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A comparison of the flavor and compositional quality of peanuts from several origins

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The flavor and biochemical quality of peanuts obtained from Argentina, China, and USA for the crop years 1986, 1987, and 1988 were evaluated for composition, descriptive sensory properties and gas chromatographic volatiles. Roasted peanutty flavor was more intense in USA-grown peanuts, and fruity/fermented, an undesirable flavor, was less intense in USA-grown peanuts than peanuts from the other two origins. Flavor attributes in Argentina-grown peanuts varied more among crop years than the others. Similar patterns occurred for the corresponding volatile compounds. Sugar content was greater, while lipid and Kjeldahl nitrogen contents were less in the Argentina-grown peanuts than peanuts from the other two origins.

INTRODUCTION

Peanuts are exported by many countries, such as the People's Republic of China, Argentina, India, Sudan, Malawi, Egypt and the USA (How & Young, 1983; NPC, 1990). How and Young (1983) compared the fatty acid content of peanuts from several of these countries. Pettitt *et al.* (1992) published methods for differentiating between peanuts grown in Argentina and China for purposes of monitoring USA import quotas. Sanders *et al.* (1992) published information on the comparison of shelf-life stability of peanuts from Argentina, China and the USA that were sampled for the present study.

Flavor of peanuts is very important to their acceptability. Need for data on the comparison of flavor and shelf-life quality for peanuts of various worldwide origins prompted this investigation to establish such baselines of information by means of descriptive sensory analysis and chemical methods. This information can provide processing industries with benchmarks of comparative analytical information on typical peanuts of diverse origin available from major exporting countries. Although Argentina, China and the USA consistently supply peanuts for export, little has been published on the comparison of quality factors. The purpose of this investigation was to determine flavor quality, gas chromatography volatiles, and proximate composition of peanuts from these major exporting countries.

MATERIALS AND METHODS

Peanut sampling

Through the Agricultural Research Service (European Export Research Unit, Rotterdam, The Netherlands) and the National Peanut Council of America, Export Committee, peanut samples were obtained from shipment lots of commercial peanuts arriving in Europe. Lots from China, Argentina, and the USA (1986, 1987 and 1988 crop years) were sampled in Rotterdam. Ten 6·8-kg lots of typical commercial shipments from each of the countries for each crop year (90 lots total for 3 years) were randomly sampled.

Peanut sample roasting and peanut paste preparation

Roasting and peanut paste preparation were carried out according to the description in Johnsen *et al.* (1988) and Sanders *et al.* (1989*a*,*b*). Roast color was measured by the method described by Crippen *et al.*

(1992), and set at a Hunter L value of 50, which is between the Number 3 and 4 USDA color chips. However, maximum roast quality depended on the origin of the peanut and was optimized by sensory screening of samples by three trained panelists for the best balance of peanut flavor quality at various colors (see description of sensory analysis below). A medium florunner peanut roasted to a Hunter L value of 50 that possessed a balanced flavor profile for character notes was chosen as a warmup sample for panelists in descriptive sensory analysis as well as for a reference for instrumental calibration.

Descriptive sensory panel analysis

The sensory panel consisted of 12 in-house employees who were trained in sensory descriptive flavor techniques and had at least 1 year's experience in evaluating peanut flavor characteristics (Johnsen *et al.*, 1988; Meilgaard *et al.*, 1991). A 15-point universal flavor scale was employed for evaluating intensities (0, not detectable; 15, intensity stronger than anything detectable in peanuts thus far). The panelists were uninformed as to the origin of the peanut samples. Two subsamples from all three countries were randomly assigned for presentation at a given session. Six samples were presented at a session. Each subsample was presented twice in separate sessions (replicates). Within the country (treatment) the 10 samplings were randomly assigned to each panel sessions. The three crop years were presented over a 3 year period. The samples were presented 6–12 months after harvesting. Each country–sampling combination was presented as a peanut paste to the panel in duplicate according to Sanders *et al.* (1989*a*,*b*). A reference peanut paste was presented at each panel session as a warmup sample. On a given day the samples were presented in a unique random order.

Proximate analyses

Samples of each of the 90 lots were analyzed for moisture (AOCS Method Bd 2-52 (AOCS, 1969)), Kjeldahl nitrogen (AOCS Method Ac 4-41 (AOCS, 1969)), total lipids (AOCS Method Ba 3-38 (AOCS, 1969)), and sugar (AOAC Method 974.06 (AOAC, 1990); total as sucrose equivalent). Each sample was corrected for moisture. Aflatoxin levels (at the port of entry) were acceptable for peanuts entering the European Community. Shelf-life stability and oil quality studies have been reported (Sanders *et al.*, 1992).

Gas chromatographic volatiles analysis

Gas chromatographic flavor volatile profiles were conducted on all 90 peanut butter samples that had been roasted for optimum flavor and peaks were previously identified by mass spectra and comparison of retention times to known standards (Fore *et al.*, 1979; Dupuy *et al.*, 1983; Crippen *et al.*, 1992; Vercellotti *et al.*, 1992). Each sample was run once in duplicate. These 90 samples were then compared for key marker compounds. The reference florunner peanuts, as described above, were also used as a gas chromatographic standard for identification of compounds and quantitation of component peaks. To inject peanut paste samples onto the gas chromatographic column, a folded plug of fine glass wool (50–55 mg) (8 μm, Pyrex Fiber Glass, Corning #3950) was placed about 5 mm above the base of an 84 × 9 mm OD glass cartridge used as a sample tube for direct gas chromatography of peanut butter volatiles (Lovegren *et al.*, 1987). Approximately 2 g of peanut butter at room temperature was placed in a 3 cm^3 Luer lock disposable plastic syringe (Plastipak, Becton-Dickinson, East Rutherford, NJ, USA, Catalog BD 5585) with a small weighing spatula. A 15 gauge stainless-steel syringe needle, 10 cm long with 90° flat end and Luer lock hub (Unimetrics, Box 863, Joliet, IL, USA) was attached to the syringe. Peanut butter (0·5000–0·5050 g total weight) is deposited above the glass-wool plug on the inside wall of the direct gas chromatography sample tube in two to three strips about 3 mm wide, 1–2 mm thick, and 3·5 cm long using a short side-to-side motion as the needle is drawn up the tube.

The peanut butter sample tube prepared as above for direct gas chromatography was placed, with the glass-wool plug at the bottom, in the injection port inlet of a 7.12/Tracor 222 gas chromatograph. At a maximum inlet temperature of 127°C (Tracor) the sample was purged with nitrogen for 28 min at 20 ml/min carrier gas flow onto the top of a Tenax GC-8% polymetaphenylether column (8 ft × ⅛ inch; Ni 200) cooled to about 20°C with a wet towel. The sample cartridge was removed from the injection port after completion of volatiles stripping. To separate the concentrated flavor compounds the column was temperature programmed first to 50°C, held for 2 min, increased at 3°C/min to 225°C, and then held for a total run time of about 85 min. Data collection and analysis was accomplished with a Hewlett–Packard 3357 Laboratory Automation System computer. Baselines on computer reconstruction analysis of curves were used which followed the lower valleys of the profile. Each sample was run gas chromatographically in duplicate and means of peak areas used in tabulating results after checking standard deviations. Retention times and volumes of peaks from C_5 to C_{15} normal hydrocarbons, injected as above, were used to calculate Kovats indices for key marker compounds as well as unknowns (Kovats, 1965).

Statistical analysis

Analysis of variance was conducted to determine the differences among treatments for each descriptive sensory attribute, each peak from the gas chromatographic data and the components of the proximate composition on data. Significant differences were measured at $P < 0·05$. The sensory data analysis was a randomized complete block analysis with samples from all countries

presented in each session and the crop year and session effects confounded in the block effect. For sensory data and proximate analysis data, contrast statements were used to compare country means for a given crop year when a significant country by crop year effect occurred. If no country by crop year interaction occurred then the LSD mean comparison test was used to compare countries. Unbalanced treatment replication in the gas chromatographic and proximate analysis data mandated the use of least squares means analysis to compare means between countries within a crop year (SAS, 1988).

RESULTS AND DISCUSSION

Descriptive sensory flavor analysis

The analysis of variance for the flavor descriptors is shown in Table 1. The data for individual country by crop year treatment combinations along with mean comparisons are reported in Table 2. Each mean consists of 10 samplings from the country each year.

Roasted peanutty flavor was greatest (Table 2) in the peanuts grown in the USA. The USA 1987 and 1988 crops were significantly different than the China 1987 and 1988 crops, respectively, but the USA 1986 and the China 1986 crops were not significantly different. USA peanuts were significantly greater in roasted peanutty flavor than the Argentinian peanuts for each crop year. The Chinese peanuts had roasted peanutty intensities greater than the Argentinian peanuts for all crop years although in 1988 there was not a significant difference. It is not known if USA-grown peanuts had genetically enhanced flavor or if the cultural practices used in the USA result in this more intense roasted peanutty flavor. It was most likely a combination of genetics and cultural practices. Meanwhile, sweet aromatic varied from year to year and from country to country with no consistent trends (Table 2).

Sweet taste was significantly greater in the USA-grown peanuts than the China grown peanuts for all three crop years. Sweet taste was significantly greater in the Argentina-grown peanuts than the USA and China-grown peanuts for the crop years 1987 and 1988. There were not significant differences between the Argentinian peanuts and those from the other countries for the 1986 crop year. The Argentina-grown peanuts tended to be sweeter than peanuts from other countries and were greater in sugar content which correlates with this more intense sweet taste. The USA peanuts tended to be greater in sugar content than the Chinese peanuts, which was reflected by a sweeter taste as well.

Woody/hulls/skins is not considered an off-flavor, but when out of balance with the desirable flavors it is not a desirable flavor. It is almost always present in good-quality peanuts, but should be a background flavor and not a dominant flavor. The peanuts grown in China were greater in woody/hulls/skins than the USA-grown peanuts for each crop year. Woody/hulls/skins was significantly greater in the China-grown peanuts than the Argentina-peanuts for the 1987 and 1988 crop years, although, in 1986 there was no difference. The Argentinian peanuts were not significantly different from the USA-grown peanuts for the 1987 crop year, but were significantly less in intensity than both China and USA for the 1988 crop year. The peanuts grown in the USA had the most consistent intensities for woody/hulls/skins.

Cardboardy flavor was greater in the Chinese peanuts than in the USA-grown peanuts during all years sampled, although in 1986 and 1988 the differences were not significant. The Argentinian peanuts were significantly greater in cardboardy flavor than both the USA and Chinese for the crop year 1986. Chinese peanuts were significantly higher than USA peanuts in 1987. They were higher than Argentina-grown peanuts in 1988. The USA peanuts had consistently low intensities, while Argentinian peanuts varied greatly from year to year.

Painty flavor was consistently low in intensity for the USA grown peanuts. In the crop year 1986 the Argentinian peanuts had a significantly greater painty flavor than the USA and Chinese peanuts. In the 1988 crop

Table 1. Mean squares and coefficients of variation from the analysis of variance for descriptive flavor analysis[a]

Source	df	RPT	RBN	DRT	SAC	WHS	CBD	PTY	FFY	SWT	SOR	BTR	STY	AST
Year	2	1·03	3·00**	1·16**	1·33**	0·01	0·77**	0·27**	0·20	0·13	0·06	0·52**	0·04**	0·97**
Error A[b]	37	0·55	0·16*	0·17**	0·15	3·33**	0·11	0·07	0·11	0·09	0·07*	0·08**	0·01**	0·04**
Country	2	19·66**	0·81**	1·69**	2·15**	1·07**	1·14**	0·64**	9·15**	5·32**	0·40**	1·42**	0·01	0·18**
Year × country	4	1·58**	1·63**	1·44**	2·27**	1·29**	1·58**	1·23**	0·20	1·06**	0·50**	0·81**	0·01	0·11**
Error B[c]	132	0·37	0·10	0·09	0·13	0·03	0·01	0·05	0·16	0·06	0·05	0·04	0·01	0·02
CV[d]		13·22	12·98	12·24	12·43	8·37	61·36	88·34	53·07	11·83	20·44	11·49	7·60	6·57
Grand mean		4·6	2·5	2·4	2·8	2·2	0·5	0·2	0·7	2·1	1·1	1·8	0·8	2·2

[a] RPT, roasted peanutty; RBN, raw/beany; DRT, dark roasted; SAC, sweet aromatic; WHS, woody/hulls/skins; CBD, cardboardy; PTY, painty; FFY, fruity/fermented; SWT, sweet; SOR, sour; BTR, bitter; STY, salty; AST, astringent.
[b] Error A, session (year) or session nested within crop year.
[c] Error B, pooled residual error term.
[d] Coefficient of variation around country and year × country.
* Means are significantly different at $P = 0·05$.
** Means are significantly different at $P = 0·01$.

Table 2. Means[a] and statistical comparison of means within crop year for the descriptive flavor analysis data

Flavor	USA[b]	China[b]	Argentina[b]
Roasted peanutty			
1986	5·0a	4·0a	3·6b
1987	5·4a	4·6b	4·2c
1988	5·2a	5·0b	4·4b
Raw beany			
1986	2·8b	3·1a	2·3c
1987	2·1c	2·3b	2·6a
1988	2·2b	2·4a	2·4a
Dark roasted			
1986	2·3b	2·2b	2·5a
1987	2·6a	2·5a	1·9b
1988	2·8a	2·7a	2·3b
Sweet aromatic			
1986	3·3a	3·0b	2·6c
1987	3·0a	2·6b	3·1a
1988	2·6b	2·3c	3·1a
Woody/hulls/skins			
1986	2·1b	2·2a	2·4a
1987	2·2b	2·4a	2·1b
1988	2·2b	2·4a	2·1c
Cardboardy			
1986	0·3b	0·5b	1·1a
1987	0·4b	0·6a	0·5ab
1988	0·4ab	0·6a	0·3b
Painty			
1986	0·1b	0·1b	0·7a
1987	0·2a	0·2a	0·2a
1988	0·2b	0·4a	0·1b
Sweet			
1986	2·3a	2·0b	2·2ab
1987	2·0b	1·9c	2·6a
1988	1·9b	1·7c	2·6a
Sour			
1986	0·9c	1·1b	1·3a
1987	0·9b	1·2a	1·1ab
1988	1·1a	1·1a	0·9b
Bitter			
1986	1·7b	1·9b	2·0a
1987	1·8b	2·1a	1·6c
1988	1·8b	2·0a	1·4c
Astringent			
1986	2·3b	2·4a	2·4a
1987	2·2a	2·2a	2·1b
1988	2·1a	2·2a	2·0b
Fruity/fermented[c]	0·4c	0·6b	1·2a

[a] Flavor scores reflect intensity units of the spectrum scale (Meilgaard *et al.*, 1991).
[b] Means with the same following letter are not significantly different ($P = 0.05$) based on contrast comparison for each attribute. Comparisons are made by rows.
[c] Crop years are pooled because of lack of crop year by country interaction.

year the Chinese peanuts were significantly greater in painty flavor than the USA and Argentinian peanuts.

The fruity/fermented flavor associated with improper curing or drying, or freeze damage was significantly different ($P < 0.01$) among all three countries of origin with no significant country by crop year interaction. The peanuts grown in the USA had the lowest intensity of fruity/fermented (0·42 intensity) while the peanuts grown in Argentina had the greatest intensity (1·19). The intensity of fruity/fermented for the peanuts grown in China (0·62) was between those of the other two countries.

Sour taste in USA-grown peanuts was significantly less than that in Chinese and Argentinian peanuts for crop year 1986, and significantly less than China for 1987. In the 1988 crop year the Argentinian peanuts were significantly less sour than peanuts from the other two countries (which were not significantly different from each other). The Argentinian peanuts were not significantly different in sour taste from the Chinese or USA peanuts in the 1987 crop year, but they had a significantly greater sour taste than the Chinese and USA peanuts in the 1986 crop year.

Bitter taste was greater in the Chinese peanuts than the USA-grown peanuts for all crop years, although not significantly greater in 1986. The Argentinian and the Chinese peanuts were significantly different for all three crop years. In the 1987 and 1988 crop years the Argentinian peanuts were significantly less bitter than the USA and Chinese peanuts.

Intensities of astringent mouth feel were fairly consistent in the USA and Chinese peanuts over crop years, while the Argentinian peanuts exhibited an obvious decrease in astringent intensity from 1986 to 1988. In Table 2 the 1986, USA peanuts were significantly higher than the 1987 and 1988 crop years, but the actual difference is small. The Chinese peanuts were significantly greater than the USA peanuts in the 1986 crop year. They were not significantly different for the other two crop years. Argentinian peanuts were significantly less than China and USA for 1987 and 1988.

Dark roasted flavor was not significantly different between the USA and the Chinese peanuts for any of the three crop years. The Argentinian peanuts were significantly greater in dark roasted flavor than the USA and Chinese peanuts for the 1986 crop year and significantly less in the other two crop years.

Raw/beany flavor was significantly different among all three countries for all three years, although, the trends were different for each year. The USA and Chinese peanuts paralleled each other, the Chinese peanuts had a more intense raw/beany flavor for all crop years. The Argentine peanuts were significantly less in intensity than the USA and Chinese peanuts for 1986, but were significantly greater for the 1987 crop year. In 1988 the Argentinian and Chinese peanuts were not significantly different from each other in raw/beany flavor, and the USA peanuts were significantly less.

Proximate chemical analyses

Analysis of variance of the proximate analyses showed that country and country by crop year interaction significantly affected the component concentrations. Country and crop year means with mean comparison

Table 3. Means and statistical comparison of means between country within crop year for the proximate analysis data

	USA[a]	China[a]	Argentina[a]
% Lipids			
1986	50·8a	49·1b	48·2b
1987	51·6b	51·8a	48·4c
1988	41·6b	41·3b	47·8a
% Kjeldahl nitrogen			
1986	5·1a	5·1a	4·9b
1987	5·1a	5·3a	4·9b
1988	5·3a	5·4a	4·7b
% Sugar			
1986	5·4b	5·2b	7·2a
1987	5·5b	5·3b	7·8a
1988	4·8b	4·0c	9·2a

[a] Means with the same following letter are not significantly different (P = 0·05) based on contrast comparison. Comparisons are made by row.

(LSD) are given in Table 3. Argentinian peanut samples differed in proximate analysis (less fat, greater sugar, and less protein nitrogen), in comparison with the USA or Chinese samples for all 3 years. Sugar content between crop years was not significantly different. Moisture (not reported) was similar for all 90 samples for all three crop years, but to compensate for slight differences each sample was corrected for moisture. Results of quantitative proximate analysis for the peanut samples (corrected for moisture content) are listed in Table 3 as means for all the samples for each country within a year.

The trends in proximate analyses indicated that diverse origin samples vary in composition from year to year within country. Lipid content was lowest in the Argentinian peanuts in 1986 and 1987. In 1986 and 1987 the USA peanuts had greater lipid contents than peanuts from both Argentina and China. Nitrogen levels were lowest in the peanuts from Argentina. For

Table 4. Means[a] and statistical comparison of means within crop year for the gas chromatographic analysis

	Kovats index[b]	USA[c]	China[c]	Argentina[c]
Pentane/acetone	500			
1986		72·1b	119·8b	233·0a
1987		107·1b	186·4a	132·8ab
1988		177·8b	204·7b	339·4a
Methylpropanal	534			
1986		30·2ab	24·2b	35·8a
1987		27·4a	28·8a	22·8a
1988		39·1a	28·5b	44·3a
Methylbutanal	741			
1986		43·2b	40·8b	56·6a
1987		35·5a	39·4a	33·5a
1988		42·0a	33·5b	39·9a
Pentanal	779			
1986		3·5b	4·3b	6·1a
1987		2·4b	3·2a	2·8ab
1988		2·6b	4·5a	5·1a
N-Methylpyrrole	826			
1986		18·7b	16·2b	34·0a
1987		20·8b	29·3a	28·2a
1988		28·2b	29·5b	35·8a
Hexanal	860			
1986		10·6b	8·7b	25·5a
1987		8·4b	14·8a	8·6b
1988		9·6b	24·1a	14·2b
Hexanal/ methylpyrazines	909			
1986		4·7b	7·7b	48·9a
1987		6·9b	27·2a	9·6b
1988		11·5a	15·5a	14·2a
Dimethyl- pyrazines	1035			
1986		21·5b	14·7b	42·9a
1987		38·5a	39·9a	41·8a
1988		43·9a	35·5b	48·6a
Pentylfuran	1066			
1986		14·2b	15·1b	36·5a
1987		13·7b	22·3a	12·5b
1988		8·1b	19·5a	13·2b
Methylethyl- pyrazine	1165			
1986		28·9b	23·6b	52·0a
1987		32·0b	39·9a	34·0ab
1988		33·0b	35·4b	44·6a
4-Carbon substituted pyrazine	1238			
1986		32·5b	27·4b	54·7a
1987		55·7b	62·6ab	70·7a
1988		43·6b	42·4b	89·9a
RT: 52–54 min	1369			
1986		6·1a	8·6a	11·6a
1987		8·5a	13·0a	6·7a
1988		4·3b	13·7a	17·0a
Vinylphenol	1443			
1986		13·0a	15·5a	27·0a
1987		93·4a	86·7a	43·9b
1988		104.0a	95·2a	84·5a
Decadienal	1463			
1986		10·4b	17·3b	38·5a
1987		43·0b	61·8a	31·1b
1988		65·7b	75·0b	91·7a
RT: 58 min	1552			
1986		13·0a	11·1a	12·7a
1987		25·3a	24·7a	17·3b
1988		25·8a	21·1b	20·6b
Total volume (upper base line)				
1986		359·9b	381·8b	756·0a
1987		574·5a	744·7a	511·3a
1988		421·6b	745·0a	664·9a

[a] Integrater counts $\times 10^{-3}$ as FID response to GC peaks.
[b] cf Kovats (1965) for method of calculation.
[c] Means with the same following letter are not significantly different (P = 0·05) based on least squares means comparison for each compound. Comparisons are made by rows.

each crop year, the peanuts from China and the USA contained similar amounts of nitrogen. The Argentinian peanuts had the greatest concentration of sugars. Sugar content was slightly greater in the USA peanuts than the Chinese peanuts. Each country's growing conditions, climatic variations, and the peanut variety result in a distinct peanut product. How these factors affect the peanut quality is not known from this study.

Gas chromatographic analyses

The results of the analysis of variance of roasted peanut volatiles indicated there were significant differences between countries and for country by crop year interactions. Treatment means of key marker compounds in the aromas of roasted peanuts measured by gas chromatography from each of the countries for each crop year are presented in Table 4. In addition to 15 frequently identified compounds considered, the main component of the various peaks, total volatiles, were used to characterize the country effect, crop year effect and country by crop year interaction. Total volatiles encompasses the compounds that contribute to both desirable and undesirable flavors. The compounds that contribute to desirable flavors (pyrazines) do not increase much after roasting where undesirable flavor compounds (carbonyls) increase with storage. The total volatiles is a good indicator of peanut flavor quality. As differences in roast color are an indicator of optimum flavor production, relative quantities of these marker compounds are indicative of inherent flavor potential (Lovegren *et al.*, 1982; St. Angelo *et al.*, 1984; Crippen *et al.*, 1992; Vercellotti *et al.*, 1992).

Off-flavored peanut butters exhibit large peaks in their volatile profile that are not present or are less concentrated in the on-flavored samples. However, many compounds were present at concentrations below the detection limits of the instrument, and non-volatile, off-flavor components would not be detected by this method (Dupuy *et al.*, 1983). Thresholds of sensory perception (Stahl, 1973; Fors, 1983) for some compounds may be quite low and their impact great in the total flavor of the peanut butter while not being detected by gas chromatography. While improved preconcentration and separation by highly efficient capillary columns will permit better delineation of these low threshold peaks, for sake of the present study semiquantitative comparisons of volatiles patterns between roasted peanuts of comparative origin can be made with this method.

Gas chromatographic analysis means, shown in Table 4, indicate that the Chinese and Argentinian peanuts were more variable for volatiles that have been previously associated with off-flavors, such as hexanal (Buckholz *et al.*, 1980) while the USA peanuts were more consistent from crop year to crop year. The overall gas chromatographic profiles of the Chinese peanuts were quite close to those of the USA samples whereas Argentinian peanuts tended to have greater levels of off-flavor related compounds, such as pentanal.

Although the relationship between gas chromatographic marker volatiles and descriptive sensory intensities for specific flavor attributes of the peanuts is not fully defined, these data indicate that differences exist in characteristic flavor qualities among peanuts from the various countries for each crop year. This is particularly true with respect to known off-flavor compounds such as methylpropanal, methylbutanal, pentanal, hexanal, and decadienal. Although the GC data indicate that Chinese and Argentinian peanuts have higher total volatiles, in general, suggesting lower flavor quality, peanuts from China were actually of high flavor quality based on descriptive flavor analysis. The USA-grown peanuts were consistently low in total volatiles. Although gas chromatography can differentiate the individual samples on a per case basis, taking the mean of 10 samplings from each country in a given year signifies that the good-quality samples from these countries were diluted by low-quality samples.

CONCLUSIONS

This information established a benchmark for the flavor properties and chemical composition for comparison of international origins of peanuts. Argentinian peanuts tend to be more variable in flavor quality from year to year than USA or Chinese, which generally indicates the degree of crop consistency. USA-grown peanuts have lower intensities of off-flavors such as fruity and cardboardy flavors, and greater intensities of desirable flavors, such as roasted peanutty flavor, than the Chinese and Argentinian peanuts. On a comparative basis the proximate analyses of the Argentine peanut samples for all 3 years showed differences in lipid, protein nitrogen, and sugar composition which was quite distinct from the more similar Chinese and USA peanuts. In terms of gas chromatography roasted peanut volatile markers, the Chinese and USA samples were more similar and consistent than the Argentinian ones. Whether the volatiles differences were more a function of varietal, growing, or of postharvest treatment factors cannot be determined from this study. The flavor attributes—cardboardy, painty, and fruity/fermented—do not follow the country × crop year interaction trends predicted by concentrations of the off-flavor marker compounds. However, the data were indicative of distinct differences among peanuts from the various countries of origin.

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