Table 3, Duncan's Multiple Range Test showed higher flavor means for the NC 7 cultivar. The NC 7 cultivar was shown to be more stable during storage than the Fla Early Bunch cultivar by Branch *et al.* (1). Blanchability was higher for the NC 7 cultivar as demonstrated by ease of skin removal by hand after water immersion and during preparation for sensory evaluation.

Table 2. Levels of Significance for the Main Effects of Sensory Attributes on Cultivar, Treatment, and Storage Condition.

Attributes	Time (months)	Cultivar	Treatment	Storage Condition
Appearance	2			
	5		**	
	8		**	**
Color	2			
	5			
	8		**	
Aroma	2		**	
	5	*a	**	*
	8		**	
Texture	2		**	
	5		**	
	8		**	
Flavor	2	*	**	
	5	**b	**	**
	8	**	**	*

[a]P ≤ 0.05

[b]P ≤ 0.01

Table 3. Mean Flavor Scores for NC 7 and Fla Early Bunch Peanuts at 2, 5 and 8 Months of Storage.[1]

Cultivar	Time (months) 2	5	8
NC 7	6.70a	6.76a	6.53a
Fla Early Bunch	6.40b	6.26b	6.12b

[1]Scale of 9 to 1 where 9 = extremely good, 5 = borderline, 1 = extremely poor. Means within each column not followed by the same letter are significantly different (P ≤ 0.05).

Treatment means for both cultivars and all storage conditions are shown in Table 4. The INS and IWS nuts had significantly lower texture and flavor scores as compared with the CNI and NI samples at the second month. No significant differences were observed in the other attributes at the second month of storage.

Although rancid aromas were observed in raw samples by Branch *et al.* (1), panelists failed to observe these off-aromas or flavors in the oil-roasted peanuts at the second month of storage. It is believed that the volatile aroma compounds were lost during the cooking process, and the rancid aromas observed in raw samples resulted from oxidation of surface lipids.

At the fifth month, IWS peanuts had significantly lower appearance scores than the CNI or NI peanuts. There was no significant difference among color scores of the treatments. Aroma scores were highest for the CNI peanuts, intermediate for the NI peanuts, and the lowest for the INS and IWS peanuts.

Table 4. Mean Sensory Scores of NC 7 and Fla Early Bunch Oil Roasted Peanuts Evaluated at 2, 5, and 8 Months of Storage.

Storage Months	Treatment	Sensory Scores[1] Appearance	Color	Aroma	Texture	Flavor
2	CNI	7.10 a	6.99 a	7.48 a	7.14 a	6.82 a
	NI	7.11 a	7.04 a	7.54 a	7.25 a	6.96 a
	INS	7.08 a	6.79 a	7.19 a	6.81 b	6.25 b
	IWS	7.04 a	6.86 a	7.29 a	6.81 b	6.17 b
5	CNI	6.92 a	6.72 a	7.41 a	7.21 a	7.01 a
	NI	6.98 a	6.82 a	7.19 b	7.34 a	6.71 b
	INS	6.83 ab	6.72 a	6.97 c	6.87 b	6.27 c
	IWS	6.66 b	6.57 a	6.97 c	6.84 b	6.06 d
8	CNI	6.93 a	6.66 a	7.30 a	7.32 a	6.97 a
	NI	6.87 a	6.43 ab	7.08 ab	7.24 a	6.46 b
	INS	6.59 b	6.18 b	6.83 bc	6.85 b	6.19 b
	IWS	6.34 b	5.88 c	6.58 c	6.71 b	5.67 c

[1]Scale of 9 to 1 where 9 = extremely good, 5 = borderline, 1 = extremely poor. Means in each column and within each storage month not followed by the same letter are significantly different (P ≤ 0.05).

As observed at the second month, texture scores for the INS and IWS peanuts were significantly lower than those of CNI or NI peanuts. The INS and IWS peanuts were described by panelists to be "tough," "crisp," and "hard." All treatments had significantly different flavor scores at the fifth month, with the CNI peanuts receiving the highest score. Hot water immersion appeared to alter flavor properties at the fifth month of storage as illustrated by significantly lower scores.

Appearance scores of INS and IWS peanuts were significantly lower than the CNI and NI peanuts at the eighth storage month. The same pattern was also observed with the texture scores. The IWS peanuts had significantly lower color and flavor scores than the other peanuts.

Rancid aromas and flavors were noted by panelists in raw peanuts of the Fla Early Bunch cultivar at the fifth and eighth months. Non-immersed peanuts had significantly higher flavor scores than the immersed peanuts at the second and fifth months. However, by the eighth month, rancidity was detected in oil-roasted samples, and the flavor scores of NI peanuts were similar to the scores of the INS peanuts. The IWS peanuts had the lowest flavor scores, and were described by panelists to be "musty," "old," "bitter," and "foreign." The bitter tannins in the skins probably contributed to the off-flavor which developed during storage.

Table 5 lists duo trio results for the peanuts stored for 8 months. The duo trio evaluation for flavor and texture comparisons showed that panelists were able to significantly distinguish between NI and INS peanuts at 5% probability. However, no significant differences were observed between IWS and INS nuts.

Unlike the findings of the duo trio test, results shown in Table 4 showed no significant differences in flavor between NI and INS peanuts at the eighth month. Significant differences in texture were detected between non-immersed and immersed peanuts.

Table 5. Duo Trio Comparisons for Non-immersed and Immersed Peanuts at 8 Months of Storage.[1]

Samples	Number different from NI[2]	Number different from IWS[3]
NC 7 INS	14*	12
Fla Early Bunch INS	13*	7

[1]A total of 18 judgements were made for the duo trio tests.

[2]Samples consisted of identified and unidentified NI peanuts and unidentified INS peanuts.

[3]Samples consisted of identified and unidentified IWS peanuts and unidentified INS peanuts.

*Significant at $P \leq 0.05$.

Conclusions

Sensory evaluations made on non-immersed and immersed peanuts subjected to accelerated storage at non-refrigerated conditions showed significant sensory quality differences. These differences were mostly due to water immersion. Although sensory scores were lower for the immersed peanuts than the non-immersed nuts, the attributes were acceptable throughout storage as the scores ranged from 5.67 (borderline) to 7.29 (good).

Storage conditions had little effect on sensory characteristics indicating potential in the use of the hot water immersion method for preserving peanuts at non-refrigerated conditions.

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Literature Cited

1. Branch, A. L., R. E. Worthington, I. L. Roth, M. S. Chinnan, and T. O. M. Nakayama. 1987. Effect of hot water immersion on storage stability of non-refrigerated peanuts. Peanut Sci. 14:26-30.
2. Cobb, W. Y. and B. R. Johnson. 1973. Physiochemical properties of peanuts, pp. 209-265. *in* Peanuts - Culture and Uses. Amer. Peanut Res. Educ. Soc., Stillwater, OK.
3. Green, P. 1951. Method of blanching nuts. U. S. Patent 2,558,899.
4. Green, P. 1955. Method and machine for removing skins from nuts. U. S. Patent 2,702,574.
5. Heaton, E. K. 1983. Personal communication. Georgia Agricultural Experiment Station, Experiment, GA.
6. Lawler, F. K. 1961. Ingenuity creates new processes. Food Eng. 33:38-40.
7. Peryam, D. R. and F. J. Pilgrim. 1957. Hedonic scale method of measuring food preferences. Food Technol. 11:9-12.
8. Peryam, D. R. and V. W. Swartz. 1950. Measurement of sensory differences. Food Technol. 4:390-395.
9. Reeve, K. J. 1962. Split skins spun off in new nut blancher. Food Eng. 34:51.
10. SAS Institute. 1982. SAS User's Guide: Statistics, 1982 Edition. Cary, NC: SAS Institute Inc. 584 pp.
11. Woodroof, J. G. 1983. "Peanuts: Production, Processing, Products." 3rd Ed. AVI Publishing Co., Westport, CT. 330 pp.

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